SCIENTIFIC AMERICAN
[Entered at the Post Office of New York, N. Y. as Second Class matter.]
A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.
Vol. LXXVI.—No. 12. ESTABLISHED 1845. | NEW YORK, MARCH 20, 1897. | $3.00 A YEAR. WEEKLY.

COMPRESSED AIR SYSTEM ON THE UNITED STATES MONITOR TERROR.

The use of compressed air as a motive power on board a war ship presents several advantages over steam or hydraulic power, which render it a powerful competitor. As compared with steam, it is less dangerous, especially during an action, when a broken steam pipe might prove terribly fatal, and it enables certain parts of the ship to be kept at an even temperature, which would otherwise be rendered uncomfortably hot by the presence of steam piping. Steam and hydraulic engines, moreover, require exhaust pipes discharging outside the hull of the ship; whereas the exhaust from the pneumatic cylinders may be turned into the ship or into the outside air, as may be most convenient. There are certain localities in a ship where the exhaust from a pneumatic engine would prove a valuable source of ventilation, as, for instance, in a turret crowded with men and machinery, or in the close confinement of a steering room situated below the protective deck. As compared with hydraulic power, the compressed air system is cleaner and more convenient, and free from the discomfort that arises from the leaking of hydraulic pipes and cylinders.

It was about eight years ago that Secretary Whitney of the Navy Department authorized the Pneumatic Gun Carriage and Power Company, of Washington, to build a pneumatic system for steering the monitor Terror and operating her turrets. Owing to delays in the completion of the ship, the new system was not tried until late in 1896, when the whole of the elaborate plant was put to a thorough test at sea, and gave the greatest satisfaction to the naval experts. As the Terror was the first vessel in the world to be so equipped, there was considerable anxiety as to the success of the experiment; but now that the plant has demonstrated its ability to do all

(Continued on page 185.)

