IMPROVED GATLING GUN.

Important and valuable improvements have recently been made in the Gatling gun, and also in its feed mechanism, by the Gatling Gun Company, of Hartford, Conn. The gun retains its primary features of revolving barrels and locks. The new feed makes it possible, however, to manipulate the gun with greater facility than heretofore. The rate of firing is greatly increased and the gun may be fired at any angle of elevation or depression, the feed being positive in its operation. In the old form of Gatling gun the feeding depended upon gravity, and this made it impossible to fire the gun at any considerable elevation or depression. The old feeding apparatus was bulky and was a conspicuous mark for the enemy. The new feed is much lighter, smaller, and more economical than the old.

The cartridges used in the new feed are attached to strips of tin, and are fed to the gun with great rapidity. They are discharged and the empty shells thrown aside automatically while the barrels of the gun are revolving.

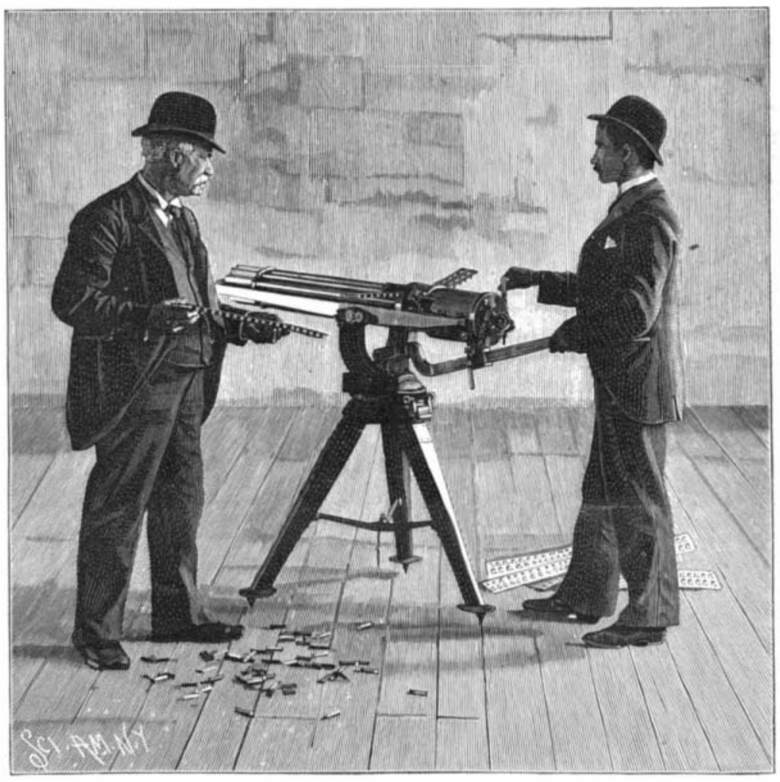
For fort and naval uses, the gun may be operated by an electric motor, the firing being controlled by a button, the gun being fired rapidly or slowly, as desired. The motor is attached to the breech of the gun, and appears, when in motion, merely as an elongation of the breech. It develops one horse power and weighs about 100 pounds. The entire mechanism is very compact, and is inclosed to protect it from injury. This new motor attachment makes it possible to discharge the gun at the rate of over 3,000 shots per minute.

The manufacturers of the improved gun attach particular importance to the gain by the new feed in cheapness, compactness, and the general simplicity. Each feed strip holds 20 cartridges and costs but a few cents, and may be refilled, if necessary, as many as thirty times.

