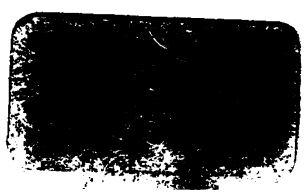

Colt, Samuel.

COLT

ON THE

APPLICATION OF MACHINERY

TO THE MANUFACTURE OF

ROTATING CHAMBERED-BREECH FIRE-ARMS.

ON THE

APPLICATION OF MACHINERY

TO THE MANUFACTURE OF

ROTATING CHAMBERED-BREECH FIRE-ARMS,

AND THEIR PECULIARITIES.

BY

COLONEL SAMUEL COLT, Assoc. Inst. C.E.

(TO WHOM
A TELFORD MEDAL WAS AWARDED,
SESSION 1851-52).

WITH AN ABSTRACT OF THE DISCUSSION UPON THE PAPER.

EDITED BY

CHARLES MANBY, F.R.S., M. Inst. C.E.
SECRETARY.

THIRD EDITION.

BY PERMISSION OF THE COUNCIL.

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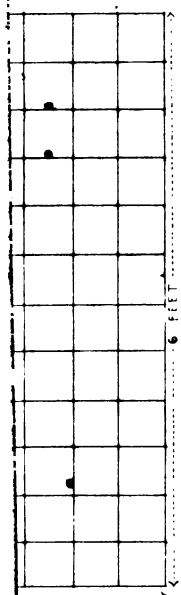
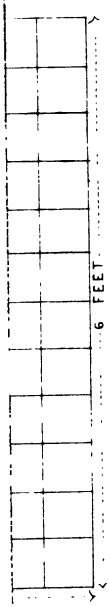
1855.

Description of Plates 1 and 2.

PLATE 1.

PLATE 2.





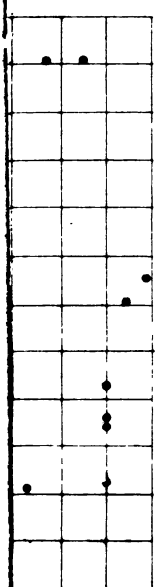


PLATE 2.

FIG. 2. — ARM COLT'S LARGE REVOLVING PISTOL.

Range	50 Yards
Number of shots (from a Rest)	54
Hit	54
Miss	0
Above	41
Below	13
Right	23
Left	31

FIG. 3. — ARM. COLT'S LARGE REVOLVING PISTOL.

Range	100 Yards
Number of shots (from a Rest)	64
Hit	37
Miss	27
Above	15
Below	22
Right	18
Left	19

FIG. 4. — ARM. COLT'S SMALL REVOLVING PISTOL.

Range	50 Yards
Number of shots (from a Rest.)	48
Hit	48
Miss	0
Above	25
Below	23
Right	33
Left	15

FIG. 5. — ARM. COLT'S SMALL REVOLVING PISTOL.

Range	50 Yards
Number of shots (from a Rest.)	18
Hit	18
Miss	0
Above	10
Below	8
Right	13
Left	5

INSTITUTION

OF

CIVIL ENGINEERS.

November 25, 1851.

SIR WILLIAM CUBITT, President, in the Chair.

No. 862.—"On the application of Machinery to the Manufacture of Rotating Chambered-Breech Fire-Arms, and the peculiarities of those Arms." * By COLONEL SAMUEL COLT (U.S. America), Assoc. Inst. C.E.†

AMONG the various departments of practical science, there is perhaps none in which more rapid advancement has been made within the present century, than in the manufacture of fire-arms, and great ingenuity has been displayed in devising improvements in them; but it is the extent to which machinery may be used in their construction, that must render the subject interesting to Engineers.

It is not the design of this paper to enter upon a history of the first employment of fire-arms, nor yet to trace all the gradations of improvement that have taken place, since their introduction as weapons of war, such a subject being somewhat foreign to the scientific views and peaceful occupations of Civil Engineers; but as experience has shown that perfect weapons of defence are indispensable for the pioneers of civilization in new countries, and still as necessary for the preservation of peace in old countries, the best means of producing them by the aid of machinery, must be interesting; it is therefore intended briefly to examine, chronologically, as far as recent researches extend, the gradual advances in the form and construction of fire-arms with magazines or chambers for repeated discharges, and to contrast them with the modern repeating chambered-breech arms introduced by the Author.

The principal collections of arms examined for this purpose are those in the Tower of London, the United Service Museum, the Rotunda at Woolwich, Warwick Castle, in England, and the Musée d'Artillerie, and the Hotel Cluny, at Paris; all these show that at all times and in all countries, the attention of armourers has been constantly directed to the subject, and much ingenuity has been displayed in the improvement of these engines of destruction, and as the use of gunpowder became better understood, and fire-arms were more generally employed, the desire to improve them increased, and their construction was materially changed. The chief progressive steps, after their first introduction, were, the hand-gun, the match-lock, the pyrites, or wheel-lock, the flint-lock, and the percussion-lock.‡

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* The discussion upon this subject was extended over a portion of two evenings, but an abstract of the whole is given consecutively.

† The Author was subsequently elected Assoc. Inst. C.E. May 4, 1852, and a Telford Medal was awarded for this Paper in the Session 1851-1852.

‡ The first small fire-arms were called Hand Cannons and were fired from a rest, by the application of a match; when their weight was further reduced and a match-lock

The Author had been aware since the year 1835, of the existence of ancient examples of repeating fire-arms, but it has only been on the occasion of his present visit to Europe in 1851, that he has been able to devote any attention to their chronological history, as exhibited in the specimens existing in the museums and private collections, to which he has recently obtained access. These specimens it is necessary to describe briefly, in order to render apparent the simplicity of design, the superiority of workmanship, the uniformity of construction by means of machinery, and the thorough efficiency of the repeating arms now submitted to the Institution.

The earliest specimen which the Author has been enabled to discover, is a match-lock gun now in the Armoury of the Tower of London, supposed to be of the fifteenth century (Fig. 1, Plate 1). It has a revolving breech with four chambers, mounted on an arbor parallel with, and welded to the barrel. The hinder end of the arbor is attached to the gun-stock by a transverse pin, or nail. Notches are made in a flange, at the fore end of the breech, to receive the end of a spring, fixed to the stock, and extending across the breech, for the purpose of locking it, when a chamber is brought up into a line with the barrel. The antiquity of this arm is evident, from the match-lock contrivance for igniting the charge, and the fittings, and mounting indicate an Eastern origin. Each charge-chamber is provided with a priming-pan, with a swing cover, which, before firing, would require to be pushed aside by the finger, to present the priming-powder to the match. A repetition of the fire is effected by throwing back the match-holder, and turning the breech by hand, to bring up another loaded chamber.

In the collection at the Musée d'Artillerie, at Paris, there are two specimens of match-lock guns, with revolving breeches, both of them being very similar to that which has been described; these have each eight chambers rotating by hand, and the covers of the priming magazines require to be pushed back by the finger before firing.

The next match-lock arm (Fig. 2, Plate 1) was found by the Author in the possession of Messrs. Forsyth and Co., who obtained it, about twenty-four years ago, from the late Lord William Bentinck, the Governor-General of India, whence it was brought with other curious weapons. The construction of this arm closely resembles that shown in Fig. 1, just described; but the workmanship is superior, and it is more elaborately ornamented. The breech, which requires to be moved by hand, has five chambers, each having a priming-pan with a swing cover. The arbor is attached to the barrel, which, at the end adjoining the breech, is enlarged to correspond with the diameter of the revolving chamber, to which it forms a kind of shield.

But in order to mitigate the danger, which was no doubt apprehended from the simultaneous discharge of all the chambers, by the spreading of the fire from the exploding chamber, which would be the inevitable effect of this shield, the maker has provided vents for the charges, by boring holes through the enlargement of the barrel, corresponding to the charge-chambers in the revolving breech. In one respect this gun gives evidence of progress, inasmuch as the breech-arbor is more firmly secured to the stock by two square pins, thus insuring a firmer connection between the parts. The method of locking the breech is similar to that of the first arm described (Fig. 1), except that the spring for securing the breech is fastened to the barrel instead of to the stock. The thinness of the metal of the

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was added, they were called Calivers. In a short time they were mounted on a stock, rendered more portable, and termed Arquebuse; the shorter arms of this kind being called Petronel, or Poitrinal, from their being fired from the shoulder, without a rest. The German Reiters introduced the Pistol, named from Pistoia, in Etruria, a place celebrated for the manufacture of that species of arms. The introduction of the Musket, the Rifle, and the various modifications of them, has been very gradual, but has been accelerated latterly, by the general determination to give long-range arms to the troops.—*Sec. Inst. C.E.*

barrels and the extreme length of the revolving chambers, in both these specimens of arms, would seem to indicate the bad quality of the gunpowder used at the period of their construction.

The third specimen is a decided advance on the preceding guns. This arm (Fig. 3, Plate 1), which was found in the Armoury at the Tower, is furnished with a pyrites wheel lock, and one priming-pan is common to all the six chambers of the revolving breech; this pan is fitted with a sliding cover, and is so arranged that the serrated edge of a vertical wheel may project into it, amongst the loose powder in the pan; to this wheel a rapid rotary motion is given, by means of a trigger spring acting upon a link lever, attached to the arbor of the wheel, the teeth of which, striking upon the pyrites, create the sparks which ignite the priming powder. The fire is then communicated laterally to a train of powder about 2½ inches long, before it reaches the charge in the breech, and which train of powder and priming require to be renewed each time before the charge in the adjoining chambers can be exploded. A stop-pin is made to enter the orifices in the wheel, to stay its action until the proper time, and on pulling the trigger the firing is effected.

In this instance, also, the breech is rotated by hand, and the barrel and breech are brought into contact by a nut working upon the threaded end of the breech arbor. By the employment of one priming-pan for all the chambers, and from the apparent necessity for closing the rear end of the breech with a cap, so as to leave but one small opening for the passage of the fire, from the priming-pan to the breech, the liability of the several chambers to be simultaneously fired was greatly increased; for the cap, which covers the rear end of the breech, prevents the escape of the fire laterally, and forms, in fact, a channel for guiding the deflected fire to the touch-holes of all the charges. This gun has no stock in front of the breech; but unlike the previous specimens, the barrel is cut away on each side, so as to allow the balls to escape in case of premature explosion. A pistol of nearly identical construction (Fig. 4, Plate 1) is in the collection at the Rotunda, at Woolwich.

In the Hotel Cluny, at Paris, there is an arm of the 17th century, with a pyrites lock and eight chambers, very similar in general construction to that found in the Tower, but differing materially in the arrangement of the touch-holes. There is one main priming-tube, extending from the pan to the rear of the revolving chambers, with eight corresponding tubes, extending from the rear to within a short distance of the front end, where an orifice is pierced into each chamber, for the purpose of igniting the charge immediately behind the bullet, thus obliging the charge to burn backwards, towards the breech. This arrangement, which was evidently made for the purpose of preventing the simultaneous explosion of the charges, has produced a construction of arm, almost identical with that of the modern Prussian needle-gun, for which the great feature of the more rapid ignition of the whole of the charge of powder has been claimed. The priming-tube and the pan, as in the arm at the Tower, require to be filled with gunpowder every time a chamber is discharged.

