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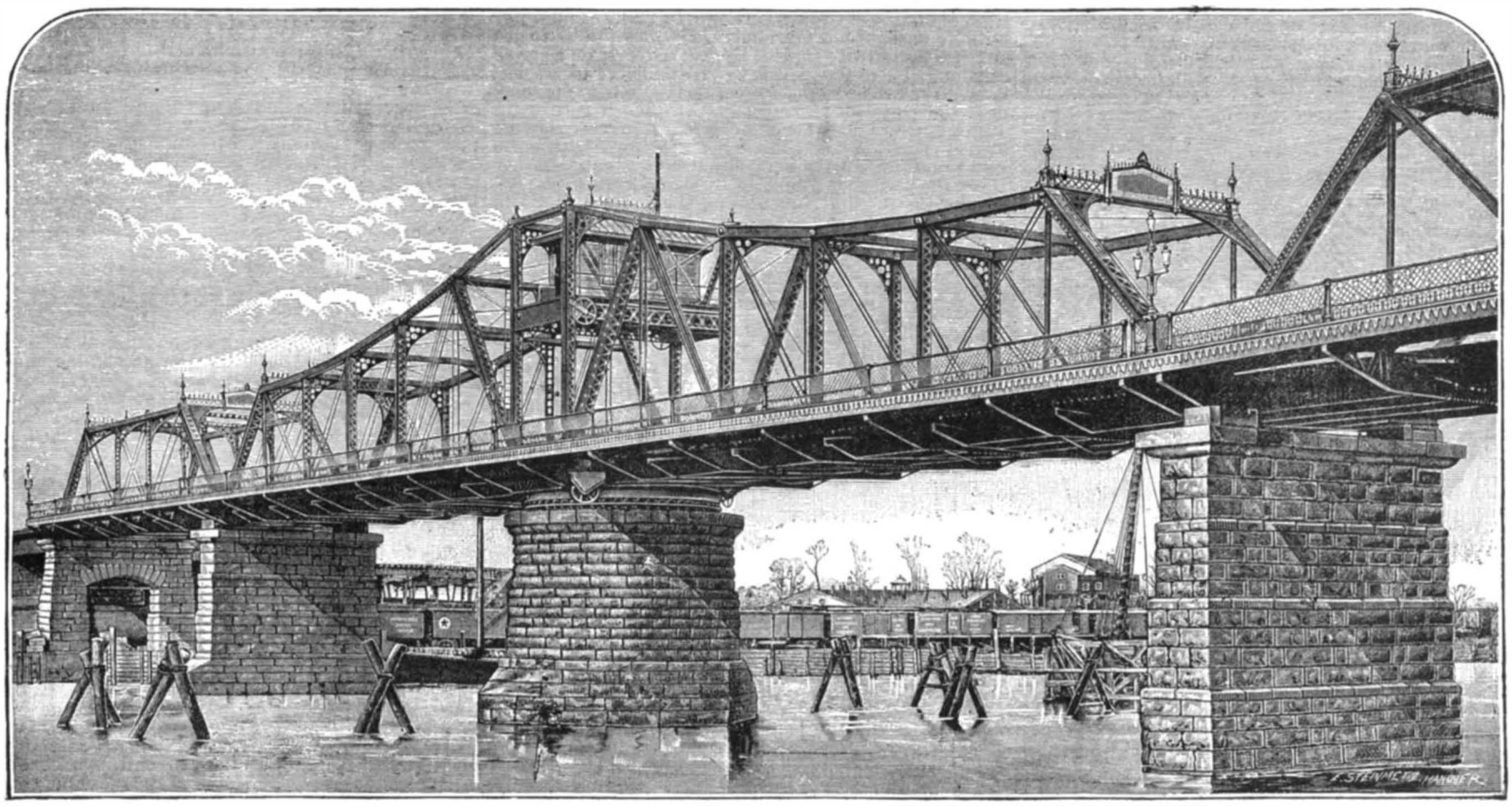
DRAWBRIDGE OVER THE HARLEM RIVER.

