steel was adopted ; but, as this showed too great a tendency to be racked by fire, a compound armor was constructed by welding a plate of steel on one of iron. More recently nickel-steel armor (first made by Krupp) and the Harvey armor have been much used. The latter consists of soft steel, the surface of which has been carbonized and hardened so as to give it great power of resistance.

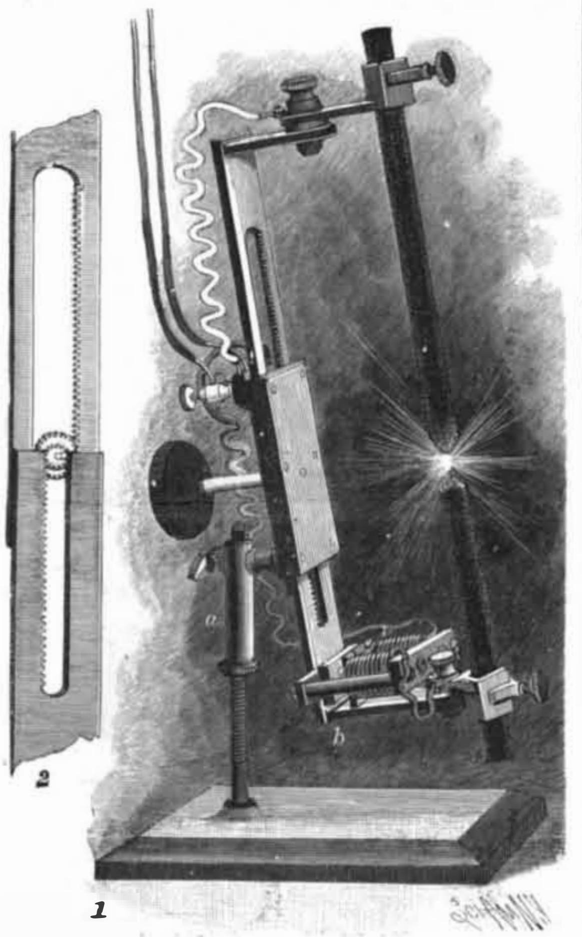
Finally, it became necessary to use armor on coast fortifications, as it was impossible to build walls thick enough to resist the terrible force of the new guns, and even if the masonry could have withstood the high explosives in the projectiles the embrasures in such thick walls would have limited the range of the guns behind them. Plates of armor like those used for vessels were employed on land fortifications, but later chilled iron armor, which was first made by Gruson in 1860, was substituted for rolled iron armor. The great weight of the former rendered it impracticable for use on vessels, but made it especially effective in annihilating the live force of the striking projectile. It is used for stationary parapets, for batteries and for revolving turrets. Our engravings Nos. 3 and 4 show interior and exterior views of a battery made of chilled iron, for 24 centimeter guns, in course of construction. The porthole plates are curved so as to cause the attacking projectiles to slide off, and these plates are supported by pillar plates. Below the porthole plates are the pivot plates that carry the pivots on which the carriages swing, and in front of them, reaching to the lower edge of the portholes, is the glacis of beton or stone blocks. The battery is in a casemate which is protected at both ends from the shells of the enemy by heavy walls and earthworks.

Where a wide range is to be covered, armored turrets are used which are made to revolve so that the guns can be fired in all directions. Chilled iron armor of the type used for vessels is employed for these turrets, and the form and arrangement of the first ones were the same as in the turrets of monitors. Gruson was the first to undertake the construction of a turret to which chilled iron is adapted, and thus a new model for armored turrets was obtained. The cylindrical form with a flat or arched top has generally been abandoned and the preference given to a cupola-like arrangement of the whole turret, which presents no vertical surface, whereby the action of the striking projectile is very much weakened. Our illustrations Nos. 1 and 2 show a revolving cupola or turret for two 24 centimeter guns, in course of construction. No. 2 shows the cupola resting on a wrought iron base which, in turn, is revoluble on a circle of rollers. The tongues and grooves that form the connection between the separate plates are plainly shown. The gun carriages have no sidewise movement, as this is obtained by the revolution of the cupola. The guns are raised and lowered by hydraulic power, and when fired the recoil is taken by two hydraulic brake cylinders for each gun, limiting the recoil to 2 to 3 calibers. The guns return automatically to the firing position. Aim is not taken through the portholes, but through a little sight opening in the roof of the turret. The revolving mechanism and the pumping mechanism for the hydraulic power are usually operated by hand, but in France, where the turrets were intended to turn in carrousel fashion during a battle, motors were used. A brake device is provided to prevent accidental turning of the turret when only one gun is to be fired. A suitable stationary glacis is arranged on the masonry foundation and surrounds the revolving portion of the turret. This is illustrated in cut No. 1. This glacis is embedded to its upper edge in beton or granite. Forty or forty-five men are required to operate such a turret, only six of whom are needed to man the guns. Under favorable circumstances each gun can be fired about once in three minutes.