Fig. 5, Plate 1, represents an elaborately-finished Spanish gun of a more recent date, with a flint-lock. The breach is rotated by hand, and it is locked in the proper position for firing, by a pin, which enters a hole in the rear end of the breech, and which has to be drawn back, prior to bringing up a fresh chamber in a line with the barrel. The chief peculiarity of this gun is, that a magazine of priming powder is provided, immediately above a fixed priming-pan, which serves for the four chambers of the breech. The magazine is hinged to the pan and is fitted with a sliding bottom, which, when drawn out, is intended to allow a certain amount of powder to fall into the pan, and when pushed back cuts off the supply. The rear surface of this magazine serves also as the steel, or striking surface for the hammer,

and it is ribbed on its face to receive the blow of the descending flint. The fore end of the breech is closed in by a filling piece of wood, attached to the barrel, and the hinder end is enclosed in a cap, as in the last example. This arm is therefore like the others fatally defective, the priming powder in the magazine would inevitably explode; the priming fire would be conducted to all the other touch-holes, and the lateral fire, at the other end of the breech, would be directed into the several chambers, and explode all the charges prematurely.

In the Armoury at Warwick Castle there is a gun which appears to be an attempt to insure greater safety in firing, but at the expense of greater complexity of mechanism. It has a flint-lock and a breech with four chambers, to be rotated by hand; each chamber is furnished with a priming-pan, and a steel, which latter forms also the cover. The firing of one charge is not, therefore, so liable to ignite the powder in the other chambers. The stock in front of the breech is very thin, so as not to cover the other three chambers; consequently, if a premature explosion took place, no material injury could occur to the arm. The chambers would appear to have been fastened by a spring from the end of the barrel.

An arm very similar in construction to the last was found in the Tower of London (Fig. 6, Plate 1). The breech is composed of four distinct tubes, or chambers, attached together by two end plates. Each tube, or chamber, is provided with a priming-pan and steel, and the breech is rotated by hand. It is retained in the required position for firing, by a bolt acting upon the rear end, which is withdrawn, by hand, when the breech is required to be moved round on its arbor.

The specimen (Fig. 7, Plate 1), which appears from its construction, to come next in order of date, was obtained by the Author from Messrs. Forsyth and Co.; it bears the evidence of English construction, as on the lock is inscribed "John Dafte, London," in characters which indicate that it is scarcely more than a century old; it may, however, be a copy of an older arm. There is evidently an attempt, in this arm, to produce a more compact weapon, for instead of having a projecting pan and steel for each chamber, recesses are made in the periphery of the breech, to form pans, and one steel was probably provided to stand over the breech, attached to the barrel. The breech, containing six chambers, is rotated by hand, and is locked when in position for firing, in the same manner as in Fig. 3; priming powder is also placed in a pan for each chamber, whilst the weapon is being loaded; these priming-pans are each covered by a sliding plate working in parallel guides affixed to the periphery of the breech, with the intention of protecting, in a more perfect manner, the priming of the adjoining chambers, and thus preventing premature explosion. Connected with the hammer, is a small bar which projects forward, so that when the trigger is pulled, the hammer, in its descent against the steel, brings the small bar into contact with a projection on the cover of the upper priming-pan, pushing it forward, and exposing the powder in the pan to the action of the sparks struck from the flint of the hammer. This arrangement has the advantage of compactness, and in this particular it may be considered a mechanical improvement on its predecessors; the stock does not reach beyond the base of the breech, and the barrel is cut out in front of the chambers, to allow the balls to escape, in case of premature explosion. This arm bears evidence of being radically defective; for in consequence of the holder of the steel being fastened over one of the chambers, into which the fire would be deflected, premature explosion necessarily followed, the steel was broken off, and the arm was probably rendered useless by the first discharge.

In the collection at the United Service Museum, London, is a brass model pistol, with six chambers, said to have been constructed in the time of Charles the First. This specimen displays more ingenuity and greater skill,

in its design, than any of the early weapons hitherto discovered; but it is, evidently, only a model of a proposed construction, and has never been practically tested, as if it had been used, it would have been blown to pieces by the first discharge. In its general design it greatly resembles the arm last described; each chamber being provided with a similar priming-pan and sliding plate to cover it, and attached to the hammer is a bar, for pushing back the cover, and exposing the powder to the fire from the flint. A steel, for the flint to strike on, is jointed to the barrel, in the same place and in the same manner as in the arm, Fig. 7, Plate 1, and is consequently open to the same objections. The arbor, on which the breech turns, is screwed into the barrel and is attached to the stock by a pin passing through it. From this description, it will be understood that the model under consideration is tolerably free from the defects previously pointed out; but inasmuch as it possesses no means of regulating the contact of the breech and the barrel, so as to prevent the spread of lateral fire, it, like all the preceding specimens, offers no security against the simultaneous discharge of all the chambers.

It is not a little surprising that the next example of a rotating chambered-breech gun, with a flint lock, Fig. 8, Plate 1, patented by Elisha H. Collier (U. S. America), in 1818, should exhibit nearly all the serious defects which had doubtless been discovered, and had been, to some extent, remedied by the earlier makers. The objectionable parts of this arm are the priming magazine, the flue which would conduct the fire round to the different touch-holes, and the cap in front, which would direct the lateral fire into the adjoining chambers. The breech is made to bear against the barrel, by means of a coiled spring, which would probably be efficient while the gun was clean, and each chamber is recessed to receive the abutting end of the barrel, with the intention of effecting a closer junction. This bearing up of the chambered-breech against the barrel is maintained, during the firing, by a bolt which is thrust forward by a cam on the spindle of the hammer, when the trigger is pulled, and would be effective for a few discharges, until the junction between the cylinder and the barrel, or the arbor on which the cylinder turns, became foul. The valve, which forms the bottom of the priming magazine, is self-acting, and supplies a certain quantity of powder to the pan, when the magazine (which forms at the same time the cover of the pan, and the steel for the hammer to strike upon) is brought into its elevated position. In order to rotate the breech, the hammer is thrown back to half-cock, the breech is then drawn out of contact with the barrel, and another chamber may be turned up by hand into a line with it.

The arrangement of the flint-lock chambered-breech fire-arm, contrived by Wheeler of Boston, and patented by Cornelius Coolidge in August 1819,* differs from the arm patented by E. H. Collier (in whose patents Coolidge was interested), in having fastened to the chamber, and to the arbor, a coiled or spiral spring, which being wound up, is intended to constitute a power for assisting in causing the cylinder chambers to rotate, as by a complicated arrangement in the lock, an escapement motion was effected by the action of the lock itself. This arm possesses all the complication, and the imperfections of the worst of the other arms, with the same liability to premature explosion; and these defects have been admitted, inasmuch as E. H. Collier acknowledged that "in manufacturing these arms he improved the gun as he went on, and left out the spring because he thought it was useless;"—"he wanted to get rid of all superfluous parts, and left the spring out, because he considered the gun was better without it;" thus leaving the chambered-breech to be rotated by hand.

During the latter part of the last century many ingenious persons directed

* Vide "Descriptions des Machines et Procédés spécifiés dans les Brevets d'Invention, de perfectionnement et d'importation." Tome xi. p. 42. Paris, 1825.

their attention to the improvement of fire-arms, with a view to simplify their construction, to render them more effective, and to combine safety with celerity in firing.

Among some of the most important of these improvements, may be mentioned the peculiarly-constructed breech, patented by Mr. Henry Nock in 1787, and the application of fulminating powder for igniting the charge in the chamber of the barrel, for which the Rev. Mr. Forsyth obtained a patent in 1807. The principal objects of this latter invention were to supersede the flint lock, and to obtain the rapid and complete combustion of the whole charge in the barrel, so as to obviate the loss of force which formerly resulted from the escape of air through the touch-hole. Many ingenious contrivances have since been introduced by the manufacturers of fire-arms, of different countries, for simplifying the mechanical arrangement for firing by percussion, the adoption of which has now become general.

These improvements advanced-fire arms towards perfection; but still they laboured under great disadvantages, chiefly from the waste of time in reloading, which prevented the full extent of the rapidity of discharge that an ordinary gun constructed of iron or steel could endure, from being taken advantage of.

The Author, living in a country of most extensive frontier, still inhabited by hordes of aborigines, and knowing the insulated position of the enterprising pioneer, and his dependence, sometimes alone, on his personal liability to protect himself and family, had often meditated upon the inefficiency of the ordinary double-barrelled gun and pistol, both involving a loss of time in reloading, which was too frequently fatal, in the peculiar character of Indian border warfare.

By the United States' Government, also, it was considered an object of great importance to obtain an effective repeating arm, as the peculiar characteristic of the mode of attack by the mounted Indians, was to overwhelm small bodies of American soldiers by rushing down on them in greatly superior numbers, after having drawn their fire, and then to despatch them, whilst in a comparatively defenceless state, from the necessity of reloading their arms.

After much reflection and repeated trials he effected an arrangement in the construction of revolving fire-arms, without having seen, or being aware, at that period (1829), of any arm more effective than a double-barrelled gun having ever been constructed, and it was only during a visit to Europe, in the year 1835, that he discovered he was not the first person who had conceived the idea of repeating fire-arms with a rotating chambered breech.

The first arrangement, contrived by the Author, was the combination of a number of long barrels, to rotate upon a spindle, by the act of cocking the lock, and similar in construction to those now generally made; but from the weight and bulk of the arm it soon appeared better to have only a rotating cylinder containing several chambers, and to discharge through one barrel. For this he took out a patent in 1835, in which he claimed, as peculiarly his own, the arrangement, or construction, shown in Figs. 9 and 10.

Fig. 9, Plate 1, represents a pistol, exhibiting the mechanical combination of the arm at that early stage; the hammer is hung at the fulcrum A: the key-bolt, or catch-lever, which holds the cylinder, is hung at the fulcrum B. The lifter, to move the ratchet, has a working connection with the hammer on the left side, at C. The arm, D, of the lifter, works into the teeth of the ratchet, on the left: E, represents the ratchet when connected with the shackle. F, F, is the middle and forward part of the shackle, on which the ratchet is placed. G, is the arbor on which the cylinder revolves: the end H, is the nut that holds the arbor in its place when in the shield: I, I, represent the forward end of the arbor, which passes through the plate, and the projection on the lower part of the barrel, and the barrel is secured to the

arbor by a key at J. K, represents the fulcrum of the trigger; L, is the spring which forces the connecting rod against the end of the hammer: M, is the spring which forces the key that holds the cylinder: O, is the main spring. By drawing back the hammer, the pin P, operates upon the after end of the key-bolt, or catch-lever, that locks the cylinder and raises it, consequently, the other end R, is drawn from the cylinder, and the arm D, of the lifter begins to act on a tooth S, on the left side of the ratchet, which being connected with the cylinder by means of the shackle, turns until the next chamber is brought opposite the barrel. When the pin P, is relieved from the key by passing over its upper end T, the pin allows the end R, of the key to be forced by means of the spring M, into the succeeding ward of the cylinder: at the same time, by the action of the lower end of the hammer U, upon the connecting rod V, a forward horizontal motion of the rod is produced, when the end W, is brought in contact with the upper projection of the trigger, and forces it down to a proper position for the finger, when the claw X, of the trigger, hooks into the connecting rod, which holds the hammer, when drawn back, or set, by means of the end V, entering the lower catch Y, on the hammer.