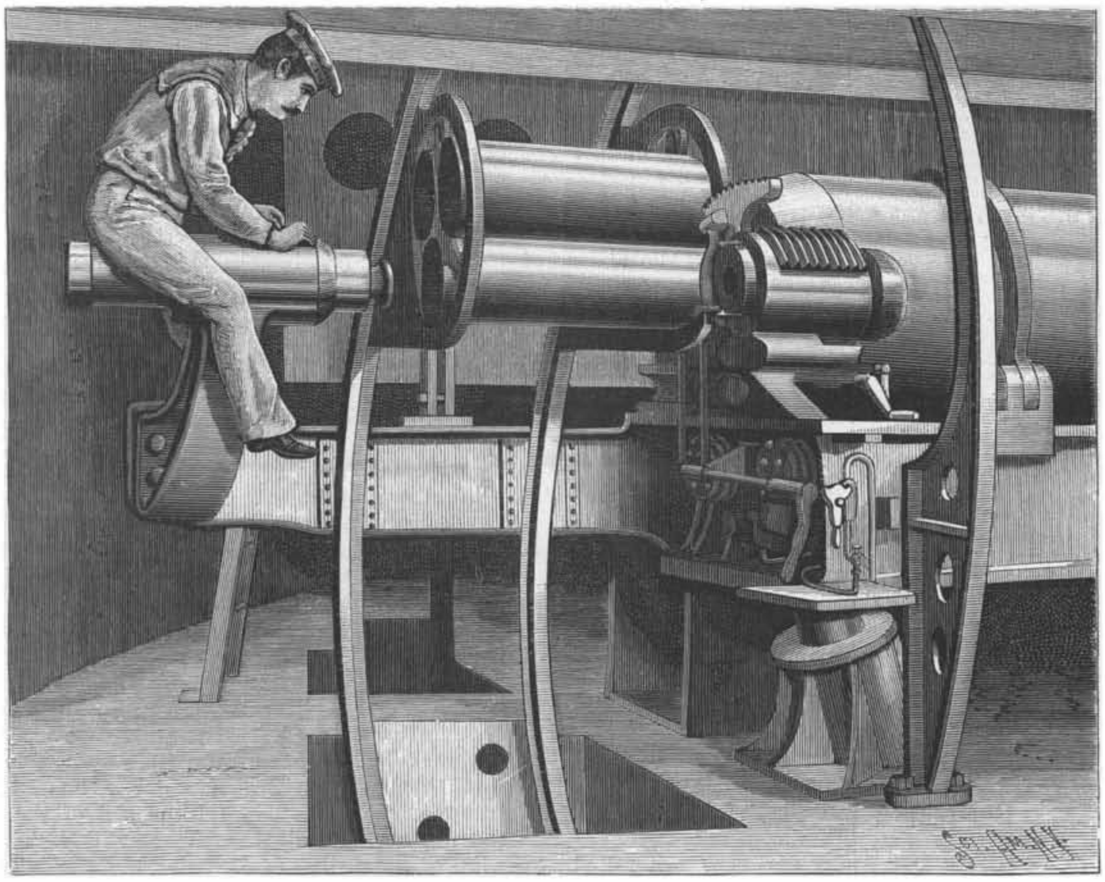
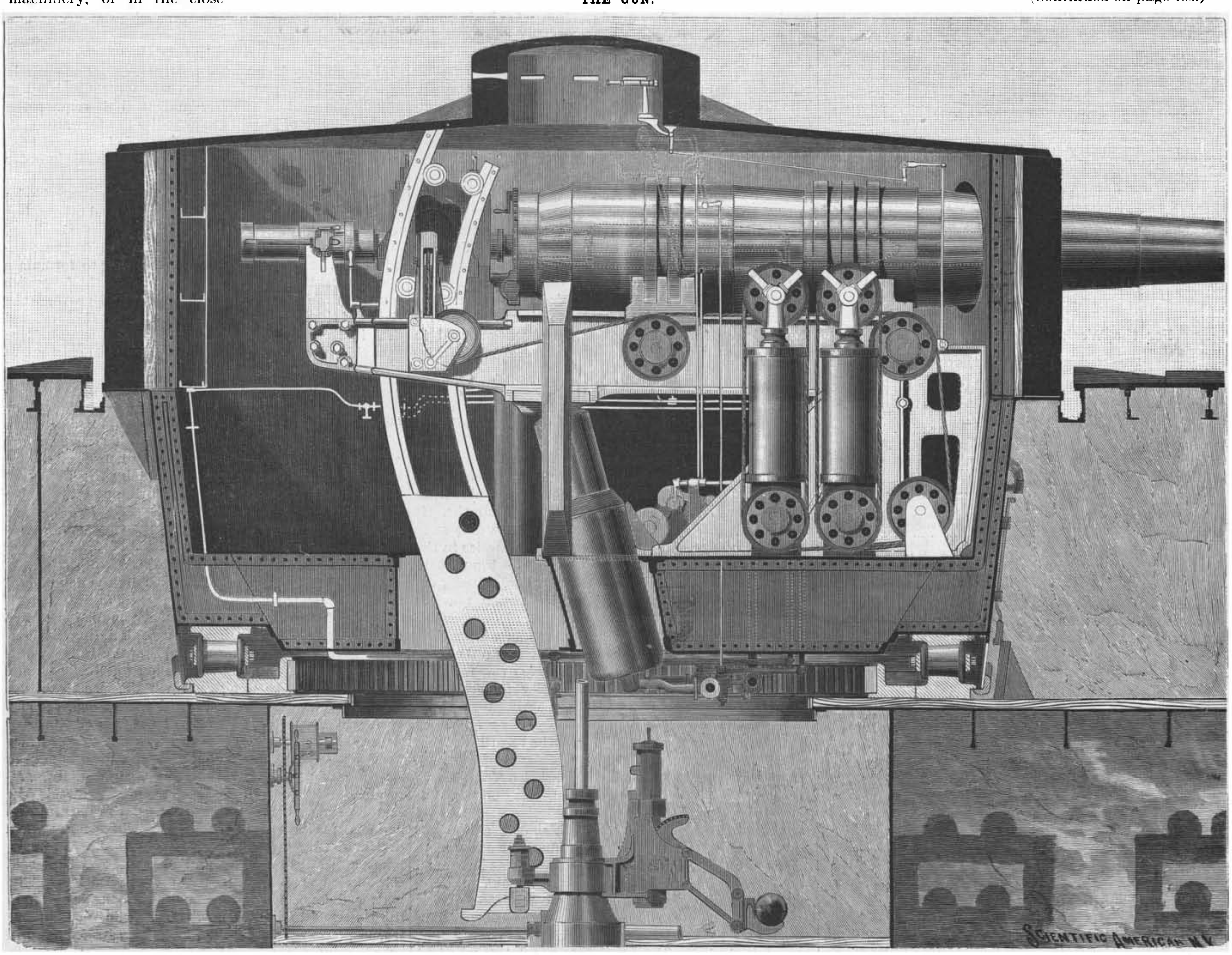


Fig. 2.—LOADING CAR IN POSITION BETWEEN THE TELESCOPIC RAMMER AND THE BREECH OF THE GUN.