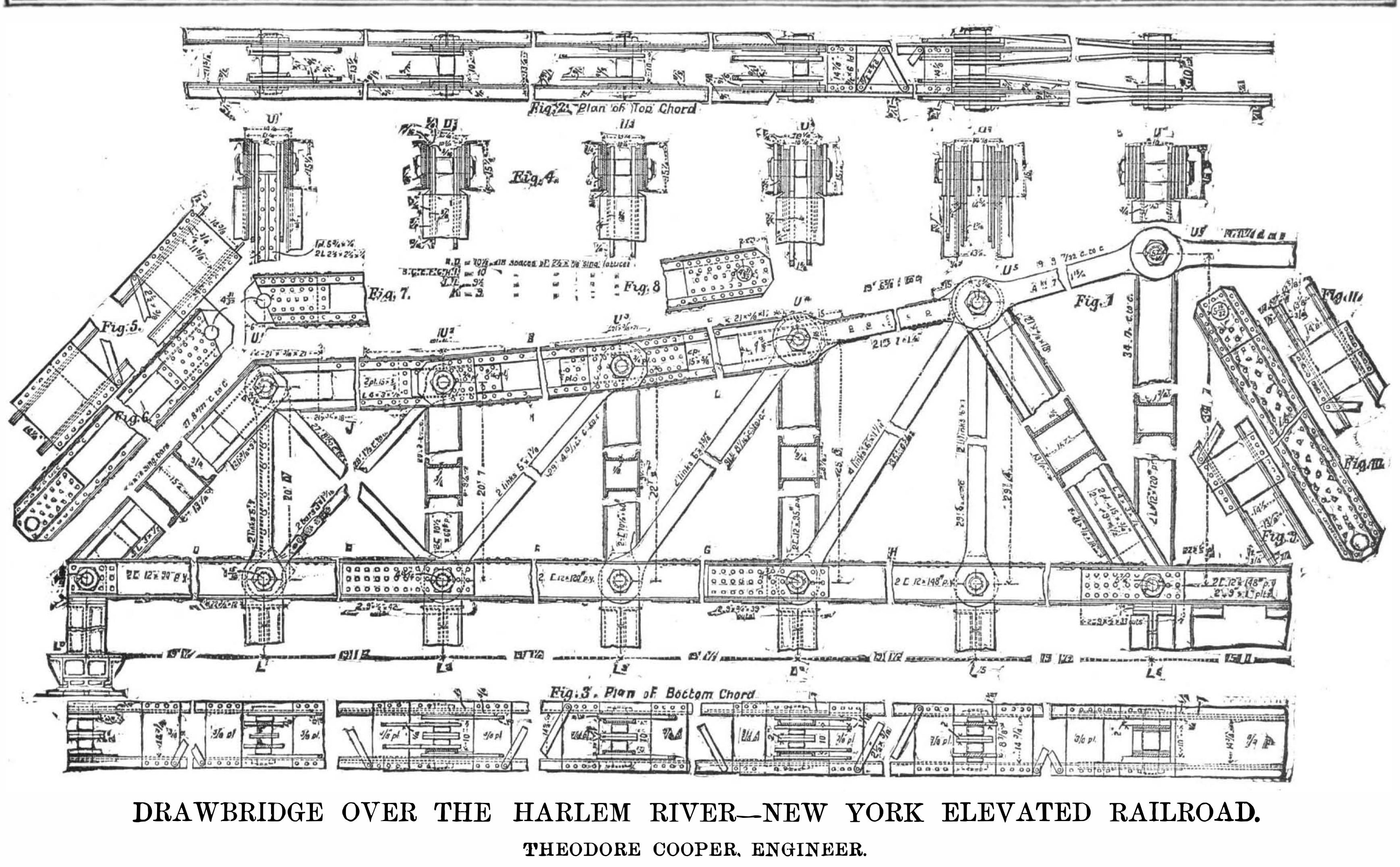
THE bridge was designed to connect the Elevated Railroad system on the east side of New York with the Suburban Rapid Transit Company's system of elevated roads on the annexed or northern district. This bridge consists of one draw span 246 ft. 6 in. from end to end at the center of the river, and two fixed side spans of 100 ft.

As one of the remarkable features of this bridge is the simple method of handling the draw, a detailed description of this will be of interest. It may be remarked at the start that this draw moves in a direction opposite to the pull of the ropes, and this is accomplished as follows:

The bridge rests and turns upon a ring made up of fifty-four cast iron coned wheels, 16 in. in diameter at the base; the drum thus formed is 26 ft. in diameter. The wheels are held truly radial by two guide rings, one inside and one outside of the wheels. The outer ring is grooved to receive the operating ropes. A tension rod connects the axle of each wheel with a movable center or hub (turning upon a steel shaft 6 in. in diameter), to which the guide rings are also braced by angle iron struts. The axes of the wheels are inclined upward toward the center at such an angle as to bring the upper bearing lines of the wheels in a horizontal plane. Heretofore, the axes of the wheels have been placed in a horizontal plane, thereby compelling the use of two inclined tracks for the wheels to roll between. But in this place the upper bearing plates, forming the upper circular track, are of wrought iron planed flat, while the lower track circle is made of cast iron segments, bolted together and firmly anchored to the masonry; its bearing surface is planed to conform to the inclined position of the wheels. On the upper bearing plate are springs for equalizing the load on the rollers.

The operating ropes—wire cables—are led by properly placed sheaves, as shown in the engraving, to a small room located in the center of the bridge, and the floor of which is at an elevation equal to that of the portals. There are four of these ropes, one at each corner, and the lower ends are secured to the guide ring at diametrically opposite points. These ropes act in pairs; two open the draw and the other two close it. Those ropes at diagonal corners operate together, or in the same direction. One of these ropes, after being





DRAWBRIDGE OVER THE HARLEM RIVER—NEW YORK ELEVATED RAILROAD.

THEODORE COOPER, ENGINEER.

passed around a drum carried in a frame placed between and uniting the plungers of two hydraulic rams, is secured to the framing at a point alongside of its own ram. The rope that operates in the contrary direction is led around a drum in the same frame, and fastened alongside of the opposite ram. It will be seen that either of these ropes may be made to pull upon the guide ring, according to the direction in which the rams move. At the other side are two more rams, working together, and two ropes arranged in the same way.

Each pair of rams has a stroke of 6 ft., so that the ropes and guide ring to which they are attached have a movement of 12 ft., but the bridge moves 24 ft. and turns a quarter of a circle at each stroke. If the lower horizontal portion of the right hand rope be pulled in a direction toward the right, the bridge itself and the guide ring and rollers will move against this pull, or toward the left.

The cylinders of those rams that work together are connected with each other by pipes. A small steam pump takes its supply from a tank, and pumps either to the rams or to the accumulators, which are two large wrought iron boiler shells, capable of standing a working pressure of 400 lb. to the square inch; they are simply large air chambers by which to obtain a permanent air pressure. They are so proportioned that, when filled half with water and half with air at 300 lb. pressure, the draw can be swung open and closed again without the use of the pump. The pumps are provided with small air check valves, so that the operator can supply any leakage, and on top of the accumulators is a valve by which any excess of air can be relieved. The piping is provided with the usual safety valve attached to hydraulic machinery. A four-way valve guides the water to and from the rams. As the working rams are operating, the remaining two push the water back into the supply tank.