On pulling the trigger to discharge the pistol, the connecting rod is drawn from the catch of the hammer, when the main-spring forces the hammer forward, the upper end striking the percussion cap; during which operation the lifter, by means of its lateral motion to the left, falls below a succeeding tooth on the ratchet: when by the lateral motion of the after end Q, of the key, which holds the cylinder, the pin P, of the hammer, is permitted again to fall below it. By repetitions of the same motion of the hammer, the same effect is produced until each succeeding chamber is brought round and is discharged.

Fig. 10, Plate 1, represents the principle of the invention as applicable to rifles and muskets. In order to set the lock, the fulcrum of the lever being at A, by drawing down the ring B, the end C, operates upon the rod D, of the hammer, whose fulcrum being at E, throws back its end F, when the trigger at G, whose fulcrum is at H, operates upon the catches of the hammer, at I, to hold the lock when it is set. When the end F, of the hammer, is removed from the adopter, whose bearings are at J, J, it is drawn back by means of the coiled spring K, until its end L, is drawn back sufficiently to allow the cylinder to turn. After the finger is released from the lever, when the lock is set, a small spring draws it back to its former place, to make room for the end D, of the hammer, so that its force may not be impaired. By pulling the trigger from the catch of the hammer, the main-spring, which is connected to the hammer by the stirrup O, forces its end F, forward against the end M, of the adopter, whose end L, is brought in contact with the percussion cap, placed upon the tube N, so as to explode the charge of powder. In loading the arm it is only requisite to draw the key J, which will liberate the barrel; then by drawing the key that locks the cylinder, which is effected by drawing back the hammer to half-cock, the cylinder may be taken from the arbor.

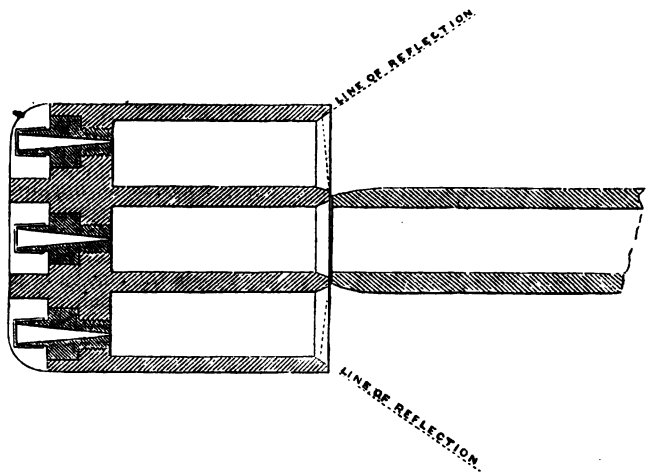
Fig. 11, Plate 1, represents a rifle made by the Author, in 1836, to rotate and fire by the continued action of the lever, or by the use of a trigger.

The arms so constructed, consisting of a large number of pieces, and assembled in a complicated manner, were soon found to possess many practical disadvantages, arising chiefly from the wish of the Author to construct compact and good-looking weapons. His original experiments had all been made on skeleton arms, solely with a view to utility, and in them there was not the liability to premature explosion, from the escape of fire at the mouth of the chamber, or by the intercommunication of the ignited detonating caps; but when he enclosed the rear and the mouths of the rotating chambers, the fire, being confined beneath the shield and the cap, was communicated successively to the percussion caps, and in front was conveyed into the cham-

bers, so that premature and simultaneous explosion of the charges necessarily took place.

In consequence of these premature explosions it became necessary to remove the shield from over the base of the chambers, and to introduce partitions between the nipples, or cones, to prevent the fire from spreading to and exploding the adjoining caps; but this only partially accomplished the object. There still remained risk of explosion from the spreading of the fire laterally between the base of the barrel and the face of the chamber. To meet this danger, the metal plate which was attached to the barrel and projected over the chambers, was removed: this obviated to a certain extent, but did not altogether prevent, the simultaneous explosion of the charges; for during a trial of the arm, by order of the American Government,* an accident occurred, from the simultaneous explosion of two chambers, which induced the Author, after much reflection, to give a slight chamfer, or bevil, to the orifice of each chamber, so as to deflect, or throw off at an outward angle, the fire which expanded laterally across their mouths. The reason for this alteration was, that when the lateral fire met the rectangular edge of the orifice of the chambers, the angle of incidence being equal to the angle of reflection, the fire was conducted downwards or inwards to the charge; but when the flame struck the chamfered edge, it was directed outwards away from the charge. This action is shown in woodcut (Fig. 1), and unimportant as this alteration may appear, it has proved so effectual, that if loose powder is placed over the charge, in the adjoining chambers, it is not now ignited when the pistol is discharged. These and other improvements have brought the fire-arm to its present safe and effective condition, and the Author believes that no casualty can occur, nor that more than one charge can be fired at one time if the metal is sound and the arm is properly loaded.

Fig. 1.



The early arms of the Author were made from 1836 to 1842, partly by hand-labour, and partly by machinery, by the Patent Arms' Company, established at Paterson, United States, where a capital of nearly £30,000 was expended without any beneficial result, except in gaining experience, both in the arms themselves and in the machinery required for their manufacture.

* Vide "Report of the Secretary of War, 25th Congress, First Session, June 1837."

About the year 1837 the Florida war broke out, when the Seminole Indians, retreating into the 'ever-glades,' defied the power of the United States' troops, and a comparative handful of savages resisted successfully for a long time all the forces sent against them. The Indians were as expert in the use of the rifle as their white invaders, who could make little or no impression on them: in this strait the Government applied to the Author, who went to the seat of war with a supply of repeating arms, which even in their then comparatively rude state were found so effective that more were ordered, and in the hands of the hardy Mounted Rangers, commanded by General Harney, who by their aid became the terror of the Red men, the war was soon brought to an end, for when the Indians saw their foes fire six times without lowering their weapons to load, they knew their former tactics were useless, and they surrendered. This success, however, though very glorious for the Government, was exactly the reverse for the Author, for by exterminating the Indians, and bringing the war rapidly to an end, the market for the arms was destroyed. They were, however, most successfully used by Commodore Moore, of the Texas Navy, as well as by Colonel Jack Hays and other distinguished Texan Rangers, during the wars with Mexico and the Indians from 1837 to 1848.

In consequence of the peace they were scarcely again employed, until the year 1847, when the Mexican campaign commenced, under the command of General Taylor, who having seen the utility of these weapons in Florida, where he was also in command, sent Captain Walker, of the Texan Rangers, to procure from the Author a supply of these arms: not one, however, could be procured, but by great exertion, commensurate with the exigencies of the period, a number were manufactured; and it has been stated that "those Texan Rangers, with Colt's repeaters, walked right into the towns and hamlets of the Mexicans and drove the population out against all resistance."

Colonel Charles A. May, the celebrated dragoon officer, in giving evidence respecting the arms said, "These arms were used with a great deal of effect, by General Harney, during the Seminole war; since then I have had them almost constantly; and at the commencement of the Mexican war, was fortunate in procuring some of them: by General Taylor's order I armed one of my squadrons with them, and found them very useful. When I went last into New Mexico, I armed all my force with them. They were used with great effect. They possess very many advantages over the ordinary arms. They have great precision, and are shot with great facility, accuracy, and force. They are much more efficient than the ordinary arms. They can be used very readily while on horseback, while at full speed, with great accuracy. I have found no difficulty in shooting a ball through a buffalo. I do not know whether the Texan Rangers in the Mexican war were armed with these pistols by the Government, but almost every one had them. They were very much dreaded by the Mexicans. The Texans use them with great precision. I have no hesitation in saying, that I consider that ten men with Colt's pistols in their belts, and who understand their use, can go anywhere, and can keep off almost any force. I should not hesitate, with ten men, armed with these pistols, to go anywhere across the plains."

Such is the general history of the weapon; and in the manufacture, numerous improvements naturally suggested themselves, both in the arms and in the tools used in their production, until the former assumed their present shape, and the latter almost entirely superseded hand-labour.

Figs. 12, 13, and 14, Plate 1, represent the arms as at present constructed, at the Author's manufactory, at Hartford, Connecticut, U. S. America. They differ from those formerly made, principally in the greater simplicity and the better proportions of the parts of the lock and the framework; important additions and improvements have been made in the loading lever, and rammer for forcing the balls firmly into the cylinder (Fig. 12, Plate 1), the employment of the helical, or spiral groove on the arbor on which the

cylinder turns, whose sharp edges are intended to prevent fouling, by scraping off any smoke, or dirt accumulating on the cylinder, from the lateral fire entering the centre opening; and the inclined plane leading to the recesses on the periphery of the cylinder, to direct the bolt below the opposite shoulder in the recesses; thus preventing the cylinder from being accidently thrown too far, by the sudden action of cocking. The lock (as shown by Fig. 15, Plate 1, which is a skeleton arm, expressly arranged to exhibit the working parts) is now composed of five working parts, instead of seventeen, as formerly, and it is obvious, that if the several parts of the machinery are made proportionally strong, for the work they have to do, so is the arm rendered more efficient by the greater simplicity of the general construction.

In all arms having a moveable breech, it is desirable to bring the barrel and cylinder as nearly in contact as possible, in order to prevent the escape of lateral fire, and yet to leave freedom for motion, without friction: this is now effected by the base pin, on which the cylinder turns, entering a corresponding opening in the under part of the barrel, being there held in place by a key, passing through and bearing against the back end of the slot in the barrel, and the fore end of the slot in the base pin, which is thus drawn up to the bottom of the hole, and yet the barrel is prevented from being brought too close upon, or in absolute contact with, the cylinder, whilst its end is still held in its proper position with respect to the cylinder. In the event of any abrasion of the end of the cylinder, or of the barrel, by deepening the cavity, or filing the end of the base pin, the key can be driven further in, and the proper distance for the readjustment of those parts be maintained, whilst the essential rigidity of structure is secured.

In loading the present arm, it is necessary to draw back the hammer to the half notch, to allow the cylinder to be rotated freely by hand; a charge of powder is then placed in each chamber, and the balls, without wadding, or patch, are put one at a time upon the mouths of the chambers, turned under the rammer and forced down, by the lever, below the mouth of the chamber. This is repeated until all the chambers are loaded. Percussion caps are then placed on the nipples, when by drawing back the hammer to the full catch, the click, or lever is brought into contact with one of the ratchet teeth, on the base of the cylinder, bringing the nipple into the precise position to receive the blow of the hammer: the arm is then in a condition for being discharged by simply pulling the trigger; and a repetition of the same motion produces the like results, until all the chambers are discharged through the barrel.

Machinery is now employed by the Author, to the extent of about eight-tenths of the whole cost of construction of these fire-arms; he was induced gradually to use machinery to so great an extent, by finding that with hand-labour it was not possible to obtain that amount of uniformity, or accuracy in the several parts, which is so desirable, and also because he could not otherwise get the number of arms made, at anything like the same cost, as by machinery. Thus he obtains uniformity as well as cheapness in the production of the various parts, and when a new piece is required, a duplicate can be supplied with greater accuracy and less expense, than could be done by the most skilful manual labour, or on active service a number of complete arms may be readily made up from portions of broken ones, picked up after an action.