As only long cannon for direct fire can be employed in such revolving turrets and batteries—generally arranged in pairs in the former—cupolas for howitzers and mortars have to be differently arranged. These weapons are always fired at the same angle, and therefore the cupola which turns in the circular glacis can be quite flat and, on account of its light weight, be rigidly connected with the carriage, which revolves on a central pivot. Carriages of this class are especially adapted for inland fortifications and are called "armored carriages." For the shorter mortars the cupola is contracted to a sphere inclosing the mortar, only a small portion of the cupola about the opening extending from the glacis.

By the introduction of the disappearing turrets an attempt was made to obtain greater safety than could be expected with turrets which simply revolved so that only their portholes are turned from the enemy. The first of these were constructed by the Schumann-Gruson works and were arranged for small and medium sized guns, but later a disappearing turret for heavier guns was built in France by Galopin. In such turrets the moving part, which is made cylindrical and covered with a slightly arched hood, has a sinking movement as well as a turning motion, and can be lowered until its top is on a level with the glacis, so that when in loading position there is no opening exposed to the enemy and the turret itself is scarcely visible. The disadvantages of this arrangement are that the wall carrying the portholes is so straight as to have very little resisting power, and that the motors required for large plants are very expensive. The Frenchman Mougin tried to solve the question of obtaining greater safety while retaining the approved armored cupola, by mounting a comparatively flat dome on a turntable by means of a cradle, so that when tipped forward the portholes are brought under the glacis, and when the cupola is swung back the portholes return to the firing position. This pendulum turret also has its disadvantages, the chief of which is that the circular opening between the cupola and the glacis cannot be covered, and if the portions of the enemy's shells should find an entrance there, they might easily disable the turret.

We have, as yet, mentioned only fortifications which to a certain extent may be considered proof against the fire of an enemy ; that is, those in which an effort is made to supply protection against indirect as well as direct fire. In many cases, especially in coast fortifications, such overhead covering is not deemed necessary, and as a substitute for the closed revolving turrets, either the barbette turret—in which the guns fire over a stationary ring of armor—have been borrowed from armored vessels, or the disappearing carriage, designed by Moncreiff and completed by Armstrong and others, has been adopted. In the former the gunners are protected by a shield connected with the carriage mounted on a turntable. A longitudinal opening is arranged in this shield to provide for aiming the gun high, and it is closed by the barrel of the gun, which is thus left uncovered. In the disappearing carriage the gun also stands on a turntable in a basin of masonry or armor that is provided with a perfectly flat top, also of armor, which cannot be seen from a distance. If such an invisible turret is to be brought into action, the barrel of the gun is raised by means of a pneumatic device, and appears at an aperture in the roof, which is opened at the proper time, and then after being fired the gun is returned automatically, by recoil, to the protected loading position. Disappearing carriages of the front pintle form are used in batteries in which the guns are fired over an armored parapet.



HAND FEED ARC LAMP.

Armored fortresses are found on the coasts of all civilized countries. In Germany and Italy—in the latter much has been done for the defense of its long stretch of coast—the above described Gruson chilled iron turrets are preferred, but elsewhere, as in England and the United States, disappearing carriages are more used. There are immense inland fortifications of unusual strength in Roumania, on the Russian frontier, which consist of three lines of defense about half a mile apart, the first consisting of portable armor shields for small rapid firing guns, the second of disappearing shields for medium sized guns, and the third of disappearing armored turrets. There must be from three hundred to four hundred such armored structures there, the greater number of which have been made by the Gruson works from designs of the late of Mr. Schumann. The fortifications at Bucharest must include two hundred and three armored turrets and these, as well as the fortifications on the Meuse, at Liege and Namur—with a total of one hundred and ninety-two armored turrets—were built from the plans of the Belgian engineer Briahnont. Of course, there are many armored turrets of this kind in other places, notable on the eastern frontier of France, in regard to which we have no detailed information.

As shown by the above, armor has become more and more indispensable on account of the development of projectiles, and the old competition between guns and armor is no longer restricted to naval warfare, but has been extended to warfare on land.—Der Stein der Weisen.