To provide for the case when the bridge may have a large momentum, and the operator desires to reverse or break the movement of the draw to prevent the water ram which would occur on the non-operating rams, the supply pipes are furnished with check valves, which lift and connect with the accumulators, thereby allowing the bridge to cushion on the air in the accumulators.

A small pump is introduced for the purpose of getting a plunger small enough to be worked by hand during repairs to the boiler. By the use of this pump, driven by hand, and the accumulators, which can be pumped up when the draw is not in operation, the addition of the ordinary hand gear was considered unnecessary.

The wedges are operated by two small rams connected by rods with the arms of a bell-crank in bearings secured to the floor beams at each end of the bridge. To the lower arms of these cranks are attached rods which move the wedges and rollers. The movement of this bell crank also locks and unlocks the bridge. In closing, the ends of the bridge swing clear of the masonry; when closed, water is admitted to the proper ram, which then turns the bell crank at each end of the bridge. The arms carrying the rollers approach the vertical position, and each wedge moves in the same direction as its own roller, but not so fast. The ends of the bridge now rest upon the rollers, which in turn rest upon heavy iron plates on the masonry.

The speed of the wedges is now increased, and they come to a bearing; the rollers move a little further, and the ends of the bridge are supported by the wedges. When the other ram works, the ends of the bridge are lifted by the rollers, the wedges are withdrawn, and the bridge is free to swing. The same hydraulic pressure, but of course controlled by an independent valve, operates these rams.

The liquid used in the rams is glycerine mixed with water in such proportion as to be unaffected by the coldest weather.

The main object of employing this form of mechanism for operating draws was the avoidance of toothed gear of any kind—a class of mechanism which usually gives a great deal of trouble on drawbridges, because of the difficulty of getting a positive control of the bridge during high winds. This is caused by the necessary slackness of the gear, due to black lash, which permits the knocking of the bridge back and forth. A very small play between the teeth of the gears is sufficient to allow the ends of the bridge a considerable movement. The method above described differs from those employing gears, as there is no possibility of any of its parts binding so as to prevent the moving of the draw. An even bearing upon the rollers, if there should be a distortion of the bridge, is always obtained by the equalizing springs.

The bridge carries a double track railroad with footwalks at each side 6 ft. wide, and has been in constant and satisfactory use since last June, the great traffic of the river requiring it to be opened twenty-five to forty times daily. It requires about one minute to open and one to close the draw.—*Engineering.*

EARLY EXPERIMENTS IN STEAM NAVIGATION.

AN ACCOUNT OF ELIJAH ORMSBEE'S FIRST STEAMBOAT AND DAVID GRIEVE'S FIRST SCREW PROPELLER BOAT (1794), COMPILED BY THE HON. ELISHA DYER, ASSISTED BY SANFORD B. SMITH, ASSISTANT LIBRARIAN OF THE RHODE ISLAND HISTORICAL SOCIETY.

DAVID WILKINSON'S STATEMENT.

ON my way home from Hope Furnace, I called at the ore bed in Cranston, and found Mr. Ormsbee (I think Elijah, of Providence) repairing the large steam engine, which raised the water seventy-two feet from the bottom of the ore pits. The engine was made with the main cylinder open at the top, and the piston raised with a large balance lever, as the news of the cap on the cylinder by Boulton & Watt had not come to this country when that engine was built.

Mr. Ormsbee told me he had been reading of a boat being put in operation by steam, at Philadelphia, and if I would go home with him and build the engine, he would build a steamboat. I went home and laid my patterns, cast and bored the cylinder, and made the wrought iron work, and Ormsbee hired a large boat of John Brown, belonging to one of his large India ships—should think about 12 tons. I told him of two plans of paddles, one I called the flutter wheel and the other the goose-foot paddle. We made the goose foot to open and shut with hinges, as the driving power could be much cheaper applied than the paddle wheel. After we had got the boat nearly done, Charles Robbins made a pair of paddle wheels, and attached them to a small skiff, and run about with a crank by hand power. After having the steamboat in operation, we exhibited it near Providence, between the two bridges. I think while the bridges were being built. After our frolic was over, being short of funds, we hauled the boat up and gave it over.

MR. JAMES SALSBURY'S STATEMENT.

James Salsbury, ship carpenter, of Providence, said: "Elijah Ormsbee was the first man who applied steam to propel vessels. She was a side paddle boat. My father had a side wheel boat, the wheels being made to turn with a crank, which was fastened to something like a hub, in the center of the wheel, and went clean across, from side to side. There were boxes over the wheels to keep the water from flying. It was laid up in our garret for many years, but one day I put it in order, and went off and used it. The object of it was to paddle close up to water fowl. My father got the idea of this from Mr. Ormsbee's boat; but that was a kettle—tea kettle was the phrase we used—by which he applied steam and obtained the power to turn the wheels. He had some kind of an engine, I cannot tell what it was."

COL. JOHN S. EDDY'S STATEMENT.

Col. John S. Eddy said: "I went with my father when I was fourteen years old to Kettle Point, and there was Mr. Ormsbee with a canoe with a kettle in it raising steam to propel it.

"This was sixty-four years ago, in 1794. He did not build it on Kettle Point, but went down there to get out of the sight of people. He worked first on a canoe dug out of a log, and afterward applied it to a long-boat. We used to talk a great deal, when steamboats first came into use, about Elijah Ormsbee's getting up such a thing, a great while before. I do not recollect what was in the boat; but when tinkering with it, he said he meant to make her go by steam. Elijah Ormsbee made the first boat propelled by steam in America.