To minutely describe and illustrate the machinery would absorb too much time, and render this paper too voluminous, there being hundreds of distinct operations, involving a great variety of peculiar contrivances and mechanical motions; a general descripton of the mode in which the various parts of the arm are manufactured, will suffice to render the system clear to engineers, conversant with the effect of machines; and the specimens (placed on the table) which are entirely formed by machinery, will illustrate the description.

The manufacture of arms, both in Great Britain and on the Continent, is carried on almost entirely by manual labour, the various parts being forged, filed and ground into the requisite form, by workmen at their own houses, the barrels alone being forged, bored, and ground, in manufactories established for the purpose, and machinery being employed only for cutting out the stocks. At the Government small arms manufactory, at Enfield, under the intelligent direction of Mr. Lovell, steps onward have, however, been made, in the use of machinery for some portions of the work. Still no general uniformity among the parts can exist, and in America, where manual labour is both scarce and expensive, it was imperative to devise means for producing these arms with the greatest rapidity and economy, and at the same time with such uniform precision, as could only result from the use of self-acting tools.

The machinery requisite for constructing the repeating fire-arms, though, at first view, like a cotton, or silk factory, apparently intricate, is in reality composed of the simplest elements, and consists in a repetition of known mechanical actions specially applied. It will suffice to describe the operations on a few parts, commencing with the lock frame, which is the basis of the whole, and to which all the other parts are adapted.

Like all the other parts, the lock frame is forged by swages, and its shape completed by one blow. The action of the machines commences by fixing the centre, and drilling and tapping the base for receiving the arbor, which having been previously prepared,—the helical groove cut on it, and the lower end screwed,—is firmly fixed into its position, furnishing a definite point from which all the operations are performed, and to which all the parts bear relation. The facing and hollowing of the recoil shield and frame; the cutting and sinking the central recesses; the cutting out all the grooves and orifices, planing the several flat surfaces, and shaping the curved parts, prepare the frame for being introduced between hard steel clamps, through which all the holes are drilled, bored and tapped, for the various screws; so that after passing through twenty-two distinct operations, the lock frame is ready for finishing by hand, which consists in merely removing the rough edge, or burr, left by the machinery, and giving it the last polish and hardening.

The rotating chambered cylinder is forged from a solid piece of steel, turned, channelled, tapped, polished, and engraved, and then the chambers are bored out by a machine, which insures the most perfect precision of dimensions and uniformity of relative position.

In the same manner, the barrel, forged solidly from a bar of cast steel, is bored and completed to calibre, and is then submitted to the various operations of planing, grooving the lower projection, beneath the barrel, with which the base pin is ultimately connected, tapped, and then rifled by a self-adjusting machine, which gives to the longitudinal grooves, the form of a contracting pitch spiral, commencing nearly straight at the lower end, and terminating at the muzzle in a curve of much smaller radius.

All the various parts of the lock are made by machinery, each having its relative initial point to work from, and on the correctness of which the perfection depends.

So with the stock and the mountings, the ramrod lever, &c., all are formed and worked by different sets of machines.

In fact, all the separate parts travel independently through the manufactory, arriving at last, in an almost complete condition, in the hands of the finishing workmen, by whom they are assembled, from promiscuous heaps, and formed into fire-arms, requiring only the polishing and fitting demanded for ornament.

A large number of machines is necessarily required for these operations; as it has been found advantageous to confine each one to its peculiar

province, rather than to employ any more comprehensive machine, for several operations.

By this system the machines become almost automatons, performing certain labour under the guidance of women, or children, and thus the economy and precision of the manufacture are insured.

The improvements which time and experience have gradually introduced, have at length brought this fire-arm to its present state, and have rendered it the reliable and efficient weapon for field-service which it has proved to be, in the actions between the American's and Mexican armies.

The official reports to Congress from the officers serving in that war, established the reputation of the arm, and this is confirmed by Major-General Taylor, late President of the United States, who, whilst commanding the American Army in Mexico, wrote in these terms to the Author:—

"I have been much pleased with an examination which I have made of your new-modelled repeating pistols, and feel satisfied that, under all circumstances, they may be safely relied on:" and this opinion is universally concurred in by the officers of the United States' Army and Navy, who have had ample opportunity of proving their efficiency in active service. Among others, Major Thornton, the Inspector of Fire-arms for the United States' Army, stated, that "After much firing and examination the Board of Ordnance adopted Colonel Colt's pistol for the service, as the best weapon presented for their consideration. Experiments showed, that six rounds of the pistol could be loaded and fired in a minute, with much greater accuracy and penetration than he had ever thought necessary for a pistol. A horseman could use it with one hand and have the other free to manage his horse. The dragoons and mounted riflemen should all be armed with these weapons, as in the hands of men accustomed to wield them, he considered them most efficient arms both for attack or defence."*

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* The "New Quarterly Review" for July 1852, contains the following apposite remarks:—"We must now advert to the 'repeating principle,' as applied to fire-arms in general, but more especially to pistols and carbines. It is to our transatlantic friends that we are indebted for the perfection of these weapons, for though, more than two centuries ago, various attempts were made to produce a series of successive discharges from one arm, without the necessity for reloading, it is to Colonel Colt's perseverance, energy, and mechanical skill, that the merit is due of having successfully vanquished all the difficulties that presented themselves in their construction.

"Innumerable were the objections he had to contend with at the outset. Military men sneered at the idea as preposterous. 'They would always be liable to get out of order'—'They would take too long to reload'—'They would besides always be missing fire,' &c. &c. The Colonel did not, as many under the circumstances would have done, sit down and wage an idle paper war with his opponents. He did better—he set to work and demonstrated, that they none of them knew anything whatever of the subject on which they were all so confident. It was, however, natural that prejudice should be roused against an innovation of the kind—no invention of any value was ever yet otherwise received.

"As regards the liability of the revolving pistol to get out of order, this was satisfactorily disproved, by a severe trial instituted by order of the Board of Ordnance of the United States, who directed a holster pistol to be discharged twelve hundred, and a belt pistol fifteen hundred times, cleaning them but once a day: after which ordeal neither of the pistols appeared to be in the slightest degree injured.

"With respect to the cost of production, as almost every part is formed by machinery, hand-labour being only required in the finishing department, Colonel Colt seems likely permanently to retain in his own hands the business which his ingenuity has created, for he will, of course, always be in a position to undersell any imitators that may appear. Greater security is also obtained from the same cause, for we find that, upon 'proof,' only one barrel and one cylinder burst out of 2,082 manufactured in the year 1850. The most perfect uniformity of detail is attained from the mechanism employed, for the several

Colonel Chalmers, R.A., has kindly furnished the diagrams of practice at Woolwich (Plate 2), made in the absence of the Author; with pistols taken indiscriminately from the Great Exhibition. They extend from the

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parts of each class of weapon are precisely similar, so that if any become damaged on service, a great number of available arms can be immediately compounded of those which have been partially injured.

"The ramrod attached to these pistols consists of a very clever but simple compound lever, which, forcing the ball effectually home, hermetically seals the chamber containing the powder, and by the application of a small quantity of wax to the nipple before capping, the pistol may be immersed for hours in water without the chance of a miss-fire.

"The movements of the revolving-chamber and hammer are admirably provided for. The breech, containing six cylindrical cells for holding the powder and ball, moves one-sixth of a revolution at a time; it can therefore only be fired when the chamber and the barrel are in a direct line. The base of the cylindrical breech being cut externally into a circular ratchet of six teeth (the lever which moves the ratchet being attached to the hammer), as the hammer is raised in the act of cocking, the cylinder is made to revolve, and to revolve in one direction only. While the hammer is falling, the chamber is firmly held in its position by a lever fitted for the purpose; when the hammer is raised, the lever is removed and the chamber released.

"So long as the hammer remains at half-cock the chamber is free, and can be loaded at pleasure. The rapidity with which these arms can be loaded is one of their great recommendations, the powder being merely poured into each receptacle in succession, and the balls being then dropped in upon it, without any wadding, and driven home by the ramrod, which of course is never required to enter the barrel.

"While carried in the pocket, or belt, there is no possibility of an accidental discharge of these pistols. Whenever it is required to clean the barrel and chamber, they can be taken to pieces in a moment, wiped out, oiled, and replaced.

"The hammer at full-cock forms the sight by which aim is taken. The pistol is readily cocked by the thumb of the right hand, a plan in every way far superior to the arrangement whereby the hammer is raised by a pull on the trigger: this is in every respect most objectionable, the pull materially interfering with the correctness of aim; and the sear-spring having the duty of the main-spring to perform as well, is apt constantly to be getting out of order. Not so Colonel Colt's; as regards the purposes for which they are intended they may be pronounced in every respect perfect.*

"The gallant Colonel has applied the same principle to a carbine, which, from the facility it offers for loading, is admirably adapted for cavalry.

"'Modern fire-arms,' observes an able contemporary, 'as used for purposes of war, are just now in a transition state. Since the invention of the percussion lock, but little attention has been paid in this country to their improvement. The ill-concealed contempt with which purely scientific attempts are received, by those who make their only boast of being "practical men," is nowhere so prevalent as in England, and accordingly we find, that while we have remained stationary, the great continental military powers and the United States have not only availed themselves of each improvement as it appeared, but have stimulated invention by liberal patronage. The result of this obstinate adherence to an antiquated system has, fortunately, not yet been tested by an European war. Can we doubt what would be the result of an engagement between two bodies of troops, one armed with the English musket and the other with the needle-gun, which, taking the number of shots only into account, is 3½ times as effective? Or, in the case of a frigate engagement, what would be the fate of any boarding party having to face a body of men armed with Colt's "six-shooters?" What an eager rush would there be to wipe off the burning disgrace! What sums would be squandered in trying to do that in a few months, which had occupied other nations years! The "practical men," no doubt, would attempt to console us, by calculating how many needle-guns and revolvers had got out of order during the campaign, and how bravely English soldiers stood up to be shot at by an almost invisible enemy.'

"As might be imagined, Colonel Colt's invention has called forth a host of imitations. We have examined and carefully tested these successively, and with the exception of two or three, found them to be all decidedly inferior to the American original, which, of course, being protected by patent, cannot be copied in its main essentials. Consequently, none of the English revolvers have either the lever ramrod, or the separation between the nipples, which Colonel Colt regards as most essential."

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* Since this article was first published, Colonel Colt has established in London a manufactory for his revolvers. The building he has fitted up for the purpose is the one at Thames-Bank, near Vauxhall-Bridge, lately in the occupation of the workmen engaged in making the mouldings, &c., for the New Palace at Westminster. In the Appendix, page 29, will be found a description of the manufactory, extracted from No. 218 of Charles Dickens' "Household Words," May 27th, 1854.

13th to the 21st of October, 1851, and exhibit extraordinary force and precision in firing.

With a large revolving pistol, at a distance of 50 yards, out of sixty shots, five shots traversed the bull's-eye of 6 inches diameter, and thirty-nine shots hit within a square of 2 feet. Fig. 1.

In another case, at 50 yards, out of fifty-four shots, forty-six shots were placed within 2 feet square, of which six were in the bull's-eye. Fig. 2.

In the next case, at a distance of 100 yards, out of sixty-four shots, thirty-seven balls hit the target, of which two traversed the bull's-eye, twenty-seven missing the target; indicating that the sights were arranged for a shorter distance. Fig. 3.