THE PNEUMATIC SYSTEM FOR MANIPULATING THE TEN INCH GUNS ON THE MONITOR TERROR—SECTIONAL VIEW OF ONE OF THE TURRETS.

COMPRESSED AIR SYSTEM ON THE UNITED STATES MONITOR TERROR.

(Continued from first page.)

that was claimed, we may look for its further adoption among the navies of the world.

The air for driving the various pneumatic devices is compressed by two separate engines, one being placed in the hold near the forward turret and the other near the after turret on the berth deck. The working pressure is 125 pounds per square inch, and there is no reservoir for the air except an eight-inch pipe, which runs through the vessel and supplies the two turrets and also the steering device in the steering room at the extreme after end of the ship. These two engines supply sufficient air for turning the turrets, elevating the guns, lifting the ammunition into the cages, raising the cages to the breech of the gun, ramming home the charge, closing the breech, checking the recoil, and, lastly, and most important operation of all, steering the ship itself.

The two turning engines are placed upon the floor of the turret, one on each side of the big guns. Each engine has two cylinders, 8 inches in diameter by 14 inches stroke. A worm on the crank shaft operates a set of gears by which the power is multiplied many times over before it reaches a driving pinion, which, in common with the engine and gears, is firmly bolted to the framing of the turret and of course turns with it. The pinion meshes with a large circular rack which is bolted to the deck of the ship and lies immediately within the circular steel track upon which the turret rotates. The engines are controlled by suitable levers and hand wheels situated within easy reach of the officer in the sighting hood, the latter being placed over and between the guns, as shown in the sectional view, Fig. 1.

The elevation and depression of the gun is effected by means of a massive ram, which is hinged to the floor of the turret and bears against a shoe on the under side of the gun carriage near the breech of the gun. On each side of the turret is a cylinder containing glycerine and water, a portion of which, when the gun is to be elevated, is forced by compressed air into the ram, the supply being regulated by valves which are operated by means of levers in the sighting station above mentioned.

By reference to the large sectional view of the turret, Fig. 1, the reader can obtain a clear idea of the method adopted for sighting the great 10 inch guns. From the forward end of the massive gun carriage, a small vertical rod is carried up to a bell-crank lever situated near the roof of the turret. Another rod extends from the short arm of the lever and is connected to another bell-crank lever attached to the sighting hood. The long arm of this lever carries a sighting telescope which is placed opposite one of the narrow horizontal slits which are cut through the side of the hood. The system of levers is so proportioned that the axis of the telescope and the axis of the gun will always be parallel, any change in the elevation or training of the gun being accompanied by a similar change in the position of the telescope. With his eye at the telescope and his hand upon the levers which control the air valves of the turning and elevating machinery, the officer brings the cross hairs of the telescope to bear upon the mark, and by pressing an electric button hurls a 500 pound steel projectile with unerring precision at the hostile ship.

Immediately below the turret is the handling room, adjoining which are the magazine and the shell rooms, with which it communicates through doorways which, when not in use, are closed by watertight doors. Directly below the center of the turret is a pneumatic loading machine, which rotates upon a vertical shaft, and may be swung to the right or left as desired. The 500 pound shell and the cartridge, the latter in two parts, are run out from their respective rooms on an overhead trolley and placed in the tray of the loading machine, as shown in Figs. 1 and 3. The tray is pivotally attached to the body of the machine by a set of parallel rods and a lever which carries at its inner end a circular rack. Above the rack is an air cylinder whose piston rod terminates in a vertical rack which engages the circular rack before mentioned. By admitting air at the top of the cylinder, the tray with its load is raised to the required height and the latter is placed in the pockets of the loading car.