"He was the first inventor of the power loom. He made half a dozen of them to go up to Blackstone factory. I understood that Elijah Ormsbee made them. They are not in existence now. He was inventing all the while."

CAPTAIN JOHN H. ORMSBEE'S STATEMENT.

About the year 1794, perhaps 1796, Elijah Ormsbee, born in Rehoboth, Mass., and residing in Providence, R. I., where he learned the trade of a house carpenter—a man of much ingenuity and mechanical skill, having been employed at his trade in Albany or Lansingburg, on the Hudson River, and having seen the difficulties of navigating that river in the craft of those days—conceived the idea, as he informed others in the presence of the writer of this, that if vessels could be constructed to be propelled by steam power, the difficulties of navigating the Hudson would be done away with; he having occasionally been employed at the ore bed in Cranston, where steam power was applied to pump the water from the mine, while the ore was raised from the shaft by oxen. Mr. Ormsbee undertook to apply the power of steam to a boat. To effect this, he obtained from Messrs. Clark & Nightingale the loan of a long-boat, belonging, to the best of my recollection, to the ship Abigail, then lying in Providence. This boat he took to a retired place, about three and a half miles from Providence, known as Winsor's Cove.

A copper still, of from one hundred to two hundred gallons capacity, owned by Colonel Ephraim Bowen, used by him in his distillery in the south part of the town for the distilling of herbs, was also loaned to him by Colonel Bowen. The cylinder and castings were cast at Pawtucket, I believe at the furnace of the Wilkinsons.

All the wood work and most of the wrought iron work was done by himself in a shop near the cove where the boat lay. This cove was selected for its little exposure to travelers by land or water, that he might not be disturbed at his work, and in case of his want of success in his undertaking, he would not be subject to the derision of the community. He, however, succeeded in getting his machinery in operation, and on a pleasant evening in the autumn he left Winsor's Cove in the first boat propelled by steam that ever floated on the waters of Narragansett Bay and Providence River, and arrived in safety at the lower wharf, so called, in Providence. The next day he left in the boat for Pawtucket, to show his friends in that village the success that had attended his enterprise. At Pawtucket the boat remained a day or two, and then returned to Providence.

At Providence he employed several days in going down and up the river, and experiments on the management of the machinery. The writer of this accompanied him to steer the boat. Having been accustomed to a boat from ten years of age, and then being twelve or over, I was competent with good watching to do that duty, while Mr. Ormsbee occupied himself in making such improvements in the working of the machinery as could be done in so limited a space.

The steam power was not applied to elevate and depress the piston rod, as was done by Watt. Of this mode, I have understood that he knew nothing. The steam was applied to raise the piston, and then the steam being condensed by cold water, the piston returned by atmospheric pressure.

In this way, the paddles of the boat at her sides were moved forward and aft, no wheels being used, but upright paddles which did not lift out of the water, but when moved forward they closed, and when moved aft they expanded their whole width, being, to the best of my recollection, about eighteen to twenty-four inches wide. The progress of the boat was from three to four miles per hour. But the poverty of the constructor and inventor prevented his making improvement, and having no Livingston to assist him, his embryo prospects were destroyed, and he returned the still to the distillery and the boat to its owner.

At his leisure hours, he constructed a miniature boat, about four feet long, with two wheels on each side, which could be put in motion by hand, the hand moving the machinery in the place of steam. *This miniature boat,* I have been informed, *was stolen or taken from him; but for what purpose was not known, as it was not heard of after the boat had been taken away.*

Mr. Ormsbee was employed by Col. Ephraim Bowen, to apply steam power for the pumping out of the vats at his distillery, for filling the stills, etc. The power of steam was from that generated in the stills, and while he could attend to it personally, the steam did its work very well; but in his absence, as no one understood as he did the management, it did not operate so well, and I believe it was given up after six or twelve months' trial, and Mr. Ormsbee returned to his occupation as a carpenter.

But his mind still ran on inventions for usefulness. He obtained a patent for a hand fire engine. The certificate of his patent is in my possession, but it did not answer his expectation. And in the time of the war with England, 1812 to 1815, he turned his attention to power looms, by which he was enabled to obtain a support for his family. Peace taking place, a more perfect loom was introduced, and he turned his attention to the making of sash. The tools he used or machinery for mortising and cutting tenons he kept to himself, and his tools and machinery for sash were his last attempt.

NOTE FROM CAPTAIN MARTIN PAGE.

In a kind note under date of August 28, 1860, from Captain Martin Page, he says, speaking of Mr. Ormsbee's steamboat: "I have never been able to find out the year it was built. . . . The inventor had not the means to perfect it, and it was given up. . . . I sailed for India in the year 1791, December 30, returned May 17, 1794. On my return, I heard something said about Ormsbee's steamboat. I think it must have been built in 1792 or 1793, before he invented the spring shuttle."

JEREMIAH CHILDS' STATEMENT.

Jeremiah Childs, born December 10, 1768, stated: "Ormsbee applied side wheels, turned by steam power, to a common whale boat, but could not make any great degree of speed. Christopher Capron gave me five dollars for calking her. I would as lief undertake to calk a board fence, and worked there only half a day. Somebody said he had nothing but a tea kettle for a boiler, but there must have been something else.

"Elijah Ormsbee was a very ingenious man, and invented looms. He made a boat to go by steam, which was about eighteen feet long. When steamboats came here, we used to say, we had seen such power before. He came from Seekonk. . . . The family belonged to Providence, and built the house at the corner of Main and Wickenden Streets."