HAND FEED ELECTRIC LAMP FOR LANTERNS.

BY GEORGE M. HOPKINS.

While a good automatic lamp is undoubtedly preferable to a hand lamp for uses necessitating the absence of the operator from the vicinity of the lamp, it is certain that an ordinary hand lamp is not to be despised, and when the hand feed is supplemented with a magnetic device for striking the arc, the difference between the two types of lamps referred to is not to the disadvantage of the hand lamp when the latter is used in a lantern or for some other purpose which permits the operator to remain near the lamp, so that he may adjust it at intervals of about four or five minutes.

The lamp shown in the illustration has been used for an entire evening without a flicker. The upper, or positive carbon, is cored, and the lower, or negative, is solid, hard Carré carbon.

On the threaded rod extending upward from the base plate is placed the sleeve, a, which is connected with the slide holder so as to have a slight inclination, as is usual in lamps for lanterns, in order to expose more of the face of the crater of the upper carbon. The slide holder contains two slotted slides; the one holding the upper carbon being 7½ inches long, the one holding the lower carbon being 5⅛ inches long, each being 1¼ inches wide. To the lower end of the lower slide at b is pivoted an arm extending outwardly and supporting the lower carbon-holding socket. To the arm near the joint thereof is secured an upwardly extending stud carrying an armature. An electromagnet having an elongated yoke is supported in front of the armature by brass studs attached to a brass cross arm fixed to the lower slide. A curved brass spring fastened to the armature bears on the poles of the magnet and serves the double purpose of throwing the armature back and the carbon upwardly when the armature is released, and of preventing the armature from sticking to the magnet.

The upper carbon-holding slide is provided with a fixed arm extending outwardly and supporting an insulated carbon-holding socket. These sockets are connected with their respective arms by bolts, which are surrounded with soapstone insulators provided with flanges which separate the sockets and the arms. The heads of the bolts are insulated by means of mica washers. The holes through which the bolts extend are made oblong to permit of adjusting the carbons in a way to secure the best results, that is, by arranging the point of the lower carbon so that it will be slightly in front of the axial line of the upper carbon when the lamp is in operation.

In the slots of the carbon-holding slides are secured racks, which engage pinions on the spindle journaled in the slide holder (Fig. 2). The pinion for the lower carbon slide has half as many teeth as there are in the pinion for the upper slide, so that when the spindle is turned by the rubber hand wheel the carbons are moved in proportion to their relative consumption.

To an insulating strip attached to the back of the slide holder are secured two binding posts for receiving the wires connecting the lamp with the current supply. One binding post is connected with one terminal of the magnet, and the other terminal of the magnet is connected with the lower carbon socket. The other binding post is connected with the upper carbon socket.

The magnet is wound with coarse wire (No. 16 or No. 14), and the armature is adjusted to pull down the lower carbon about one-eighth of an inch. The carbon-holding sockets are formed of square brass tubing, with a screw at one angle which forces the carbon toward the opposite angle, and thus centers and aligns the carbons.

The Edison direct current is suited to this lamp when about fifteen ohms resistance is introduced in series with the lamp. A suitable range of current is eight to twelve amperes.

The great advantage of the arc striking device is that, after the carbons touch, the arc is instantly formed of the right length, thus saving the trouble of any fine adjustment by hand, and avoiding the possibility of any long continuance of a heavy current on the circuit. A very slight turn of the adjusting spindle, once in about four minutes, insures perfect steadiness. It is well to form a habit of thus regulating the arc after each change of slides. The illustrations are approximately one-third size.

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Prof. Langley's Aerodrome.

Prof. S. P. Langley's invention, the aerodrome, again demonstrated, to the satisfaction of its inventor, its ability to fly, on December 12, says the New York Herald.

The latest experiment was made on November 28, when the machine, launched from a specially constructed stage, flew 1,500 yards in a horizontal direction, and when its power was exhausted gracefully dropped, until it finally rested on the water. The experiment took place on an island in the Potomac River, about thirty miles below Washington. This has been the scene of all Prof. Langley's experiments. His first successful trial of the machine was made last May, when it flew about nine hundred yards.

On account of the danger of injury to the machine by falling in the trees lining the river bank, Prof. Langley only put enough water in the engine to permit its making a flight for about one and a half minutes. The engine is large enough to carry water for about five minutes. Its flight during the experiment lasted exactly one minute and forty-five seconds—a wonderful result, when it is known that no other invention has ever flown for more than a few seconds at one trial. The machine is almost entirely made of steel, and contains a peculiar steam engine of rather more than one horse power. During the last trial the engine generated sufficient power to turn the propellers something more than a thousand revolutions per minute. The weight of the machine itself is thirty pounds, and the boiler carries two quarts or about four pounds of water. The movable parts of the machinery weigh twenty-six ounces. The fuel employed is gasolene, converted into gas before use.