There are two of these cars, one for each gun, and they travel upon two vertical hoists or trackways which lead up to the breech of the guns. The hoisting is done by two pneumatic cylinders located on the floor of the turret between the guns. Attached to each piston rod and beneath each cylinder is a set of multiplying sheaves. Over these passes a wire rope, one end of which is fastened to the floor of the turret, the other end being carried to the loading car. The speed of the rope is so adjusted that the full stroke of the pistons will serve to hoist the loading car from the floor of the handling room to the breech of the gun. By reference to Fig. 3, it will be seen that the loading car contains three parallel pockets, which rotate within the frame of the car, friction wheels being interposed to facilitate the movement. One of the pockets carries the shell and the other two the powder charge. The car is automatically brought to a stop with the lowest pocket containing the shell immediately in line with the breech of the gun.

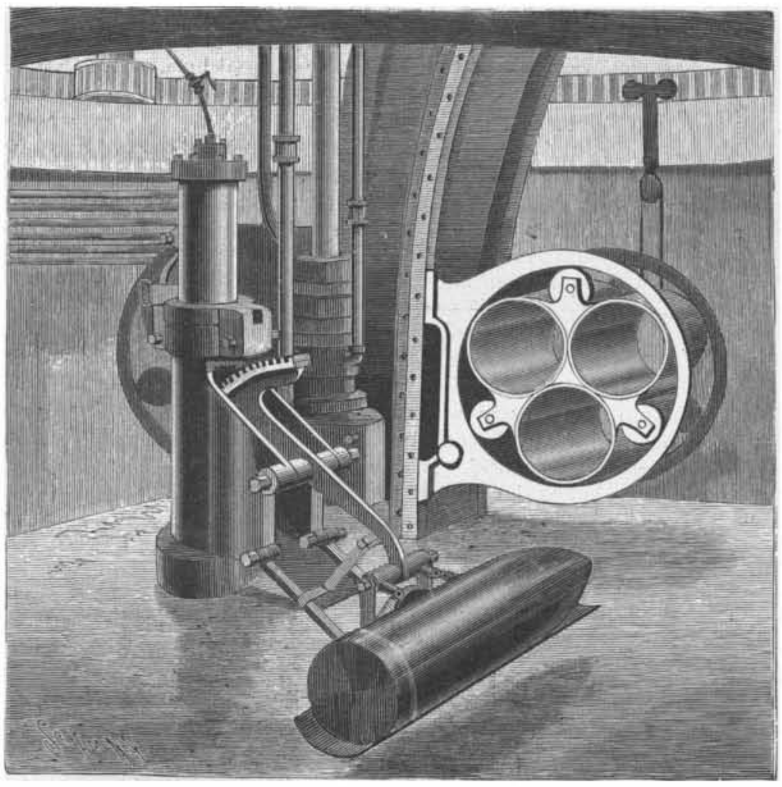


Fig. 3.—HANDLING ROOM OF THE MONITOR TERROR—PNEUMATIC LIFT FOR LOADING CHARGE INTO CAGE OF AMMUNITION HOIST.

It is then pushed home by a telescopic rammer which is operated by compressed air, the valve which admits the air being worked by a man who sits astride of the cylinder. It will be noticed that the rammer is carried by a bracket bolted to an extension of the gun carriage, and it is consequently held at all times in true line with the bore of the gun. After the shell has been rammed home, the loading car is rotated and the two sections of the powder cartridge are brought successively opposite the breech and pushed home. The breech plug is then swung round, thrust into place and locked.

The recoil of the gun is controlled by two pneumatic cylinders, 14 inches in diameter and 40 inches in length. The cylinders, whose heads can be seen in Fig. 2, below the breech, are secured to the gun carriage and the pistons to the gun. Before firing, the pressure on the recoil side of the pistons is about 500 pounds per square inch. As the gun recoils, carrying the pistons with it, this pressure is rapidly increased by compression. To reduce the pressure at the end of the recoil, a tapered rod is provided, which passes through the center of the piston and allows the air to pass more and more freely to the counter side of the piston as the gun returns. The residual pressure is utilized to return the gun to its firing position. Perhaps there is no part of the many operations performed by compressed air on the Terror in which the power shows to better advantage—the elasticity of the air preventing all shock and providing an easy cushion in the recoil and counter recoil.