The greater part of the foregoing facts have been obtained from the widow of Mr. Ormsbee and from the written statements of Col. John S. Eddy, James Salsbury, and Jeremiah Childs, on file in the records of the Rhode Island Society for the Encouragement of Domestic Industry, which were obtained by Gov. Dyer, while president of the society, in 1858. So much of these statements as relate particularly to Mr. Ormsbee, together with statements furnished me by Capt. John H. Ormsbee and Martin Page, are annexed. They contain many particulars not before alluded to. It will be found that they differ from one another, as the statements of honest men will differ when referring to things which took place half a century before.

Extract from the report of the Committee on Mechanic Arts. See Trans. R. I. S. E. D. I., p. 29, Jan. 18, 1858:

Mr. Grieve had his attention directed toward the employment of means to navigate vessels against the force of currents, without the aid of sails or the exerting of human power, by means of machinery, as early as the year 1800. On the 24th of February, 1801, he received a patent from the United States, for the "discovery that boats, or other craft, may be made to ascend rivers against the entire force of the current, by virtue of the action of the same repose wheels and other machinery." This is the language of the patent itself. The specification attached to it describes "the principle" which he had invented, as follows: "By actual experiment, I have ascertained that the motive power, or force of a current, stream, or tide of water in a river, may be applied to machinery in various ways, so as to cause a boat, or any other craft, floating upon water, to ascend or go up a river against the entire force of the current, stream, or tide of water, by virtue of said current, stream, or tide acting upon wheels and other machinery placed in, upon, and attached to said boat or craft." This is claimed "as a thing not before known or practiced, as also the machinery described by the drawings and explanations lodged in the office of the Department of State, which machinery I made use of to ascertain the above mentioned fact."

It is very evident that the claim set up in the patent, according to the terms there used to describe it, could never be substantiated. If it means that the current, stream, or tide, is the only motive power used to move the machinery and the boat containing it against the course of the current, it is most evidently what never has and never can be done.

Mr. Grieve was a man of too much common sense to pretend to such a thing. He must have contemplated some power to give motion to the machinery, and that the current acting upon machinery in motion would propel a boat against the current. If he did not mean this, we can only say that the claim is absurd on the very face of it. If the drawings of the machinery, which were deposited in the Department of State, had not been destroyed, we have no doubt they would explain the patent as we have done.

Mr. Grieve made two boats to be moved on this principle. The first was an old second hand long-boat, called a Moses boat.

Mr. Jeremiah Childs saw it in the Seekonk River, with four men in it, three of whom were traveling on a wheel, trying to turn a screw which made the boat move at a slow rate. Col. John S. Eddy saw a small boat, with a screw fixed to it, turned by a crank. Mr. James Salsbury saw this boat also. Mr. S. S. Southwort says that Mr. Grieve applied his invention at first to a ship's pinnace, and experimented with her in the cove, where her machinery was operated by four lads stationed on a horizontal wheel in the center of it, who pushed against stanchions, moving the wheel on which they stood.

This wheel operated on two shafts, that projected from the stern of the boat, to which spiral screws of heavy sheet lead were attached. The screws were be-

neath the surface of the water, and propelled the boat at the rate of from six to eight miles per hour. By the documents referred to us, we are unable to fix the time when this boat, or these boats, if more than one, were in use, any nearer than that it was before the building of the Experiment.

Mr. Varnum Wilkinson, now living, built the Experiment, he thinks in 1809 or 1810. It was between fifty and sixty feet long, from sixteen to twenty feet beam, and three feet deep from the top of the horizontal wheel to the keelson. This wheel was stepped on the keelson. On the under edge were iron cog teeth, which geared into a pinion, and which was also geared into other wheels on the ends of two shafts, one on each side of the boat, which extended beyond or to the stern of the boat, diverging from each other. On the outer end of each of these shafts was a screw about three feet in diameter. Motion was given to the horizontal wheels and through the gearing to the screws, by horses treading on it.

Col. Eddy did some work on this boat, and describes her generally as Mr. Wilkinson does. Mr. James Salsbury also recollects her. They describe, particularly, the way in which she was built, and the kinds of lumber used in her. The screws were made by Mr. John T. Jackson, and the iron work by Mr. Jonathan T. Nichols, now deceased, extensively known in his day as a very ingenious blacksmith. She was built near the William Eddy house on Eddy Street. They also agree in stating that she was built during "the embargo." Mr. Jeremiah Childs says he was on board of her, and that she was built in 1808.

Mr. S. S. Southwort saw this boat frequently; his father did some of the iron work for her. He says she had three masts, and was rigged by Mr. Richard Marvin.

Many alterations were required in her machinery, but it was finally adjusted, so as to carry the Grand Lodge of the State from Providence to Pawtuxet, on the 24th of June, 1809, which she did successfully. Her return was not quite so satisfactory. She met with a severe thunder squall on her passage back, and having no keel was driven to the east side of the bay, on Lion Shore, where she landed her passengers, with the privilege of walking home. This increased the prejudices against her, and she was attached by the creditors of Mr. Grieve and sold. The purchaser undertook to take her to Boston, but on her way there she was dashed against the vessel that had her in tow, and lost. Thus ended the Experiment, a boat propelled by a screw, built in 1808.

There is no person more distinctly remembered than David Grieve. In his Friends' garb, of a large round drab coat, knee breeches, spotless white stockings incased in his large, generous, well polished shoes with steel buckles, wide brimmed hat covering his nicely powdered wig, whose quick wit, sharp repartee, kept his shop well filled with those who gathered there to enjoy his keen satire on men and things.

The place and business was indicated by a large scroll sign over the front on Westminster Street, stating it to be the location of David Grieve, as cotton ball winder. The other front was on Walker Street; the location being at the corner of those two streets. It was high carnival when his round, rollicking countenance, bespeaking the best of health and the overflow of humor and fun, that would not brook silence or concealment, appeared.