With the small revolving belt pistol, out of forty-eight shots, at a distance of 50 yards, twenty-five shots hit within 1 foot square, of which thirteen were in the bull's-eye. Fig. 4.

In another case, out of eighteen shots, at a distance of 50 yards, five traversed the bull's-eye, and all were lodged within 2 feet square. Fig. 5.

Further experiments will be made with these fire-arms, after being adapted to the standard percussion cap of the service, which the Author is preparing at the suggestion of the Board of Ordnance, as the present state of border warfare at the Cape, in India, and in other parts of the British Colonies, demands the adoption of repeating arms, and they must necessarily be adapted to the ordinary ammunition of the service.

The Paper is illustrated by a series of diagrams from which Plates 1 and 2 are compiled.

Colonel COLT, in answer to questions from the President, explained, that the course of this invention did not differ from that of almost every other innovation; it had to combat the prejudices of those using the old arms and the interested opposition of the manufacturers, and on that account he had been driven, not only to labour at attaining simplicity and efficiency in the arms themselves, but to contrive and adapt the tools and machinery for their production, with uniformity and rapidity and at the lowest cost. After he had undergone all the anxiety, labour and risk, attendant on bringing the arms to their present state, it was objected that the idea was not new, indeed that from an early period, repeating fire-arms with revolving chamber-breeches had been well known; he was now aware of this fact, but when he first commenced his experiments, he had not the most remote notion of anything of the kind having ever been previously attempted. At that time he was a very young man, and with only limited mechanical knowledge. His first invention was a fire-arm which would, in these days, be considered a very clumsy affair, although it was very similar to several of the weapons now being made in this country, and which were asserted to be superior to his pistols. It was necessary to explain, that the weapons first made were almost skeleton arms, but when he took out his patent and commenced their manufacture, the front end of the revolving-chamber was closed in, and the base end covered with a shield, to make the arm look well; the consequence was, that simultaneous explosion of several chambers frequently occurred, and this serious defect was only remedied by removing the plate, and the shield, and chamfering the orifices of the chambers. The first weapons also were made to be cocked and fired by the same action of pulling the trigger, but it was found impossible to take a certain aim with them, as it was necessary to exert as much force with the finger as would overcome the resistance of the main-spring in cocking, and the weapon deviated from the line of sight; besides which it could not be carried on half-cock and was liable to explode the cap, if it received any accidental concussion.

Fig. 16, Plate 1, a combination of a bowie-knife and repeating pistol, made in 1836, would explain what he meant, and show how objectionable such an arrangement was in practice. Another modification consisted in having a ring trigger beneath the lock, on pulling which the hammer was raised and the chamber rotated, whilst the gun was fired by pulling an ordinary trigger. This construction required four or five additional parts in the lock. At last the present simple arrangement was arrived at, and he believed that it was almost impossible to have an accident, from the simultaneous explosion of several caps, or chambers, or to injure the weapons, without subjecting them to very rough usage, and the perfection of their fitting was so great, that they had been fired after immersion in water, or lying in the open air for a length of time.

The Honourable ABBOTT LAWRENCE, U. S. Minister, said, no words of his could so emphatically or thoroughly express the general approval of these arms, as the Report to Congress of the Committee on Military Affairs, printed January 30, 1851, wherein it was stated, that experience had proved how difficult it was to contend successfully against savages with the usual arms of mounted men, the ordinary dragoon pistol and carbine; whilst General Harney, an experienced officer, who had successfully used Colt's arms in Florida, stated, that they were the only weapons with which the United States' troops could ever hope to subdue the wild and daring tribes, against whom they were called to act; but that with them, a few bold men, well skilled in the use of these weapons, could encounter and scatter almost any number of savages.

Being a civilian, Mr. Lawrence only knew the merits of these weapons from general reputation, and from their having been adopted by the United

States' Government, after long trials and considerable experience in their use. In the army generally, they were considered the most efficient weapons ever introduced, particularly for border warfare, against savage tribes, whose cunning, hardihood, courage and skill, rendered them very formidable enemies. It was his opinion, that the British troops would never successfully oppose the Kaffirs, until they were supplied with these repeating fire-arms, and he was much gratified that one of his countrymen should have produced a weapon, which was admitted, as far as it was yet known in Europe, to be superior to any other arm of the kind; and he was assured, this gratification would be participated in by all around him, as they must remember, that the British and the Americans were brethren, sprung from the same Anglo-Saxon stock, speaking the same language, and inheriting the same feelings which animated the subjects of these realms. He felt convinced, that the arm would have a fair trial in England, that no undue prejudice would be permitted to prevail, and that the invention would be examined and tested as if it had been brought forward by a British subject. There was room enough for inventions of all countries, and all that could be desired was, that in a fair and proper spirit of rivalry, this invention should be considered and examined with that good feeling and kindness which should animate all men, in the great cause of promoting the arts and sciences, and the application of science to art.

When he came to the meeting he had not any idea of being called on to express an opinion, but having risen, he must thank the members for the manner in which they had received his countryman's paper, and he trusted, that though apparently a warlike subject, its discussion would be as productive of harmony in the Institution, as the general use of the weapons in warfare would certainly be productive of peace, for the most effective weapons were the most efficient peace-makers; and though he was himself a peaceable man, in every sense of the word, he was convinced that to maintain peace it was necessary always to be prepared for war. Every improvement in fire-arms, therefore, reduced the cruelty of war, and tended to the perpetuation of peace, and hence he should be an advocate for any improvement, which would tend to diminish the ravages of war, whether between civilized nations, or against savage tribes, in the now inevitable spread of the white man, in his course of emigration.

Commodore Sir THOMAS HASTINGS, R.N., regretted, that he could add but little interest to the discussion, as the paper had fully described the weapon and its merits: he must however state, that Colonel Colt had afforded the officers of the Ordnance every facility, for obtaining a complete knowledge of its merits, or defects, and he believed the general impression was, that no fire-arm of that size ever possessed so much power. It must be acknowledged, that war was a great evil, particularly between civilized nations, but it was equally true, that giving the utmost perfection to the weapons used, was the surest manner of annihilating modern warfare. It was well known, that in some of the great battles of the ancients, more combatants fell, than during a whole campaign of modern armies; and in the battle of Lepanto, the last great hand-to-hand fight, fifty thousand combatants fell, which exceeded the numbers killed in all the naval engagements of the last and present centuries. Every step towards perfection in weapons of war, was a humane improvement, and on that ground, independently of the necessity of arming the troops in the most efficient manner, the attention of the Ordnance had been carefully directed towards these and other improved arms, and the result of the trials had been to convince him and other officers, that they had rarely seen better practice, than with Colt's pistols. The ordinary infantry musket was considered a useful weapon at one hundred yards, but beyond that distance, it was mere random firing; now Colt's large pistol was equal in effect to the musket, at that range, and for use against savage

tribes it must be a most effective weapon. The tactics of the Kaffirs were to tease an outpost sentry, at a distance, until they had drawn his fire, and then to spring on him before he had time to reload; and in attacking a convoy, which was generally done in a defile, a rush was made, which induced the fire of the whole guard, and the men were left defenceless, except by the bayonet, which was not effective against long lances, or assagais. Now nothing could be more perfectly adapted to meet these tactics, than the revolvers, because after the savages had received the musket shots, they would rush up in a body to close quarters, and thus render the effect of the pistols more certain. After a few experiments of this kind, the savages would have become acquainted with the nature of the weapon, and the convoys might almost be sent without escort. He was of opinion, that these arms would be found extremely useful for troops on special duty, and eventually it might be advantageous to introduce them generally into both services.

Captain Sir E. BELCHER, R.N., said, that some time ago he was in Texas, among the American troops, and there saw Colt's revolvers used with great effect and precision, and had never heard of an accident occurring from simultaneous explosion of the chambers. They were generally used by the Mounted Rangers, who appeared to rely on them, for their effective attacks on the enemy.

He would suggest to Colonel Colt, whether it might not be advantageous so to modify the form, as to make the breech end of the barrel conical, and to introduce it into the mouth of the rotating chamber, in order to prevent the loss of power arising from the present escape of lateral fire, between the chamber and the barrel, and to throw the fire obliquely forward. In the old Chinese jinghals this arrangement was made, evidently from experience of its utility.

Colonel COLT explained, that such an arrangement, as had been suggested by Sir E. Belcher, had been tried, and was in fact now used in some of the imitations of his revolvers, but it added to the complexity of the weapon, which he had desired to reduce to the utmost simplicity; and it was not found, in practice, that any serious loss of power resulted from the small escape of the lateral fire, that actually took place in his revolvers, as from the accurate fitting of the several parts, the mouth of the chamber was brought into very close proximity with the base of the barrel, and yet permitted the free rotation of the chamber.

Sir THOMAS HASTINGS agreed with Colonel Colt, that there was not any necessity for the arrangement suggested by Sir E. Belcher; since everything which detracted from the simplicity of construction of the weapon, must be prejudicial to it; and the essential difference between the Chinese jinghal and Colt's revolver was, that the former was a cumbrous, unwieldy instrument, whereas in the latter there was, in the least possible compass, a weapon which, in the hands of men conversant with its use, would do as good service as the ordinary musket, and could throw five or six balls without stopping to reload. The reports of trials made under the superintendence of the Officers of the Board of Ordnance, clearly pointed out these advantages, and those gentlemen acted so conscientiously and made their reports with such fidelity, that perfect reliance could be placed in all their statements. He made these observations, because he saw on the walls some diagrams of the firing at targets, at Woolwich, which corroborated his opinion of the utility of these arms; and it was only justice to Colonel Colt to do so, as since his arrival in England, that gentleman had afforded every facility for the perfect understanding of the arm of which he was the inventor.

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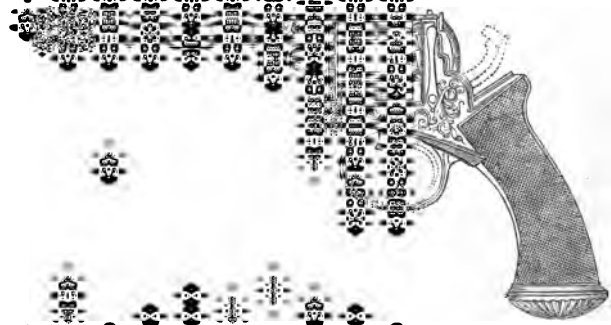

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spring; the toothed ratchet
screws, so as to admit of its

being renewed, when it was abraded by use, and motion was given to it by a ratchet pall, connected with the hammer, which was lifted by pulling the trigger. The hammer moved on a transverse pin, and was pressed down on the nipple by a back spring in the stock, being connected with it by a swivel link; the trigger was kept in position by a horizontal bent spring, and had attached to it the hammer-lifter and the ratchet pall; the point of the former fell into a notch in the base of the hammer, so that as the trigger was pulled, the hammer was raised, until the rounded portion of the base, acting as a cam, forced the lifter out of the notch, and allowed the hammer to descend on the nipple and to explode the percussion-cap. On withdrawing the finger from the trigger, the lifter and ratchet pall descended and again slipped into the notches of the hammer and the chamber, in readiness for repeating the operation of firing. The lifter was retained in contact with the hammer, by a small flat spring, the upper end of which was attached to the pall, while the lower end acted upon the lifter, which, in turning on its centre, brought the lower prolongation against the spring, below the centre, so as to press the upper end in the proper direction, in order that its action might be certain.