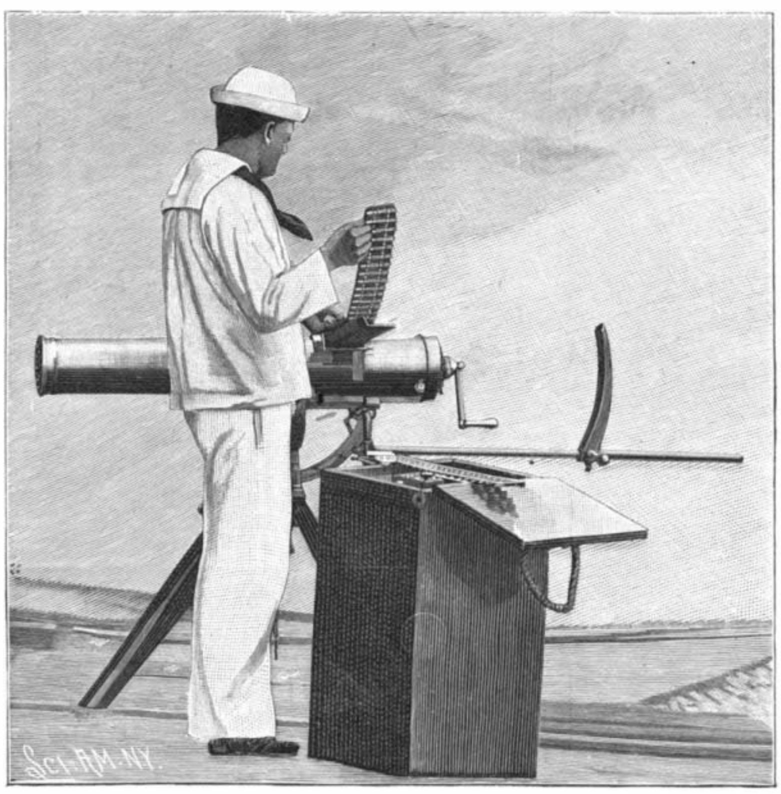
The space occupied by the former bulky feed mechanism may now be used for ammunition. Ten thousand rounds of ammunition may now be carried in the limber for immediate use.

The improved gun and new feed are so simple and easy of manipulation that any soldier can fire the gun; and this will be found a great advantage in ordinary service, either on land or on shipboard.

Further information may be had by addressing the Gatling Gun Company, Hartford, Conn.



THE IMPROVED GATLING GUN—ARMY MODEL.



THE IMPROVED GATLING GUN—NAVY MODEL.

Preservation of Propeller Shafts.

It is now about two years ago since the first of the propeller shafts fitted with the arrangement devised by Mr. Mudd, of Hartlepool, for preventing their destruction by galvanic action and corrosion, were sent to sea, and they are now rapidly coming in for examination. The device has proved successful, the shafts on examination having no trace whatever of galvanic action or corrosion, nor of the defects and decay that formerly so extensively resulted. The s.s. Guernsey, whose shaft has been running at sea for eighteen months, had her tail shaft drawn at a dry dock in the Tyne recently, and the preserver pulled loose from its attachment to the shaft, when it was found that the shaft had been entirely preserved, the rubber sleeve itself had taken no harm, and was capable of being cemented down again for a further period at sea. The s.s. Zanzibar, whose shaft was drawn at a dry dock in Cardiff, was found in perfect order, the sleeve having adhered splendidly to the shaft and retained its elasticity, forming a really good preservative, no corrosion whatever having taken place. The s.s. Elmville, dry-docked at West Hartlepool, had her tail shaft drawn and examined after having been twenty months at sea, when the same result was found. The sleeve was in perfectly flexible and good condition, and when turned back from its attachment to the shaft, the shaft and the ends of the brass liners were found in the same perfect condition in which they left the lathe when new, having taken no harm whatever during the twenty months' work. The best qualities of rubber retain their natural elasticity indefinitely when kept immersed in water and free from light and air, and these conditions are fairly satisfactorily fulfilled in the inside of a stern tube, so that the very conditions that were previously destructive to the tail shafts themselves are now those that are relied upon in this apparatus to keep the covering material in good condition, and these examinations, after long use at sea, prove that reliance may safely be placed upon them for this purpose.

SEEDS 2,000 years old have been known to sprout.

The World's Debt to Astronomy.