One incident I well remember of his meeting a cotemporary on the street, who had come from the country, and was doing, for that period, a large, profitable, and successful dry goods business. He accosted him with the remark: "Well, Friend E., I am glad to hear of thy prosperity and increase of means, as I want thee to assist me in building my new boat." The reply came short and quick: "I will not have anything to do with it. It's a foolish thing from beginning to end." "Well, Friend E., although thee lacks confidence, the boat will be built, and thee will have something to do with it." "Not if I know it or can help it," was the response. "Well, well, we'll see." The boat was built, and being a failure, was finally sold to go to Boston. It being towed to that port, it was wrecked.

A few days after the occurrence, he met his former companion, and said: "Well, Friend E., they tell me that thou art a large shareholder in the ———— insurance office. I sold the boat to go to Boston, and it was so well insured, in that office, that I wish I had several others to sell and send there. And when thee goest to that office, perhaps thee will find how much thee has had to do with that foolish thing David Grieve built." The effect upon his companion's face and temper can better be imagined than described, as it was his constant boast and exultation.

His entire freedom from any liability to imposition or deception of any kind, his shrewdness and keen appreciation being an effectual protection against either. When Friend Grieve would narrate this circumstance to his numerous hearers, his twinkling eyes and complacent smile would most effectually express his gratification at his companion's great discomfiture.

As our residences were quite near each other, our meetings were very frequent; and his pleasant greetings would fill his shop with boys and children whenever they could get access, to see his cotton ball winding and button mould turning. I never saw him without a smile on his face and a twinkling of his eyes, expressive of the humor and wit that was struggling within, against silence and suppression. His mirth and jollity were irrepressible and contagious to all and every one that were in contact with him.

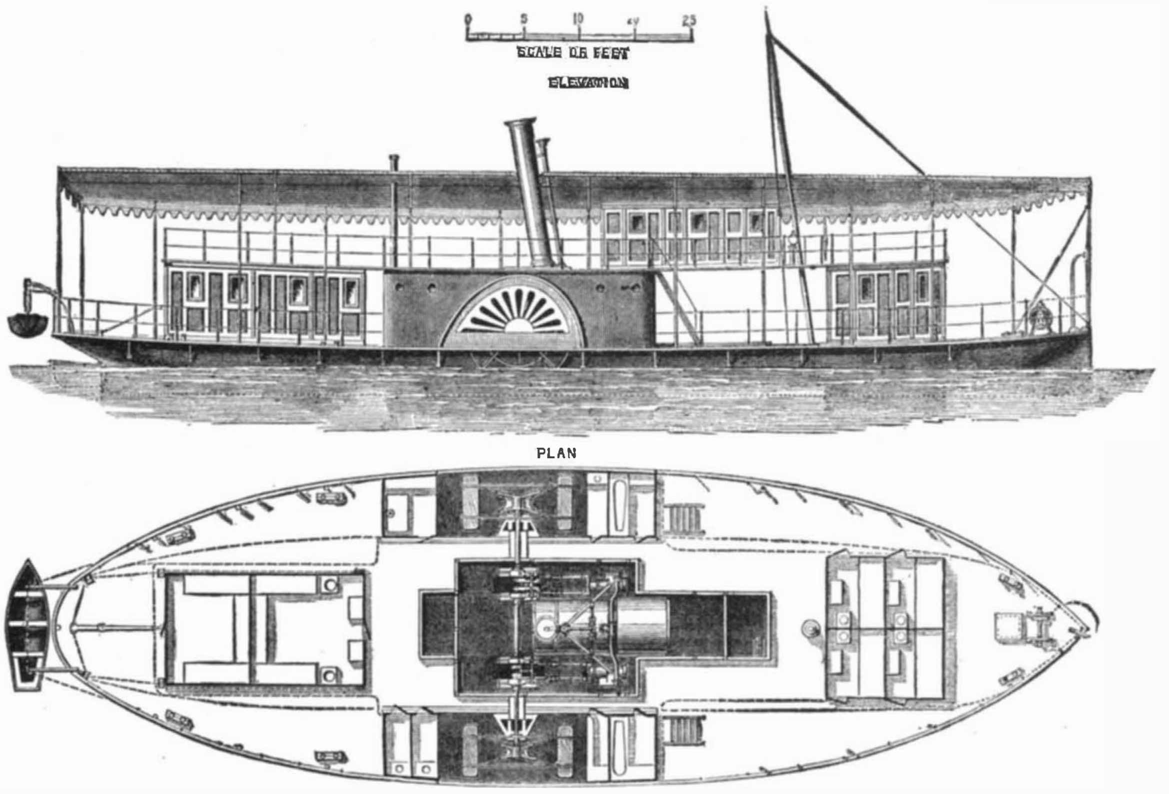
Memory recalls no one of so great an originality of character, mind, and person.

LIGHT DRAUGHT RIVER STEAMER.

THE light draught river steamer illustrated is one recently shipped by Messrs. John Birch & Co., of Liverpool. This craft is intended for regular service on the Moesie and Lematang rivers, between Palembang and Moeara Erim, Java, the total course being about 143 knots. Owing to the shallowness in some parts of these rivers, it was imperative that the draught when loaded should not exceed 2 ft. 6 in., and in view of the frequent bends in the rivers a greater length than 90 ft. was not permissible. The steamer was therefore built to the following dimensions: Length between perpendiculars, 90 ft.; breath moulded, 17 ft.; depth at side, 4 ft. 7 in.; draught of water, estimated with about 20 tons weight of fuel, cargo, and passengers, 2 ft. 6 in. Speed in nautical miles per hour at the above draught of water, $7\frac{1}{2}$ knots. The hull is built of mild steel and divided by four thwartship bulkheads into watertight compartments, the deck being sponsoned out forward and aft, as shown in the illustration, space being provided on deck for twenty deck passengers and two horses, and in the holds for nine tons of cargo and passengers' luggage.