The aerodrome is about fifteen feet long and measures fourteen feet from the tip of one wing to the tip of the other. Its wings are of silk and are stationary. The machine is driven through the air by means of two screw propellers, one on each side, about four feet in diameter.

In order to start the machine, an initial velocity had to be obtained, and this was secured by means of a movable table so arranged as to turn in any direction, and thus guide the flight of the aerodrome at the outset. Mr. Langley had constructed the launch engine apparatus, and on November 28 placed it on top of a houseboat. The table is on wheels, and the machine was launched from it in a perfectly horizontal line.

The only description of the work done by Prof. Langley which has recently been published from his own pen is the paper presented by him at the May meeting of the Academy of Sciences, Institute of France. We publish herewith an extract from this report, which we believe has never before been published in English. The report also contains a letter of Mr. Alexander Graham Bell, who witnessed the experiments.

DESCRIPTION OF MECHANICAL FLIGHT.

BY M. LANGLEY.*

"In a communication that I addressed to the academy in July, 1891, I said that the result of experimental researches had shown that it was possible to construct machines that would impart such horizontal speed to bodies having the form of inclined planes, and several thousand times heavier than air, that they would be able to support themselves in that element.

"I have said elsewhere in regard to this matter that other than plane surfaces might give better results, while on the other hand flight in an absolutely horizontal line, which is so desirable in theory, cannot be realized in practice.

"As far as I know, no heavy aerodrome or flying machine, so called, has yet been constructed that can maintain itself in the air by its own power for more than a few seconds, the difficulties encountered in free flight being, for many reasons, very much greater than those experienced in the flight of a body bearing in its ascension on a horizontal track, pressing upward against the under part thereof.

"Everyone knows that many experimenters have devoted themselves to the study of mechanical flight, and although the demonstration that I have furnished† of the theoretical possibility of obtaining mechanical flight with the means now at our disposal appeared to be conclusive, so much time has passed without bringing any practical result that there is reason to doubt that these theoretical conditions can ever be realized.

"I therefore thought it proper to devote myself to the construction of an aerodrome or flying machine, making use of the conclusions that I had drawn.

"Perhaps the academy will find some interest in glancing over the account that I present herewith, given by an eye witness who is well known to them, of the recent work of that machine. I am led to proceed in this manner, not only by the request of the witness himself, but also by the thought that my studies may be interrupted by the performance of my duties, so that it seems preferable to announce the degree of success that I have obtained, although this success is not complete.

"The experiment was made on a bay of the Potomac some distance below Washington. The aerodrome was, for the most part, of steel, but, nevertheless, enough lighter material was used in its construction to reduce the density of the whole to a little above 1, taken as a unit, so that the total weight was slightly less than a thousand times that of the volume of air displaced. No gas was used to lighten the machine, and the absolute weight, not including the weight of the fuel and the water, was about 11 kilogrammes; the extent of the supporting surface was a little more than 4 meters. The motive power was furnished by a very light machine having about one horse power. There was no helmsman, and the apparatus for steering the machine automatically in a straight horizontal line was imperfect.

"Another important point: The small dimensions of the machine did not permit of providing an apparatus for condensing the steam, and it could carry only sufficient water for a very limited course, inconveniences that would be overcome by a larger machine. It was supported only by the action of its screws, operated by steam, and the reaction of the air on its slightly curved surfaces.

"It will thus be seen that the speed estimated by Mr. Bell was that which resulted from a continuous ascending movement, and was much less than that which would be produced by flight in a horizontal line."

MECHANICAL FLIGHT.

LETTER FROM MR. GRAHAM BELL TO MR. LANGLEY.

"Washington, May 6, 1896.

"I know that you do not wish publicity before having attained more complete success in steering your apparatus automatically in a horizontal line, but I think that what I have been permitted to see to-day marks great progress beyond what has been done heretofore in this line and that the news of it should be spread, and I am pleased to be able to give my testimony as to the results of the two trials that I witnessed to-day, by your invitation, trusting that you will consent to its publication.