Astronomy is more intimately connected than any other science with the history of mankind. While chemistry, physics, and we might say all sciences which pertain to things on the earth, are comparatively modern, we find that contemplative men engaged in the study of the celestial motions even before the commencement of authentic history. The earliest navigators of whom we know must have been aware that the earth was round. This fact was certainly understood by the ancient Greeks and Egyptians as well as it is at the present day. True, they did not know that the earth revolved on its axis, but thought that the heavens, and all that in them is, performed a daily revolution around our globe, which was, therefore, the center of the universe. It was the cynosure, or constellation of the Little Bear, by which the sailors used to guide their ships before the discovery of the mariner's compass. Thus we see both a practical and contemplative side to astronomy through all history. The world owes two debts to that science: one for its practical uses and the other for the ideas it has afforded us of the immensity of creation.

The practical uses of astronomy are of two kinds: One relates to geography; the other to times, seasons, and chronology. Every navigator who sails long out of sight of land must be something of an astronomer. His compass tells him where are east, west, north, and south, but it gives him no information as to where on the wide ocean he may be, or whither the currents may be carrying him. Even with the swiftest modern steamers it is not safe to trust to the compass in crossing the Atlantic. Not only the navigator, but the surveyor in the Western wilds must depend on astronomical observations to learn his exact position on the earth's surface, or the latitude and longitude of the camp which he occupies. He is able to do this because the earth is round, and the direction of the plumb line not exactly the same at any two places. It is true that a considerable distance on the earth's surface will seem very small in its effect on the position of a star. Suppose there were two stars in the heavens, the one in the zenith of the place where you now stand and the other in the zenith of a place a mile away. To the best eye unaided by a telescope those two stars would look like a single one. But let the two places be five miles apart, and the eye could see that there were two of them. A good telescope could distinguish between two stars corresponding to places not more than a hundred feet apart. The most exact measurements can determine distances ranging from thirty to sixty feet. If a skillful astronomical observer should mount a telescope on your premises, and determine his latitude by observations on two or three evenings, and then you should try to trick him by taking up the instrument and putting it at another point one hundred feet north or south, he would find out that something was wrong by a single night's work.

We cannot measure across oceans from island to island. Up to the present time we have not even measured across the continent, from New York to San Francisco, in the most precise way. Without astronomy we should know nothing of the distance between New York and Liverpool, except by the time which it took steamers to run it—a measure which would be very uncertain indeed. But by the aid of astronomical observations and the Atlantic cables the distance is found within a few hundred yards. Without astronomy we could scarcely make an accurate map of the United States, except at enormous labor and expense, and even then we could not be sure of its correctness. But the practical astronomer being able to determine his latitude and longitude within fifty yards, the positions of the principal points in all great cities of the country are known, and can be laid down on maps. The world has always had to depend on astronomy for all its knowledge concerning times and seasons. The changes of the moon gave us the first month, and the year completes its round as the earth travels in its orbit. The results of astronomical observation are for us condensed into almanacs, which are now in such universal use that we never think of their astronomical origin. At some of the principal observatories of the country astronomical observations are made on every clear night for the express purpose of regulating an astronomical clock with the greatest exactness. Every day at noon a signal is sent to various parts of the country by telegraph, so that all operators and railway men who hear that signal can set their clock at noon within two or three seconds. People who live near railway stations can thus get their time from it, and so exact time is diffused into every household of the land which is at all near a railway station, without the trouble of watching the sun. Thus increased exactness is given to the time on all our railroads, increased safety is obtained, and great loss of time saved to every one.—Prof. Simon Newcomb, in the Chautauquan.

Fireproof Buildings.

The attention of architects and builders has been directed for some time to the difficult task of constructing an absolutely fireproof building. It has been found that a rise in temperature to 300 degrees F. will throw the heaviest steel columns more or less out of place, and that a rise to 500 F. would ruin the best steel construction. Fireproof buildings are usually constructed, therefore, by surrounding the girders with material to protect them from the heat. An elaborate form of such a construction has been introduced recently in the new Tremont Temple in Boston. It consists in placing about the great steel girders terra cotta blocks on all the exposed sides and strapping them together with iron. Upon this is stretched expanded metal lathing covered with a heavy coat of Windsor cement. Over this, in turn, comes iron furring, and this is provided also with a layer of expanded metal lath. The finishing plaster is laid on top of this last layer. It will be seen that this arrangement provides first a dead air space, next a layer of terra cotta, a Windsor cement covering, then a second air space, and finally a second thick layer of Windsor cement.