The last and most important duty performed by the compressed air is that of steering the ship. The interior of the steering room is shown in Fig. 4, and the work is performed by the two long horizontal cylinders which will be noticed arranged one on each side of the tiller. They are provided with a common piston rod, in the center of which is a hollow crosshead in which the tiller is free to slide as it is swung right or left by the movement of the pistons. Compressed air is admitted to the outer ends of the cylinders by means of a D valve, the air being simultaneously admitted at the back of one piston and exhausted from the other, according as the helm is to be put over to port or to starboard. Air is also admitted at all times at the inner ends of the cylinders, and a pipe connects them, so that as the pistons move, the air may flow freely from the inner end of one cylinder to the inner end of the other. In the center of the connecting pipe is a bypass valve, which is open when the tiller is being moved, but closes when it has been traversed the desired angle and holds the air imprisoned in the cylinders, thus locking the tiller between two elastic cushions. The heavy shocks to which the tiller is subject in rough weather will thus be received and absorbed by the air, and the framing of the ship will be proportionately relieved of the strain.

Provision is also made for steering the ship by electricity or by hand power. For the latter purpose an auxiliary tiller, which can be quickly coupled to the rudder head, is placed above the pneumatic cylinders. It is operated by means of an endless wire rope which passes through sheaves at the end of the tiller and round a drum attached to the deck beams overhead. The drum is controlled through a chain and sprocket gear by the large hand steering wheel shown in the engraving. The steering may also be controlled by an electric motor which is located in the same compartment. The shaft which operates the valve of the pneumatic cylinders has three clutches upon it, by manipulation of which the steering may be carried on by electrical connections from the pilot house or from either of the turrets. During the tests of last November the rudder was turned from hard a-port to hard a-starboard in the very short time of six seconds. In testing the turret engines, the air was exhausted from the receiver and the compressor was started. In a few seconds the 250 ton turret began to move, and in 45 seconds the full working pressure of 125 pounds to the square inch was realized. It took 52 seconds to swing both turrets completely around their full arc of training.

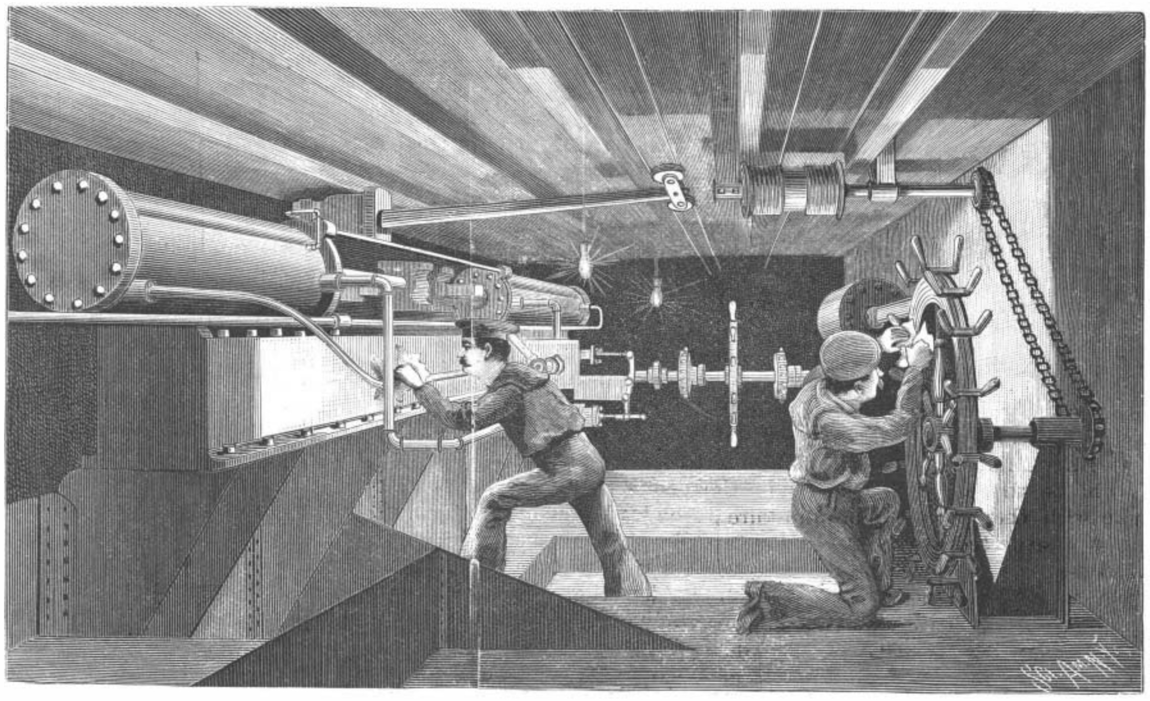


Fig. 4.—PNEUMATIC STEERING APPARATUS ON THE MONITOR TERROR.