The rotation of the chambers was obtained by a ratchet pall, acting on a tooth each time the trigger was pulled, thus causing the chambers to revolve, so far as to bring a nipple into the proper position for receiving the blow of the hammer, and in that situation it was held by a projecting stop on the back of the trigger.

In order to load the chambers it was necessary that they should revolve free of the stop: this was effected by pressing inwards another stop, attached to a spring on the side of the lock, which engaged the point of the hammer and prevented it from descending on the nipple until the chambers were loaded, when, on the trigger being pulled, the side spring stop was released and resumed its original position, leaving the weapon ready for action.

The bullets were cast with a small 'tang' on them, which served to fix a wad on each; thus no ramrod was required in loading, the bullets being merely pressed in with the finger. The aperture of the barrel was slightly expanded at the lower end to admit of the bullets entering more readily in firing. The rifling of the barrel was the reverse of the ordinary system, as it consisted of three projecting 'feathers,' or ridges, extending the length of the tube, leaving very wide grooves between them.

It would be observed, that the cocking and firing were performed by the same action of the trigger; therefore the rapidity of firing was proportionally great; the arm was very light, its construction simple, and its action certain.

With respect to the mode of manufacture, every portion to which self-acting tools had been found applicable, was planed, bored, turned, slotted, and rifled by machinery.

Mr. A. B. RICHARDS inquired whether the principle of the weapon just described by Mr. Adams was not identical with that brought before the public many years ago in connexion with a pistol with five or six revolving barrels, which he believed had been laid aside, because it was found, that after being used for a short time, the spring did not retain sufficient power to bring down the hammer with force enough to explode the cap, and if the spring was made stronger, it required the exertion of so much strength that the weapon was depressed in firing, and taking a correct aim was nearly impossible? There did not appear to be any advantage in the power of firing so rapidly, as on service it was certainly not necessary to put five or six bullets into the same adversary, and whilst directing Colt's revolvers from one point to another there was no difficulty in cocking the pistol with the thumb, using only one hand.

He begged also to ask, whether a paper, headed "Experiments with Fire-arms," dated "Woolwich, 10th September 1851," purporting to be a report

of some trials of Colonel Colt's and Mr. Adams' revolvers, was issued officially, as the results were very different from those which were generally understood to have been attained; and as the paper appeared to have been extensively circulated, it was well to arrive at a true understanding of its value?

Sir T. HASTINGS stated, that so far as he was cognizant of the matter, no report of the comparative merits of Colonel Colt's and Mr. Adams' revolvers had been officially published by the Board of Ordnance.

Captain RIDDELL corroborated the statement of Sir T. Hastings.

The SECRETARY, at the request of the President, read two communications from Colonel Chalmers, R.A., relative to the diagrams of practice with Colonel Colt's arms,* permitted by him to be transmitted to the Institution, in which he stated, "I have seen the printed document entitled 'Experiments with Fire-arms,' as published by Mr. Adams; it is not official."—"I have for some time had two of Colonel Colt's revolvers under severe trial, and with good caps they never miss fire."

Mr. PLINY MILES said, the principle of construction of Mr. Adams' revolver had been tried in America long ago, and had been abandoned. Colonel Colt had at one time fallen into the error of using it, as was evident from the bowie-knife pistol exhibited. Mr. Miles carried a weapon like that described by Mr. Adams, for nearly two years, in the Western States and the Valley of the Mississippi, but he could never make it a serviceable arm, as it required the exertion of so much strength in the finger to revolve the cylinder and lift the hammer by the same pull on the trigger as fired the charge, that the muzzle was almost invariably depressed, or turned out of range, and he never could be certain of hitting a mark; he therefore got rid of it, and purchased one of Colt's revolvers, which he found just as effective as the other was inefficient. He now rarely missed a shot, even at birds, and the revolving of the cylinder being performed by the operation of cocking, the firing could be rendered almost as delicate as by a hair-trigger, so that the most accurate aim could be taken.

Mr. C. MAY, as the only member of the Society of Friends present, rose to order: he thought the meeting had erred in quitting the question of the mode of manufacture of these weapons, for a discussion upon their relative merits, or their destructive qualities, which, he submitted, were not proper topics for the Institution of Civil Engineers; he thought all weapons might be dispensed with, except for protection against wild beasts.

From an examination of the specimens before the meeting, he was of opinion that the machinery used in the manufacture was not of the accurate description generally employed in this country, the tool-marks were more evident than in the machine-made work produced at Manchester, and no information had yet been given as to the price of production. He begged Colonel Colt to give such information on these points as he considered could with propriety be imparted to the meeting.

Mr. RENDEL, *V.P.*, agreed with Mr. May, that the efficiency of the arms was a question which would be more properly considered by the authorities at Woolwich; it would be more interesting to the meeting to know what kind of machinery was used in the manufacture of the arms, and to be informed what process each piece went through in arriving at the state to form component parts of so apparently well-constructed a weapon as that now submitted by Colonel Colt, who he would beg to enter into such details as he judged fit relative to the manufacture.

Colonel COLT said, he thought the process of manufacturing had been as fully described in the paper as could be done without prolixity: he would,

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* Vide ante p. 15, and Plate 2.

however, revert to whatever had been omitted in the paper, or in the previous part of the discussion; but it was scarcely practicable to give a clear idea of the process of manufacture without diagrams of the machines employed, and even they would hardly convey a correct impression of the action of such tools.

Each separate piece of the arm was forged hot under swages, and then underwent a series of operations in machines, each adapted especially for one peculiar service. This had been found more economical than using comprehensive tools, and a greater degree of uniformity of structure was obtained. The mode of proceeding with one part would give an idea of that for all the rest. Taking, for instance, the lock frame; the swaged block of metal was held in clamps, and the centre hole drilled and tapped for the base pin, which was then inserted, in order that each subsequent operation should have relation to, and accord with the position of that part of the arm which served as a common centre. The lower inside curve was then cut, the various slots, grooves, spring bearings, &c., were cut through clamps, by which the piece was presented to the various automaton machines, and last of all, the operations of centring, drilling, and tapping all the holes were performed, also, under the guidance of clamps. That piece passed through twenty-two distinct operations, and after leaving the last machine it was only requisite to remove by hand the rough edges left by the tools; thus a clear idea could be formed of the amount of manual labour employed.

In making the cylinder, or chamber, which was also forged from a block of steel, annealed, the centre hole was first drilled, then the exterior was turned and engraved (also by a machine), then the ratchet teeth were cut out of the solid metal, because it had been found that the ratchets, which were attached by screws, were apt to get loosened by service, and the arms were rendered inefficient and dangerous; the holes for the nipples, and the charge chambers were then bored on a kind of universal chuck, the muzzles were chamfered, the stop grooves cut and the cylinder was completed fit for use.

The barrel forged solid, by swages, from a bar of steel, was first bored and then rifled by a very simple machine, in such a manner as that the groove, at the breech end, was almost straight, and gradually contracted the pitch to a sharp curve at the muzzle, to give to the bullet the proper rotation in delivery; the exterior of the barrel was then finished in the various machines and the lever ramrod was attached.

It was unnecessary to extend this kind of description of processes, which would be readily understood by all engineers, and it must be evident that a degree of uniformity and precision was arrived at, which could not be attained by any other means. Nor could the quantity required be produced by manual labour: in his factory at Hartford, there were now thirty thousand weapons in various stages of progress, and the demand was so great, that he contemplated increasing the number to fifty-five thousand, to meet the requirement of the market; three hundred persons were employed, and about one hundred arms were finished per diem.* This must be evident proof of the paramount necessity for machinery, wherever combination might interfere with the work being done, and more especially in a country like the United States, where manual labour really could not have been procured, to produce such a quantity, independently of the great merit of the positive uniformity of the arms, which had been proved, by picking up the disabled arms after an action, when seventy-five per cent. of perfect weapons were readily made up fit for use.

* It has since been stated, that by further subdivision of the operations, and by additional machinery, two hundred and fifty pistols have been finished per diem, or fifteen hundred arms per week have been completed at the Hartford factory, by less than five hundred workpeople.—*Sec. Inst. C. E.*

In round numbers it might be stated, that supposing the cost of an arm to be 100, of this the wages of those who attended to, and passed the pieces through the machines was 10 per cent., and those of the best class of workmen engaged in putting together, finishing and ornamenting the weapons, was also 10 per cent.: thus leaving 80 per cent. for the duty done by the machinery.

The weights of the several weapons were—

	lbs.	oz.
The Army, or Holster Pistol	4	4
The Navy, or Belt Pistol	2	6
The Pocket Pistol, 6-inch Barrel . . .	1	12
Ditto 5-inch Barrel . . .	1	10
Ditto 4-inch Barrel . . .	1	8
Ditto 3-inch Barrel . . .	1	6

Mr. HODGE was happy to have an opportunity of adding his testimony to the merits of Colonel Colt's weapons, and to the simplicity and effectiveness of the machinery employed in their manufacture. The skill displayed in the design of the various machines was very remarkable, but it was evidently the result of necessity, arising from the difficulty and expense of obtaining skilled labour in the United States: this had stimulated the inventive faculties of all engaged in mechanical pursuits, and as a general rule, nothing was made by hand that could be executed by machinery. Perhaps one of the most striking evidences of practical skill was the variety of crooked cutters used for shaping, not only in Colonel Colt's armoury, but in all the machinery factories in America, and it would answer the purpose of English manufacturers, to send an intelligent foreman over to the States, to examine what was now being done there. The gunmakers at Birmingham might certainly learn much from studying Colonel Colt's system of manufacturing, and their work would be produced at infinitely less cost, if they abandoned the system of employing a number of men, each working independently in his own ill-lighted, badly-ventilated, and inconvenient workshop, forming and filing up, without any uniformity, parts of arms, which would be produced in much larger quantities, in less time and with perfect identity of form, by the simple machines used by the Americans.

He thought much was due to the greater amount of intelligence to be found among the working-classes in the States, than among the corresponding class in England. Most of the American mechanics were not only good handicraftsmen, but from their habits of thought and determination to 'go ahead,' were continually devising means of executing their work with rapidity; thus new machines were constantly invented, and the education and intelligence of the working-classes increased daily, because there was stimulus enough for thought and a consciousness in the mind of every man, that there was an ample field before him, in which he must prosper, if he used any exertion. It was ardently to be hoped, that by the extension of education among the working mechanics in England, the intelligence and inventive genius, which at present appeared confined in a great measure to a certain class, would extend to the working mechanics, whose manual skill was beyond all praise.

Colonel COLT, in answer to questions by Professor Cowper, explained, that the majority of the tools used were revolving cutters, at a slow speed for heavy coarse work, and with great velocity for fine finishing, or light operations; in slotting, shaping, and drilling, the tools were guided by steel clamps, which insured that uniformity in the several parts, which was one of the distinguishing features of his manufacture. Special machines were used for all special operations, as general planing machines had not been found advantageous.

Mr. HODGE said, that although revolving cutters were certainly used in

machine shops in England, they were not employed to the extent they might be; it was, however, the use of the shaping cutter that should be more extensively introduced; he had never seen such good work in any factory as in Colonel Colt's, and it must be entirely attributed to the judicious use of the tools he had mentioned.