THEY cut glass now by electricity.

Concretes, Cements and Mortars.*

The "White City" of antiquity was Rome, and most of the so-called marble houses of the Augustinian period were not such in reality, but owed their stone-like appearance to the plasterer's art, which at that time had reached a high state of perfection, and gave to stone the appearance and induration of the finest marble.

It is on record that some of this plastering, which in some particulars resembled the white "staff" used on the World's Fair buildings, lasted for centuries, but the art which enabled man to make and apply this material was lost before the examples perished.

It is evident the ancients, at all events the Egyptians, Greeks and Romans, possessed a knowledge of eminent mortars and cements, as is proved by the phenomenal strength and durability of the remains of edifices still standing to receive their tribute of admiration. Doubtless much was due to the durability of the stone used, but builders of to-day know that more was due to the superiority of the mortar employed. True, the action of time has fostered improvement and aided petrifaction, but had the mortar been composed of inferior materials, or manipulated unskillfully, it would have been rotten centuries ago, and the stones it held together would have been lost to us forever.

In all highly civilized communities good mortar was and is a necessity. Indeed, the quality of mortar used in any community may almost be accepted as an index of its civilization.

The city of Nineveh has left us comparatively nothing of its history, as it was a city of mud and unburnt clay, adobe walls and loamy mortar. Of Babylon we know more, as it was a burnt brick built city, with walls bonded together with bituminous mortars. Egypt, that cradle of the arts, built the massive pyramid of Sackkara of bricks cemented with Nile silt! Later, she raised her temples and pyramids of hard syenite, and held them together with imperishable asphaltic mortars; but the greater works of this wonderful people were held together with a mortar formed by an admixture of hydrate of lime and Nile silt. The Greeks, in their earlier public buildings, dispensed with mortar to some extent, and used dowels or pins made of cypress wood to hold the stones in place. All their joints, however, were rubbed or ground together, so that the junction of the stones was almost perfect; later on, mortar was used in many of their structures. The Romans, the most practical builders of antiquity, surpassed all peoples, ancient or modern, in their knowledge of the materials they made use of in their building operations, and it is to their intelligent attention to mortar making that we moderns are enabled to see the work of their hands. The importance of the manufacture of mortar was such that in all large works, national, municipal or private, it was deemed necessary to employ supervising officers, called ediles, whose duties were to inspect materials and superintend the manipulation of all mortars and cements used in the building.

We may glean some idea of the labor expended in the making of mortar from Vitruvius, who says: "That men mixed the ingredients by beating them with staves until the whole mass was smooth and plastic."

In another placé the same author says: "The builders mixed puzzolana with lime to give it (the mortar) greater strength, and piers built in the sea would be as strong as if built on land, as the mortars made this way would harden just as well in the water as on the land."

It is quite evident also that the Phœnicians were aware of the qualities of puzzolana, for some of the docks and wharves of Carthage were built of stone and cemented together with a mixture of lime and puzzolana. It is difficult at this date to trace to its source the invention of lime mortar, but it is due either to Egyptian or Phœnician ingenuity, and was a grand stride in the direction of civilization and culture, and it is curious to think that for several thousand years no further progress in its manufactûre was made. Indeed, until about the commencement of the present century, common lime mortars were made in the same manner that was adopted four thousand years ago.

In the matter of producing a water-resisting mortar, much more skill and knowledge were required; yet we find that the possession of this knowledge by the ancients antedates the Christian era by several centuries, as the use of puzzolana mixed with lime to form a cement was known to both Phœnicians and Romans long before Vitruvius flourished.

The discovery of the manufacture of a mortar that would set and harden under water was another step forward in human culture, and evinced a knowledge of chemical conditions by the early builders that is really amazing. Hydraulic lime and the modern product of cement were unknown to them, but they seemed equal to the occasion, for they found that a proper admixture of lime, puzzolana and pounded bricks formed a cement that answered well their purposes.

It is not known at what period the fact was discovered that certain limestones would yield a lime or cement capable of hardening under water. The French writer, Vicat, in the beginning of the present century, was the first to make an extended investigation of the laws governing the action of limes. Up to the middle of the eighteenth century puzzolana imported from Italy and France, and from Germany via Holland, was the standard ingredient for hydraulic mortars in England.