Those of our readers who wish to learn the full particulars regarding this ship are referred to our issue of November 21, 1896, in which an illustrated description of a sister vessel, the Amphitrite, will be found. It may be briefly stated that the Terror is an iron, low freeboard, coast defense monitor of 3,990 tons displacement and 11 knots speed. Her armament consists of four 10 inch rifled guns, carried in two turrets plated with 11½ inches of steel, and a few light rapid fire guns. Her freeboard when fully loaded is only a little over two feet, and in a seaway the waves roll freely across her main deck. This renders her an extremely difficult mark to hit, and only at the closest quarters could she possibly be sunk by gun fire.

Our thanks are due to the inventor, Mr. A. A. Spiller, of Boston, for the data from which our engravings and description have been prepared.

Cost of Track Sixty-five Years Ago.

In an old pamphlet which was discovered recently in the Astor Library, in New York, are some interesting figures with reference to the cost of a piece of track laid by the Baltimore and Ohio in 1830 and 1831. I. L. Sullivan, evidently a civil engineer, in a report to R. L. Colt, estimates that the track laid with wood sleepers, wood bearers, and plate rail, exclusive of ground and graduation, would cost $4,362 per mile; with stone blocks, wood bearers, and plate rail, of which the cost of iron was $1,324, the cost would be $5,115 per mile; with granite sills in line with plate rail, of which the iron was $2,037, the cost would be $6,500 per mile, divided as follows:

Sills at $11.50 per 100	$3,680
Bar iron	1,300
Broken stone	640
Various items	880

This engineer speculated on two ton loads and one ton cars, and said in his report that the Baltimore and Ohio would be doing a very rash thing if they went beyond this point. He also says, "The locomotive engine now operating successfully on the Baltimore road, made by Mr. Winans to run on a friction carriage, though of moderate power, has a great useful effect."

A FOUR SIDED DOVETAIL.

One who examines ornamental woodwork, such as is often seen in old English furniture, finds much to admire in the dexterity with which much of it is done.

Aside from its decorative interest, one may sometimes find in its construction clever little devices, often the invention of the skillful workman, and showing sometimes ingenuity that is very puzzling.

One is frequently surprised to find seemingly impossible things executed in the most simple way, and though these contrivances do not always give strength to the structure, yet are in themselves very interesting bits of decoration.

A most clever device of this sort is the four sided dovetail.

This is apparently two pieces of wood, usually of different colors, and four sided, dovetailed together end to end, thereby showing on each face a dovetail.

To a superficial observer, and probably to many who sought to discover the manner of so joining these pieces, it would prove a puzzle indeed, and almost impossible of accomplishment.

Like many of these peculiar devices in dovetailing, the effect and task is consummated by a very simple wedge problem. In this case the pieces are not pushed together end to end, but slipped into place from the side.

The cuts made in the one are so shaped as to receive exactly the parts of the other, and also so that when joined each side shows a dovetail.

In Fig. 1 we illustrate the method of laying out the work before sawing out the mortise. Fig. 2 shows the method of joining the two sections, and Fig. 3 shows the completed work.

An Anthropological Expedition.

Mr. Morris K. Jesup, president of the American Museum of Natural History in Central Park, has preparations well advanced for an exploring expedition which he proposes to send out in search of information in the line of anthropology and ethnology. The expedition will be the greatest, it is said, in point of time spent and territory traversed, ever backed by private individuals in this line of research.

America, Asia and Africa will be visited. Such specimens as are collected and such information as is gleaned on the subject of man in his earlier stages will be devoted by Mr. Jesup to the museum of which he is the head. This information, with some details, was given to a correspondent of the New York Times at Albany.

The expedition will be backed by Mr. Jesup from his private resources. Prof. F. W. Putnam, who was in charge of the anthropological division of the World's Fair and for many years a professor at Harvard, will conduct the expedition, and with him will be the anthropologist, Dr. Boas. They will take with them a competent corps of assistants, and will, it is expected, occupy six or seven years in their researches.