The machine for rifling two barrels at the same time, by means of an excentric wheel, was very beautiful, and he must repeat his regret, that machines were not more used in the manufacture of arms in this country.

Mr. EVANS stated, that in the year 1822, he manufactured a number of flint-lock revolving chambered-breech fire-arms, for Mr. E. H. Collier, whose patent, with that of Mr. Coolidge, had been mentioned in the paper.* Those arms were chiefly made by machinery which was still in his possession.

Mr. Evans had also made machinery for the Government establishment at Enfield, by order of Mr. Lovell, Inspector-General of Small Arms, and the arms made there were, to a considerable extent, produced by those machines.† The rifling especially was so executed, and the machine permitted the pitch of the groove to be varied, according to the will of the operator.

Mr. HODGE expressed his gratification at hearing from Mr. Evans, that machinery had been introduced into the Government Small Arms Manufactory, as Mr. Hodge had suggested it to Mr. Evans six years ago, and had for some time pressed it unavailingly on his notice.

Mr. C. MAY begged to inquire of those who were well acquainted with the working-classes in both countries, whether it was their deliberate opinion, that the American mechanics were better educated than their brethren in England? He had not been in the States; but from all he could collect he had arrived at the conviction, that the best English mechanics were better than the Americans; and he must say, that no work he had ever seen from America was equal to that produced in the machine shops of Manchester, Leeds, and other places, enjoying a reputation for good work.

Mr. GLYNN was much inclined to agree with Mr. May; and the eminence so frequently, and at times so rapidly, attained by English mechanics, would seem to corroborate those views: indeed there was scarcely any field in which more men had risen to distinction, by the exercise of skill and talent, than in civil and mechanical engineering. This could not be the case, if they had not education as well as innate talent.

Mr. HAWKSHAW was of opinion, that if the term 'education,' meant 'book-learning,' the working-classes in America, particularly in the cotton factories, possessed a greater amount of education, than the corresponding class in England; but if 'education' meant the special instruction, which enabled a working mechanic to perform his daily labour, with credit to himself and with profit to his employer, the English mechanics were the better-educated class. He, however, thought, that as far as general education was concerned, the American workman might be considered as more advanced.

Mr. J. SCOTT RUSSELL apprehended, that the comparison must be drawn between the better men of the working-classes, and not between the mere handicraftsmen, who he believed to be nearly identical in attainments in both countries. He thought that Mr. May must have formed his opinion from observations made at that paradise for the workmen, the works of Messrs. Ransomes and May, at Ipswich, where they were generally better educated, better conducted, and better cared for, by their employers, than

* Vide ante page 7. † Vide ante page 12.

in almost any other establishment he had ever visited. Now Mr. Russell did entertain some alarm as to the ultimate position of English mechanics, with respect to that of the workmen in Prussia and in other parts of the Continent. For the last fifteen years, the artizans of Germany had been receiving an amount of education, which could not fail, eventually, to render them formidable competitors, unless the English workman added education to his present almost matchless manipulative skill. He was glad that the subject of the education of the working-classes had been mentioned at the Institution, because he felt assured it was from thence that the first movement should emanate, for the introduction of a comprehensive scheme of education for that valuable class of men, the English mechanics.

Mr. W. B. ADAMS said the men worked harder in the United States, under the influence of better wages, but he did not think the produce was generally so well finished as in England. There was certainly room for a greater extent of education among the working mechanics here, and more especially for instruction in the mechanical principles of the tools and machines, the application of which was their daily occupation. The employers would find great benefit result from encouraging and even enforcing education among the working-classes.

Mr. HEPPEL said, he had for some time a considerable number of Prussian workmen in his employment, manufacturing engines and general machinery: they were better informed on general topics, but the English mechanics made themselves more really valuable, by their more positive knowledge of their duties, their greater appreciation of the necessity of precision and of accurate adjustment, and their greater readiness in emergencies.

The Hon. ROBERT JAMES WALKER (late Secretary U. S. Treasury) said, he rose with diffidence to speak of civil engineering, in an assembly where the best authorities were continually heard on that important subject; his attention had been chiefly directed to finance, political economy, and jurisprudence, but he was fully alive to the advantages of cultivating a science which conferred such inestimable benefits on mankind generally. He felt but little qualified to enlarge on the character and use of the celebrated revolver, of his friend and countryman Colonel Colt, as the principal object of his social and political course had been, to encourage free commerce and intercourse between all countries, and thus to render gunpowder and fire-arms unknown quantities in the future career of England and America.

It must be evident to all thinking men, that civil engineering was one of the most important professions connected with the advance and progress of the human race. To that profession was due the praise of having constructed railroads, bridges, and canals—improving rivers and harbours—building steam-engines, for locomotion upon land and water—and substituting machinery for manual labour (greatly for its benefit), in nearly all industrial pursuits.

To the engineers must be attributed the construction, in the United States, of nearly 4,000 miles of canals, and upwards of 10,000 miles of railroads; and by their aid, at least one great railroad would be constructed across the American continent, from the Atlantic to the Pacific.

By the aid of the same great profession a ship canal would no doubt, eventually, be cut through the American isthmus. This would be, in its consequences, the greatest work of civil engineering yet undertaken by man; and the American pioneers, now engaged in the preliminary railroad, would be greatly pleased to obtain the aid of the Institution of Civil Engineers, and of its distinguished members, in connection with their own eminent engineers, in promoting the speedy construction of that great work, not only for the benefit of England and America, but of the world at large.

Civil engineering was the application of mind to matter, and was perhaps

more important in its general effects in America, than in Europe, inasmuch as labour being much dearer in America than in England, it became necessary, in order to enter into successful competition, to substitute more machinery for manual labour, in all manufacturing operations, and thus the inventive faculties were roused, and innumerable machines were introduced which, but for necessity, would never have been thought of. And here he might be permitted to remark, that, whilst it would not perhaps be possible at present to assemble in America so large a number of distinguished and scientific engineers, as were found in this Institution, yet he thought, that education was more widely diffused among the industrial classes in the United States; that among the operatives, there were more educated heads at work than in England; and that must in a great degree be received as one of the chief causes of the progress and success of America. The educated industrial classes applied their intellect, from day to day, to improvements in the operations in which they are concerned, and hence it was that many of the most useful inventions and discoveries had originated with the working mechanic handicraftsman.

With respect to the repeating fire-arms, the account of which had been read to the meeting, he was bound to state that, during the last war with Mexico, the use of those weapons became a subject of careful discussion in the American Cabinet, of which he was then a member. From the evidence laid before the members, the decision was unanimously in favour of the employment of Colonel Colt's revolvers, in conformity with the recommendations of the distinguished officers who had used them. The results were most brilliant and successful in those campaigns, more especially in guerilla warfare; and he believed that the sentiment of the army, the navy, and those who were from necessity obliged to be prepared for offensive or defensive warfare, was clearly and decidedly in favour of the general use of Colt's repeating fire-arms.

General MACNEILL hoped he might be permitted to revert very briefly to the merits of the repeating arms invented by his friend and countryman Colonel Sam Colt; he used the term 'invented' advisedly, because he was aware of the progressive steps by which the present efficient form of the weapon had been arrived at; he knew also that Colonel Colt was not cognizant of any previous attempts to produce such weapons until he visited Europe to secure his first patents, and he had watched, with more than ordinary interest, the gradual application of the ingenious self-acting tools employed in the manufacture of those arms.

As an old military man he had the means of obtaining the private opinions of most of the distinguished officers of all grades, whose public testimony of the merits of the arms in actual warfare, was embodied in the "Report of the Committee on Military Affairs" addressed to the Senate of the United States, January 30th, 1851 (31st Congress, 2nd Session); and without trespassing on the time of the meeting by entering into particulars, which had been so extensively circulated in that report, he might state that all military men coincided in the opinion that for detached service, reconnoitring parties, convoys, outpost sentries, and generally for service against savage tribes, or border warfare, Colt's repeating arms were most efficient, and it was an acknowledged fact that, without their use, the late campaigns of the United States' armies could not have been so speedily, or so satisfactorily terminated. It was proverbially difficult to induce old soldiers to try new weapons, and there had been the usual amount of reluctance to try, and then to recommend the adoption of the repeating arms, but there was no resisting the evidence of actual practice, and the demand for them in the frontier corps, soon became as urgent as it was among the borderers, who were not so slow to appreciate the advantages of such weapons.

The machinery used in the manufacture of these arms was equally remarkable for its simplicity, the ingenuity displayed in the adaptation of the tools, and the satisfactory manner in which all the various processes were conducted, so as to produce weapons that were not only trustworthy and efficient,

but so perfectly identical in all their parts, that in assembling a pistol, the several pieces were taken promiscuously from a heap, and the arm was finished almost without manual labour. It must be evident that this was a great advantage in a country where labour was so costly, and where the borderers, the isolated pioneers of civilization, who most required these weapons, must repair them as well as use them.

As however it had been General MacNeill's lot, for many years past, to devote his energies to the peaceful occupations of Civil Engineering, he would prefer reverting to the subjects so well alluded to by the Hon. Mr. Walker, and he trusted that in future the only contest between England and America would be for priority in undertaking, and rapidity in executing, great engineering works for the benefit of the human race. In no way could this desirable end be so well attained as by combining the energy and comprehensive enterprise of American engineers, with the proverbial science, skill, intelligence, and good faith of the English engineers, who would find in the United States a hearty welcome, and a fine field for the exercise of their professional talents.

It had been his good fortune, whilst actively engaged in the execution of extensive engineering works, to have under him many young men, Scotch, Irish, and English, who all arrived with the same simple story, "they wanted work;" and though he could not give them such employment as their talents and acquirements warranted, he afforded them such occupation as he could command, and in a short time, though they might have commenced as mere chain draggers, or assistant surveyors, at the rate of a dollar per diem, they soon progressed, and in a few years some of them were realising large incomes. He did not claim any merit for thus advancing the career of these young men; they had served him well and obtained the just reward of their talents and integrity, but in all cases he felt that he was only returning, in a slight degree, the hospitality and kindness he had experienced at the hands of Telford, George Stephenson, Walker, and other eminent engineers, when he visited England many years ago as a young Captain of Engineers, with his brother officers Whistler and Knight, with whom he was associated, in a journey undertaken by order of the United States' Government, for the inspection of the great works of art in Great Britain. On that occasion it was his good fortune to be brought into contact with Mr. Robert Stephenson and Mr. Locke, at that time commencing the works which would hand down their names to posterity, as the worthy successors of the eminent men he had previously mentioned. He was proud to have known those two engineers, and to acknowledge that whatever useful work he had undertaken, and whatever success he might have obtained in his own country, had been materially aided by the intercourse he had been permitted to have with those gentlemen at an early period of their professional career.

Since the period to which he alluded a great change had taken place in the means of acquiring engineering knowledge: at that time he was told that "engineers, whose opinions were worth having, were too busy to write books;" but now at the meetings of the Institution, not only were papers brought forward and publicly discussed, but the most eminent authorities of all professions entered with interest into the debate, and the results were freely published to the world. Although perhaps there might not be the same class of works executed in the States as in Great Britain, yet there was much originality in many of the works of American engineers, and it should be his study to induce a liberal interchange of scientific and professional communications between the American societies and the Institution of Civil Engineers, and he was sure that the Hon. Mr. Walker would induce the Government to transmit all the scientific documents published by its orders.