In 1756 John Smeaton, C.E., was intrusted to build a new lighthouse on the site of the Eddystone, which had recently been destroyed by fire, and he set to work to discover some material at home which would resist the action of both surf and sea. The lime from Aberthaw answered his purpose. He investigated the cause, and proved before long that only those limes resist water which, when treated with acids, leave argillaceous residues. The spell was broken, and artificial cements followed each other rapidly after that. Parker took out his patent for Parker's cement in 1796 This consisted of lumps of chalky clay gathered from the sea coast. It became known as "Roman cement," because of its being similar in color to the Roman puzzolana. In its action it was somewhat like to our Rosendale. By inference, it followed that hydraulic cements could be produced artificially of lime and clay.

Parker made a number of experiments with clinkers, pulverized limestones, and the calcareous detritus produced by the wear of limestone roads near Leeds, mixed clay with it and burned it in a kiln at a red heat. He called the resultant "Portland cement," because it was similar in color to Portland stone. The name thus given has clung to this cement ever since, no matter where made.

In 1827 Sir Charles Paisley improved and cheapened the process of manufacture, by selecting English chalk as being best suited to the purpose, owing to its uncrystalline, fine grained quality. He mixed it with clay from the deposits at the mouth of the Medway, near Chatham, and calcined them. This made a good cement, but as the merits of white heat calcination were then not known, the quality could not be relied upon.

The credit is due to a German, Dr. Fuch, of Munich, of first formulating a scientific theory concerning the manufacture of cement, and stripping it of its mystery. He proved in a prize essay that Portland cement could be made anywhere and from a variety of materials, abundant in every locality. This essay, being translated in several tongues, was the means of raising a host of manufacturers, with the result of bringing disgrace on the manufactured article, as it lacked uniformity of quality, and could not be relied upon, and architects and engineers avoided its use and stuck to old methods.

In 1858 John Grant, a London engineer, made a number of experiments, and so far succeeded in improving the quality that he completed the Thames embankment and the London drainage works without an accident, so far as the cement was concerned. The experiments made by Grant led him to believe that the heaviest cement was the best, and his reputation, which was high, had the effect of spreading abroad the impression that to have weight was of more importance than to be finely ground.

This idea did much harm, even after it had been proved beyond a peradventure that it was fineness, and not weight, that gave to the cement its superior tensile strength. Through the efforts of Reid, Brund, Mann, Newman, and others in England; M Noel, MM. Chatony and Rivot, and others in France; Dyckerhoff, Michaelis, and Bauschinger in Germany; of Zuirek and Hanenschild in Austria; Gen. Gilmore, W. W. Maclay, Elliot C. Clarke, E. J. Desmith, and F. Kidder, of the United States, the truth has been established that the materials being good, it is fineness that imparts to the material its good quality. W. W. Maclay, engineer of the New York docks, made between seven thousand and eight thousand tests, to satisfy himself as to what constituted the best cement, and in every case he found—where materials were chemically equal—that the finer grades were the best adapted for work requiring strength. Mr. E. C. Clarke, of the Boston Main Drainage Works, made some twenty-five thousand tests with a like result.

Mr. Kidder, who watched a number of tests made at the School of Technology, Boston, arrived at the same conclusion. It may therefore be laid down as an axiom, that, no matter how good the material may be, if it is not ground to a fine texture, it cannot be relied upon. Brands possessing a uniformity of texture will give better results than an admixture of brands, and when once a brand has been found to do all that was claimed for it, and it fills the bill, it is best to stick to that particular brand. A good cement, when properly set, should equal in strength good building stone, and should have a like or greater specific gravity.

At this writing there are quite a number of brands of Portland cement in the market, many of them being imported from England, Germany, France and Belgium. Some brands are exceedingly good, while a number of them are inferior to many made in this country. Indeed, some of the Portlands made in Pennsylvania, New Jersey, and other States are as good and reliable as some of the imported high grades, though I am free to confess that but few of our own brands grade as uniformly as the Dyckerhoff or Boulogne makes. Doubtless the quality of uniformity of the two brands named is due to the care and perfection of manufacture, for neither France nor Germany possess raw material in as good a quality as is found in many places in this country.