They will first visit the northwestern coast of America to the north of British Columbia, and will work up along the entire seaboard of Alaska. Then they will cross the Bering Sea to Asia, and work down the entire coast of Siberia and China, and around through the Indian Ocean to Egypt. Preparations for this long trip, with the incidental incursions to the countries visited, have been under way for some time. Among other things, the consent of the various Asiatic countries to visit them and make investigations of this nature has been secured, in part at least, and that of the others it is expected will be obtained without serious difficulty.

The expenses of the expedition are estimated at about $60,000.

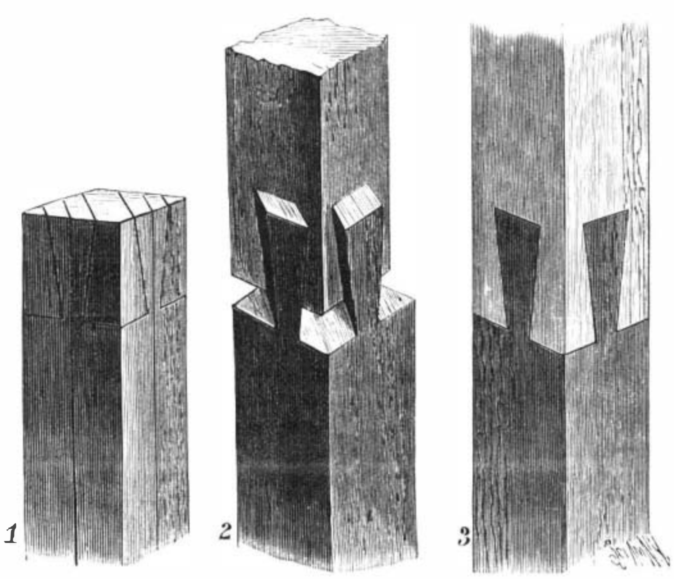
Especial attention is to be given to acquiring information on the subject of man's first appearance on this continent, and all that can be learned on the subject of the earliest visitors from Asia, with their characteristics before they came and after their arrival, as well as the route by which they came, will be carefully collected.

Mr. Jesup, it is said, desires to make as complete a collection of anthropological antiquities as is possible, and proposes that time and money shall be devoted to the work with the same patience that characterized his efforts some years ago in collecting the specimens of American woods, which now form such a valuable exhibit in the museum. In making that collection more than ten years were spent. So confident is he that a collection worth having will be secured that he has consulted with the New York City authorities on the question of space for displaying it.

It is said the expedition will be started out as soon as the necessary arrangements can be made for so long a trip. The New York City authorities, it is said, are heartily in favor of locating such collections as may be made within the museum. Just how many assistants Prof. Putnam will take with him is not determined.

The Retirement of Prof. Newcomb.

Prof. Simon Newcomb, who retired from the navy and the superintendency of the Nautical Almanac on March 12, leaves a remarkable record of public service, through which he has become one of the foremost savants of the world. In the forty years which have elapsed since he first became connected with the Nautical Almanac office, and especially in the twenty years of his superintendency, he has done more than any other American since Franklin to make American learning respected and accepted in European countries. To-day every astronomer in the world uses Newcomb's determinations of the movements of the planets and the moon; every eclipse is computed according to Newcomb's tables; every nautical almanac is based on the determinations of the Washington office, and the shipping of the civilized world is guided either by the American Nautical Almanac or by ephemerides based on Newcomb's work.



A FOUR SIDED DOVETAIL.

Prof. Newcomb was born in Wallace, Nova Scotia, in 1835. He came to the United States in 1853 and began his career as a teacher in Maryland. He became acquainted with Joseph Henry, of the Smithsonian Institution, and Julius E. Hilgard, superintendent of the United States Geodetic Survey. The latter was so impressed with Mr. Newcomb's aptitude for mathematics that in 1857 he succeeded in getting the young man appointed a computer on the United States Nautical Almanac. Mr. Newcomb entered the Lawrence Scientific School and graduated in 1858, and afterward remained three years as a post-graduate student.

While in Cambridge he found time to plan and execute one of the most ambitious pieces of astronomical work undertaken up to that date. This was the computation of the orbits of the asteroids—that singular group of miniature planets revolving about the sun between Mars and Jupiter. Newcomb's first calculations were made on four of the asteroids in 1859, and attracted much attention when presented at the meeting of the American Association for the Advancement of Science at Springfield, where he exhibited a diagram showing the changes in the orbits during a period of many thousand years. In 1860 he published a general mathematical theory of the subject, applying it to a larger number of these little planets, and this publication at once gave to the young computer an international reputation.