Science knew no distinction of country; the whole world was an open field for the exercise of engineering skill, and in that field professional brethren of all nations should strive in the contest for the noble end of doing the greatest amount of good to the greatest number of the human race.

APPENDIX.

DESCRIPTION OF COLONEL COLT'S FIRE-ARM MANUFACTORY, EXTRACTED FROM No. 218 OF CHARLES DICKENS' "HOUSEHOLD WORDS," FOR MAY 27, 1854, PAGE 354.

"WE are on the threshold of Colonel Colt's factory, in the sombre and smoky region of Millbank. Under the roof of this low, brick-built, barrack-looking building, we are told that we may see what cannot be seen under one roof elsewhere in all England—the complete manufacture of a pistol, from dirty pieces of timber and rough bars of cast-steel, till it is fit for the gunsmith's show-case. To see the same thing in Birmingham and in other places where fire-arms are made almost entirely by hand labour, we should have to walk about a whole day, visiting many shops carrying on distinct branches of the manufacture; not to speak of the tool-makers, the little screw and pin-makers; all of whose work is done here. 'We are independent people,' says my informant, 'and are indebted to no one, save the engine and fixed machine-makers.' This little pistol which is just put into my hand will pick into more than two hundred parts, every one of which parts is made by a machine. A little skill is required in polishing the wood, in making cases, and in guiding the machines; but mere strength of muscle, which is so valuable in new societies, would find no market here—for the steam-engine—indefatigably toiling in the hot, suffocating smell of rank oil, down in the little stone chamber below—performs nine-tenths of all the work that is done here. Neat, delicate-handed, little girls do the work that brawny smiths still do in other gun-shops. Most of them have been sempstresses and dressmakers, unused to factory work, but have been induced to conquer some little prejudice against it, by the attraction of better pay than they could hope to get by needlework. Even the men have, with scarcely an exception, been hitherto ignorant of gunmaking. No recruiting sergeant ever brought a more miscellaneous group into the barrack-yard, to be drilled more rapidly to the same duty, than these two hundred hands have been. Carpenters, cabinet-makers, ex-policemen, butchers, cabmen, hatters, gas-fitters, porters, or, at least, one representative from each of those trades, are steadily drilling and boring at lathes all day in upper rooms. Political economists tell us that the value of labour will find its level as surely as the sea: and so, perhaps it will: but it is a sort of sea that does not right itself quickly enough to prevent a great deal of misery; that is always recognised and deplored; but for which the best mathematicians of the school have not yet been able to find a remedy. For Science, with her two centuries of pedigree, has become a little aristocratic, and does not bend her genius down to many incidents of individual wretchedness which humbler folks cannot shut their eyes to. Perhaps if men who have learnt but one trade, and have grown old in it, could be as easily absorbed into another, when desirable, as these new gunsmiths are, the working world would go more smoothly than it does. The girls here earn from two to three shillings per day; the boys the same. The men get from three to eight shillings per day of ten hours; while one or two, being quick, clever, and reliable, are paid regularly twelve shillings per day. What is commonly called piece-work is not the system usually adopted here. It has been found to tempt the men to hurry their work at the expense of a neat finish, and the manager prefers to give a workman six months' trial, during which he learns his business of gun-making by machinery, and is also sure by that

time to have shown what wages he is worth. Only twelve of these people are Americans; one or two Germans; the rest are English.

"Listening to these facts as my conductor communicates them, we pass into a long room hung with portraits of targets as they appeared after firing at them with Colt's revolvers. All the bullet marks are, of course, very near the bull's eye—which, I hope I am not presumptuous or depreciatory of the great Colt invention in attributing in some measure to the marksman. Beyond this is the store-room, lined with wooden racks up to the ceiling, which are almost naked now, only five pistols of all the number that are made here—six hundred a week—being at this moment in store. For there is a new government order for the Baltic; and as fast as they are finished the pistols are sent away, packed in deep cases, that look very large indeed, considering that they are only for five-and-twenty single pistols each. But the conical balls and bullet-moulds, powder-flasks and percussion caps take up more room than the pistols themselves.

"Out of the hot atmosphere, and the all-pervading odour of hot oil, we pass a yard ankle-deep in iron chips (which make a dry hard road in all weathers, very destructive to leather) into a long out-building, in which the only genuine smiths are at work. Here the very beginning of the pistol is made; if we except the cutting and polishing of the stock, which have been already described in these pages.* There is little of the noise of a smithy here, except the roaring of the furnaces. A workman rams the end of a long bar of steel into the fire; and, taking it out glowing with heat, strikes a bit off the end as if it were a stick of peppermint; while his companion, giving it a couple of rough taps upon the anvil, drops the red-hot morsel into a die. This die is a plug-hole, shaped something like a horse-shoe, at the foot of a machine, bearing a painful resemblance to a guillotine. While they have been breaking off the bit of steel, a huge screw has been slowly lifting up the iron hammer-head, which plays the part of the axe in the guillotine: and now the great hammer drops, and with one stroke beats the piece of iron to the form of the die. It has cooled to a black heat now, and is shaped something like the sole of a very narrow shoe: but it must be heated again, and the heel end must be beat up at right angles to the long part—taking care that it be bent according to the grain of the metal, without which it will be liable to flaw. Thus the shield, and what may be called the body of the pistol, are made in an instant.

"In Birmingham, the barrels of fire-arms are made of old nails that have been knocked about, and which are melted, rolled into sheets, twisted again, and beaten about, till they are considered to be tougher and less likely to burst; but the American gunsmiths know nothing about this. They merely heat the end of the bars of cast steel again and beat it with steam hammers; for it would not do to draw it through holes, as thick wire is drawn, or to roll it as with ordinary round bars. These hammers are fixed, five in a frame, where they quiver with a chopping noise too rapidly to count the strokes, over a little iron plate, never touching it, though coming very close. Into the first of these the smith thrusts the red end of the bar, and guides it till it is beaten square. The next hammer beats it smaller, but still square: the next beats it smaller and longer still, but rounder. The fourth hammer beats it quite round, and the fifth strikes off the exact length for the barrel. This gradual process is absolutely necessary, for the steel will not bear being beaten round the first time; and, although five barrels may be thus forged in one minute, the rapid strokes of these hammers are said to make it quite as tough as the Birmingham plan; which seems to be borne out by the results at the Proof-House. On the same floor, the barrels and cylinders, after polishing, are case-hardened, and tinted blue, by burning in hot embers; processes which are well known.

* Guns and Pistols. See vol. iv. p. 580.

"Across the yard strewn with chips of iron again, and through the tool room, where men are turning great screws and other bolts and portions of machinery, we mount to the first floor, and enter a long room filled with machines, and rather more redolent of hot rank oil. Considering that the floor supports a long vista of machinery in full action, the place looks clean and neat, and is not very noisy. Girls quietly attending to the boring and rifling of the barrels—having nothing to do but to watch the lathe narrowly, and drop a little oil upon the borer with a feather now and then—men drilling cylinders, holding locks to steam files, cutting triggers, slotting screws, treating cold iron everywhere as if it was soft wood, to be cut to any shape, without straining a muscle. It would be difficult and tedious to describe these machines minutely, although they are very interesting to a spectator, and cannot, I believe, be seen elsewhere. Every one of them is a simple lathe; but it is in the various cutters, borers, and riflers that the novelty and ingenuity exist. Where the thing to be made is of eccentric shape, the cutter is of eccentric shape also; and although the superintendent of each machine acquires more or less skill by practice, it is in the perfection of these cutters and borers that the guarantee for uniformity consists. The bores of barrels and cylinders must be mathematically straight, and every one of the many parts must be exactly a duplicate of another. No one part belongs, as a matter of course, to any other part of one pistol; but each piece may be taken at random from a heap, and fixed to and with the other pieces until a complete weapon is formed; that weapon being individualised by a number stamped upon many of its component parts. The advantage of these contrivances is obvious. In every case of revolvers are placed, when sold, a number of such parts of a pistol as are most liable to accident; and, with these, any soldier or sailor may, in a few minutes, repair his own weapon. Seventy-odd out of a hundred of the injured revolvers picked up on the battle-field during the Mexican war were repaired with bits of other pistols on the spot.

"In the top floor, just above this, men and women, with black hands and faces, are polishing at lathes still moved, as everything is moved, by the steam-engine in the hot stone chamber below. Everybody gets a slice of his thirty horse-power; and my conductor says they have still plenty of power to spare, as if steam power were an article like gas or water, to be laid on whenever it is wanted from a distant reservoir. Such, indeed, it is; though when carried far, as I saw it by a belt across the yard, much of the force, of course, is wasted. Here is our friend the butcher, still wearing a blue smock, and very busy polishing cylinders. His work spins so rapidly that red-hot particles of emery fly off and lodge upon his face, which is specked and spotted all over in rather a comical manner. He gets a hit in the eye sometimes (for he will not wear spectacles), which causes great pain; but not more than is occasioned by the minute chips of steel which trouble the workmen down stairs, and which have to be taken out with a magnet; or, when they stick in, by scraping the eye with the sharpest knife that can be found. The butcher is very quiet and intent upon his work as the manager enters with me; but the American close to us is singing a song when we come in, and does not think of leaving off—not he. The girls have a natural shame of black hands and faces, though they cannot help themselves, and look more closely down at their work while strangers are near than the neat and tidy girls below.

"All this time we have been seeing only the making of little bits of a pistol. Pausing a moment, to see the engraving of a ship in full sail, and other ornamental work—including the maker's name stamped by great pressure on the cylinder—we come into a great room, where all the minute portions are brought to be examined. Here, by means of gauges, but chiefly by the practised eye of the superintendent, each separate article is examined, and rejected if in the slightest degree faulty. From this room the

various parts are served out to the workmen who put them together, and turn out the complete revolver.

"Every revolver being equal to six single pistols, they are rarely spoken of as braces. Most customers take only a single revolver, and the name of every purchaser being recorded, and the number, which is marked on many parts of the weapon, being noted at the same time, some curious identifications occur. Several anecdotes are related of persons who have been traced by the revolver in their possession. In the skirmishing in Florida, the death of many poor fellows whose names were unknown, and who were found killed, was certified to their friends by publishing the number of the pistol in their belt, or grasped in their stiff hands. There is a revolver, says my conductor, which was brought to me to repair, some months since; I recognized it, by the number, in a moment for one stolen from here long ago, and I think the man who brought it saw I did, for he never came to fetch it away again. In cases of murder perpetrated by a Colt's revolver, the weapon itself, if ever one should be so used, would become a conclusive evidence.

"Here is the proving-room, where the pistols undergo a preparatory trial, before being sent up for the regular Government proof. It is by no means the dark, mysterious, iron-plated room, in which I have been taught to believe that guns are proved; but an ordinary workshop, with two square wooden pipes, fixed horizontally, and open at the end, breast high. I am invited to prove a pistol, by firing it into one of these pipes, which, I am told, afford sufficient protection to the firer in case of a barrel bursting—an event, pains were taken to assure me, of very rare occurrence. After a little practice, I find that a mere novice may, with one hand, discharge the six rounds as rapidly as the eye can wink."

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