All the woodwork, including the deck, is of teak. The light deck, in continuation of the deckhouse tops between the sponson houses, carried on angle steel beams, forms a covering to the engines and boiler. An awning extends over the whole vessel, this being carried by tapered galvanized iron poles. The accommodation and deck houses consist of a light teak deck house, 11 ft. long by 13 ft. wide, fitted forward, containing four staterooms for first class passengers, each stateroom fitted with a sofa berth, $6\frac{1}{2}$ ft. by $2\frac{1}{2}$ ft., and with usual fittings. A similar house, 16 ft. 6 in. long by 6 ft. wide, is fitted on the top deck with cabins for captain, engineer, and owner, fitted in the same way. The berths are fitted with cane bottoms, in lieu of the usual cushions, this arrangement conducing more to comfort in a tropical climate. The house aft on the main deck is fitted at the fore-end with benches for six second class passengers, and at the after end with six bunks for the crew. In the sponson houses are arranged a galley, small pantry, and two baths and water closets. The engines are non-condensing, capable of developing 80 horse power, and have two cylinders, each $12\frac{1}{2}$ in. diameter by 30 in. stroke. The paddle wheels are 9 ft. 6 in. diameter, working on each side of the boat.

The boiler is of the locomotive type, built specially to pass the Dutch government regulations. The vessel was shipped in pieces, after having the hull and machinery properly erected and fitted together in the shops, to Batavia, at which place she will be put together and steam to her destination, a distance of some 200 miles. —*The Engineer.*



A LIGHT DRAUGHT STEAMER.

TRACTION INCREASERS.

TRACTION increasers, their uses and best forms, will be discussed at the next master mechanics' convention. No better subject for discussion could be found for such a body of men as will then be present—men who are intimately acquainted with the locomotive, and those who are acquainted with traction increasers in every day use, as well as those who are interested in the manufacture of these devices.

The advisability of using some device for increasing the weight upon the drivers in nearly all the older locomotives and many of the newer ones is beyond question. Few locomotives exist which would not do more work with greater economy if they had greater adhesion to the rails. That is, the cylinders are larger than need be to do the work with the steam pressure carried.

The amount that the adhesion may be economically increased varies with the different locomotives; but in many instances can be so increased as to add twenty per cent. to the hauling capacity, and this without decreasing the economy of the locomotive.

For those who have not been able before to look into this subject, a notice of a few of its leading features will be necessary to put the matter in its true light.

Traction increasers may be divided into two distinct, wholly different, and antagonistic classes. In one of these the increase of traction is produced by adding to the locomotive a permanent load over and above the weight of material necessary to construct all its parts with perfect safety, thus obtaining an increase of adhesion. In the other class a portion of the weight of the tender is added at the rear of the locomotive by a device, consisting of levers or their equivalent, on the rear of the engine or front of the tender. The greatest difference between the two methods is, increase in the total weight of the locomotive and tender in the first case, and non-increase in the second. There is of course beyond the question of safety and convenience only one side from which to look at these methods, and that is the comparative final expense.

The cost of the first method, or permanent type, will of course vary with the cost of the material used to produce the extra weight. This is almost always cast iron, and costs the locomotive manufacturers and railroad companies owning foundries about two cents per pound, as the iron is of the lowest grade. The first cost of the shifting device will vary with the competition. The cost of maintaining the permanent type will be almost nothing, while the shifting type requires repairs and attention.

The wear and tear of roadbed due to the constant additional load in the permanent type will disappear in comparison to the total load passing over the road, and for both types may be neglected.

The cost of transporting the additional load in the permanent type is against its use. This cost may be called its maintenance, which it really is, and as such may be compared to the maintenance of the shifting type. The cost of transporting this additional load is less than the cost of the same weight on any other part of the train, for two reasons. First, because the resistance of each ton additional after the locomotive has reached its normal weight does not increase the total resistance as much as the average resistance of the total locomotive per ton; that is, the average resistance of locomotives thus loaded to increased adhesion is less than the average before such load is added. Second, because the load is nearer the point where the power is applied and is carried easier, particularly on curves. The probable average resistance on a level of this additional load is 2 lb. per ton. The only outlay to overcome this resistance is in the fuel furnished to the locomotive, and the amount required is about 2,900 lb. per year, determined as follows:

Two pounds at rim of a $5\frac{1}{2}$ ft. wheel will overcome the resistance of 2 lb. per ton. This causes about 10 lb. additional pressure upon the crank pin.

Distance traveled by crank pin per mile $=\frac{2}{5\frac{1}{2}}\times 5{,}280=$ 1,920 ft.

Foot pounds of work per mile $=10\times 1{,}920=19{,}200$.

Mileage per year = about 60,000.

Foot pounds of work per year $=19{,}200\times 60{,}000=1{,}152{,}000{,}000$.

Allowing 5 lb. of coal per h. p. per hour $=\frac{1}{12}$ lb. of coal per each 33,000 foot pounds.

Pounds of coal used per year $=\frac{1}{12}\times\frac{1{,}152{,}000{,}000}{33{,}000}=$ 2,909 lb.

Assuming the cost of the coal to be $3 per ton, we have the cost of the fuel per year to be about $4.35. The interest on the first cost of the additional metal will be about $2 per ton; making the total average cost per year per ton of metal added to be $6.35. Ten thousand pounds or 5 tons is about the amount of additional weight desirable on the average locomotive. This makes a total cost of $31.75 per year for the permanent type.