The English Portland is a mixture of clay, consisting chiefly of silica and alumina and chalk, or nearly pure carbonate of lime. The clay and chalk are ground roughly, and mixed in the proportion of one to three by weight, then again ground under water. The mixture is then allowed to settle and the water to drain off, and the mass is then dried and made into cubes, bricks, or balls, two or three inches in diameter, which are placed in a kiln and heated to a white heat. They are then allowed to cool, and afterward reduced to an impalpable powder. Unlike natural cements, Portland does not deteriorate when exposed to dry air. Dr. Michaelis, a noted expert on cements, says that the "raw materials, when dried at 212° F., consist essentially of seventy-five to seventy-nine per centum, by weight, of carbonate of lime and twenty-four to twenty per centum of silicate of alumina, clay. These when burned represent sixty-two and one-half to sixty-seven per cent of lime and thirty-three and one-half to twenty-nine per cent of silicates, silica, alumina, oxide of iron, leaving four per cent for carbonate of magnesia and accessories. After the hardening of the hydrated cement, a transformation, by compressive reaction, has taken place into hydrates, silicate of lime as the most important ingredient, in hydrated aluminate of lime, ferruginous lime, hydrate of lime, basic sulphate of lime, and carbonate of lime."

The results of analyses by other investigators by microscope and chemical tests verify the conclusions arrived at by Dr. Michaelis. A preponderance of alumina favors quick setting, while an increase of iron has an opposite effect. The partial vitrification obtained in the burning causes the particles forming the whole to lose their globular character and become laminated or flattened. This feature reduces the bulk and increases the value of the cement, inasmuch as the laminated texture achieves more intimate contact by surface.

The English standard requires these tests, viz., that the cement shall weigh one hundred and ten pounds to the strict imperial bushel; that it shall pass through a sieve having from one thousand six hundred to three thousand meshes per square inch; and that its tensile strength shall be two hundred pounds per square inch at the end of seven days, the first passed in damp air, and the rest under water. American engineers exact a somewhat higher standard, some specifications calling for a tensile strength of two hundred and fifty pounds to the square inch.

* Fred T. Hodgson, C.E., in the Brickbuilder.

Army Ordnance Factories.

A valuable official summary of the present facilities of the various United States ordnance factories has recently been presented to Congress in connection with the annual request for appropriations. During the past year the work accomplished at these plants has been highly satisfactory. At Watervliet, the great factory for sea coast guns, the output has been eleven 8 inch, eleven 10 inch and six 12 inch guns, and work is in progress on a 10 inch wire-wound Crozier and upon seven 12 inch mortars. The factory is equipped for the manufacture of guns up to and including those of 12 inch caliber, and contracts have been made for the tools necessary for manufacturing 16 inch guns. The principal need at Watervliet is for a proving ground suitable for testing the large guns of their manufacture. At present such guns must be taken to Sandy Hook for this purpose, thus incurring great expense. The cost of this improvement will be $98,840. The next ordnance factory mentioned is that at Watertown, celebrated for the manufacture of great gun carriages. This plant constructs 12 inch gun lifts, barbette carriages for 10 inch guns, 8 inch carriages and carriages for the muzzle-loading 15 inch smoothbore and 8 inch converted rifles. Cast iron projectiles and other castings are made, and there is much valuable machinery for making navy chains, shackles, swivels and the life-saving shot lines. At the ordnance station at Frankford the ammunition for the new small arms is manufactured in large quantities. Last year the output was 2,537,000 cartridges, balls and blank for the 45 caliber rifles and carbines and 2,750,000 for the 38 caliber. The output also included shrapnel for field guns, fuses, gun sights and various similar articles.

The report also mentions the important work in gun manufacture carried on at Rock Island and Springfield, the powder supplied by the plant at Benicia and the satisfactory tests conducted at Sandy Hook. The report gives evidence of a very efficient system of ordnance factories, and it is to be hoped that Congress will provide ample appropriations for carrying on their work in the future.