"In the first trial, the apparatus, constructed mostly of steel and operated by a steam engine, was launched from a boat at a height of about 20 feet above the water. When propelled only by its steam engine it moved against the wind, rising slowly. While moving laterally and rising constantly, it described—with a remarkably uniform and gentle movement—curves of about 100 meters in diameter, until, having turned back on its course toward its point of departure, and at a height that I estimated to be about 25 meters, the revolutions of the screws had ceased (for lack of steam, as I understood) and the apparatus descended gently and without shock toward the water, which it reached one minute and thirty seconds after it left the boat. There was no shock and so little damage was done that it was immediately ready for a second trial.

"In the second trial, which immediately followed the first, the same apparatus was launched again and took nearly the same course under similar conditions, and with very little difference in the result. It rose uniformly and without shock, describing large curves and approaching a neighboring wooded promontory, which it, however, cleared, passing the highest trees without difficulty, at a height of 8 to 10 meters above their tops, and descended slowly, on the other side of the promontory, to the bay, at a distance of 276 meters from the starting point. You already have instantaneous photography of the flight that I took just after the apparatus was launched.

"From the extent of the curves described, which I, with other persons present, estimated from measurements that I took personally, and from the indications given of the number of revolutions of the screw by the automatic register, which I examined, I estimate that the length of the course was more than half an English mile, or more accurately a little more than 900 meters.

"The time occupied by the flight in the second trial was one minute and thirty-one seconds and the speed an average of between twenty and twenty-five miles an hour (that is, ten meters per second), on a constantly ascending course.

"I was much struck by the ease and regularity of the flight of the machine in both trials, and by the fact that when the apparatus was deprived of the motive power of the steam at the highest point of its course and thus abandoned to itself, it descended each time at a uniform speed which rendered any shock or danger an impossibility.

"It seems to me that no one could witness that interesting spectacle without being convinced that the possibility of flight in the air by the aid of mechanical means would be demonstrated."

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WHAT better New Year's gift can an appreciative employer make to his faithful foreman than a copy of "Experimental Science," with its 840 pages and 782 fine engravings of subjects that will both interest and aid him in his work?

Electric Arc in the Laboratory.

M. S. Walker expatiates upon the practical use in the chemical laboratory of the electric arc obtained from a low potential alternating current. He says it can be employed with advantage to show the effect of high temperatures upon difficultly fusible and non-volatile substances, for reduction of metallic oxides, as a partial substitute for the blowpipe in qualitative analysis and for the synthesis of certain compounds of carbon from their elements. The apparatus is arranged by fastening a cored carbon, about 10 by 1 cm., in a vertical position, so that the lower end is about 10 cm. from the top of the table. Connect by wrapping with insulated copper wire, stripped where contact is made with the carbon, then bore a conical shaped cavity 4 or 5 mm. deep in one end of another piece of cored carbon 4 by 1 cm., fix this in a wooden clamp and connect it with insulated wire as before. Connect all the wires so that the circuit will be completed if the carbons touch. The lower carbon is, of course, stationary, but the movements of the shorter piece can be controlled like a test tube in a holder. The rheostat is adjusted so that an arc $\frac{1}{16}$ to $\frac{1}{8}$ inch long can pass between the lower end of the longer carbon and the edge of the conical cavity in the smaller one, and most minerals and common metals fuse easily when a small piece is placed in the cavity. It is stated that there is practical freedom from danger when working with a 50 volt alternating current, if the apparatus is properly fixed, and that the inconvenience caused by occasional shocks is found to be less than that due to burns, etc., accidentally caused during ordinary laboratory practice.—American Chemical Journal.

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Water Beneficial in Typhoid Fever.

The Bacteriological Review commends the practice of water drinking in typhoid fever, the importance of subjecting the tissues to an internal bath having, it appears, been brought prominently to the notice of the profession by M. Debove, of Paris, believed by some to have been the first to systematize such a mode of treatment. The practice of that eminent physician consists, in fact, almost exclusively of water drinking, his requirement being that the patient take from five to six quarts of water daily, this amounting to some eight ounces every hour. If the patient subsists chiefly upon a diet of thin gruel, fruit juices or skimmed milk, the amount of liquid thus taken is to be subtracted from the quantity of water. The important thing is to get into the system, and out of it, a sufficient amount of water to prevent the accumulation of ptomaines and toxins within the body. Copious water drinking does not weaken the heart, but encourages its action by maintaining the volume of blood; it also adds to the action of the liver, the kidneys and the skin, and, by promoting evaporation from the skin, it lowers the temperature.

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* Extract of report of the meeting of the Academy of Sciences, Institute of France, t. cxxii, presented at the meeting of May 26, 1896.

† Experiments in Aerodynamics, Smithsonian Institution, 1891.