In 1861 he was appointed professor of mathematics in the United States navy, and went to Washington to reside. Here he negotiated for the 26 inch equatorial instrument.

In 1870 he was sent to observe a total eclipse of the sun, visible on the Mediterranean, and established a station at Gibraltar. Unfortunately, the usual observations were prevented by clouds, but the opportunity was utilized in extending certain original studies concerning the minor motions of the moon. Lunar tables showing the recognized motions of the moon were already in existence, notably those constructed by Hansen and published by the British government in 1857; but even before 1870 it was found that the observed positions of the earth's satellite did not correspond with the computed positions, as shown by error in the calculation of the eclipses and in other ways; yet the problem defied the combined skill of the mathematicians and astronomers of the world. With his genius for tasks deemed insurmountable by others, Prof. Newcomb had already set himself to the resolution of the problem, and while abroad he visited the various observatories of Europe, and consulted the earliest records extant. The task was not abandoned until the problem of the motion of the moon was solved and until formulæ were developed for constructing accurate lunar tables. This triumph gained fresh laurels for the young astronomer throughout the world, and brought him official recognition from different nations.

Although the two tasks just noted were everywhere regarded by astronomers as of unprecedented magnitude, they were in reality only steps toward the accomplishment of a much greater task which Newcomb had already set for himself. This herculean labor was the accurate determination of the "elements of the solar system," including the measurement of the dimensions, weights and orbits of the principal planets, the larger asteroids and the more important statellites or planetary moons. This work was carried forward in connection with official duty as opportunity offered.

As early as 1867 he published a final memoir on the secular variations of the orbits of the asteroids; this was followed in 1874 by results of investigations concerning the orbit of the planet Uranus; the final researches into the motions of the moon were published in 1876, and other results of the work were placed before the public at frequent intervals in official reports as well as in unofficial scientific papers. In 1877 he was made superintendent of the Nautical Almanac office, and thus acquired additional facilities for carrying forward the laborious task, which he has now practically completed. The details of the work fill volumes, and are so complex and elaborate as hardly to be summarized.

As might be supposed, Prof. Newcomb's important labors brought him great honor. He is the author of several works on astronomy and other subjects.

The National Forests.

A law was passed a few years ago empowering the President of the United States to declare portions of the federal territory to be forest reserves. In this way many of our great national reservoirs, the sources of our rivers, were protected.

Over eighteen millions of acres of forests or river sources of land were declared reserved by President Harrison, and on Washington's Birthday, 1897, President Cleveland approved the report of the committee which has been studying the matter. By his action twenty-one millions of acres of forest reserves are preserved. The combined area of these two reserves is as great as the States of Maine, Massachusetts, New Hampshire, Vermont, and Rhode Island.

The location of the boundaries of these forest lands has been carefully studied by a commission appointed by the National Academy of Sciences, who have aimed to include as much as possible of the great bodies of timber and unclaimed land. Wherever it was possible to secure the continued existence of forests on high mountain slopes, they did not fail to do so. The committee was composed of Prof. Charles S. Sargent, who was president of the committee, Prof. Brewer, Prof. Agassiz, Gen. Abbott, Mr. Pinchot, and Dr. Hague.

The new reserves include all the central portion of the Black Hills of South Dakota, the Big Horn Mountain range in Wyoming, the basin of Jackson Lake, and the Teton Mountains south of the Yellowstone National Park in Wyoming, all the Rocky Mountains of northern Montana, an important forest in northern Idaho, the principal part of the Bitter Root Mountain region in Montana and Idaho, the Cascade Mountains of northern and southern Washington, the Olympic Mountain region in western Washington, the Sierra summits in California north of the Yosemite National Park, the San Jacinto Mountains in southern California, and the Uintah Mountains in northern Utah.

A CORPORATION to be known as the Southern California Power Company has been organized with a capital stock of $1,000,000. The purpose of the company is to develop power from the Santa Ana River by taking the water out at the junction of Bear Creek and Santa Ana River, carrying it in a cement ditch and tunnels about four miles, thus securing a fall of 1,000 to 1,100 feet, and then running the water again into the stream. The power will be transmitted by a pole line seventy-five miles to Los Angeles, there to be used to supplant steam power. It is said that it will be the longest line and the highest voltage (30,000 volts) in use in the world.