There seem to be no objections to this method of increasing the adhesion, unless it be the heating of the driving journals; but this is unnecessary, as nearly all driving journals are capable of running cool and withstanding an additional load of 10,000 lb.

In favor of the permanent type is the increased safety of the engineer when the additional weight is put into the cab stands and in the running boards. Their solid and heavy masses will resist the blows of a broken rod and thus protect the engineer.

The cost of the maintenance of the shifting device is difficult to determine. The original cost it is also impossible to state, as competition would soon reduce it below its present figure.

The objections to this device are not many, but of some moment. The variation in the pressure upon the driving springs will cause the locomotive to ride hard, if it can withstand the increased load when added by the increaser. The variation in the weight of the tender is great, and it may be that at all times it would not be safe to remove from the tender trucks all the weight that might be called for by the locomotive. Any device that blocks up or otherwise calls for space under that already crowded place, the under side of the foot plate, is asking much, and will not please constructors of locomotives.—*Master Mechanic.*

TOPOLOBAMPO.

IN our SUPPLEMENT 582 we gave an account of the settlement of this new colony in Sinaloa, Mexico. All hopes of the success of the colony have proved delusive, the colonists have abandoned the enterprise, and such of them as could do so have returned to this country.

THE PNEUMATIC DYNAMITE TORPEDO GUN.

Sorbrero's discovery of nitro-glycerine in 1846 gave to the world the base of all that class of high explosives known under various names, as forcite, dynamite, explosive gelatine, etc., and the tremendous force liberated when comparatively small masses were exploded by detonation was soon made of service in peaceful operations by civil and mining engineers. Meanwhile the fight for superiority between great guns and heavy armor has been going on, until each has nearly reached its limit. Not that thicker armor and heavier guns cannot be produced, but they have reached the point where the cost, in money and time, necessary to produce them is practically prohibitory should a sudden emergency demand prompt action.

Neither has the naval engineer, acting as an economist, been slow to see that greater destruction could be created with less expenditure if the high explosives, so useful in peace, could be employed in the art of war, and they have applied them successfully in the development of torpedoes, both fixed and automobile—both valuable adjuncts, but limited in their sphere of usefulness. The first to the protection of channels and passes, and the second, by the distance through which they can be accurately guided and the time consumed in covering it; during which time they are subject to the deviating and retarding effects of wind, waves and currents, besides being liable to premature explosion by fire from the enemy's machine guns, capable of delivering a perfect hail of shot or shell over a wide area, and again by being intercepted short of their mark by nettings and similar devices. Add to this the great cost of delivering a single charge, which, whether successful or not, involves the loss of the torpedo, it naturally followed that military men should look for the solution of the problem in some method of firing the explosive in shells from powder guns.

Many experiments in this direction have been made, both in this country and Europe. Comparatively small charges have been thrown with varying success, the experiment frequently ending in the destruction of both the gun and gunners. Even when fired successfully the results obtained were not appreciably greater than that obtained from a powder-charged shell, as the fulminate primers necessary to produce a high order of explosion on the dynamite is even more subject to explosion from shock than the dynamite itself, and cannot be used with safety in powder guns. Consequently the impact of shell against the target had to be depended on to produce the explosion—a method not only uncertain, but, if successful, productive of an explosion of a low order. Some other force, therefore, than gunpowder must necessarily be employed before large quantities of dynamite could be successfully projected, the powder gun being limited by other considerations than those already mentioned.

Even with the slowest burning powder, the initial shock upon the projectile is enormous. The shell containing the explosive must possess sufficient strength to withstand the shock without breaking up in the gun, and when this strength is attained, the weight of the shell itself is nearly up to the maximum which the gun could deliver, leaving a small margin to be made up by the explosive, which, if it can be made to reach the target, must spend a large per cent. of its force in disrupting the shell, leaving but a small amount to be expended upon the enemy. Again, the heat developed renders the explosive much more subject to premature discharge by the shock of firing, and it can be readily seen that the military engineer must seek other methods of projecting it.

The elements necessary to success are:

1st. Ability to start the shell containing not only the dynamite, but also the far more sensitive primer necessary to its complete explosion, without shock, jar or rise in temperature.

2d. To immediately follow up the shot, after its inertia of rest has been overcome, by the continued application of a comparatively low pressure through a sufficient distance to impart the momentum necessary to throw it to the desired range.

Given such a system, the development of a gun capable of delivering aerial torpedoes containing large charges of high explosives at as great or even greater distances than that attained by automobile torpedoes, with greater speed and an accuracy unhampered by the medium through which they are projected, would be assured.

Mr. D. M. Mefford, of Ohio, was the first to indicate the correct solution of the problem, by applying compressed air as the propelling force in his pneumatic dynamite gun. The following notes of the development of the system from his gun of 2 in. bore by 28 ft. length of barrel, submitted by Mr. Mefford to Lieut. E. L. Zalinski, Fifth United States Artillery, stationed at Fort Hamilton, New York Harbor, in January, 1884, may prove of interest.

The gun submitted for experiment consisted of a hard drawn, seamless brass tube 2 in. bore by 28 ft. long, mounted on a light truss and swung at about the center of its length upon a tripod to allow elevation and training. Its breech was connected to a firing reservoir (consisting of a wrought iron cylinder having a capacity of about 12 cubic feet) by a flexible hose. An interposed stop cock, worked by hand, served to deliver the compressed air at 500 pounds pressure from the reservoir into the barrel, the amount delivered at each discharge being determined by the skill of the gunner. The action of the valve was necessarily uncertain, and

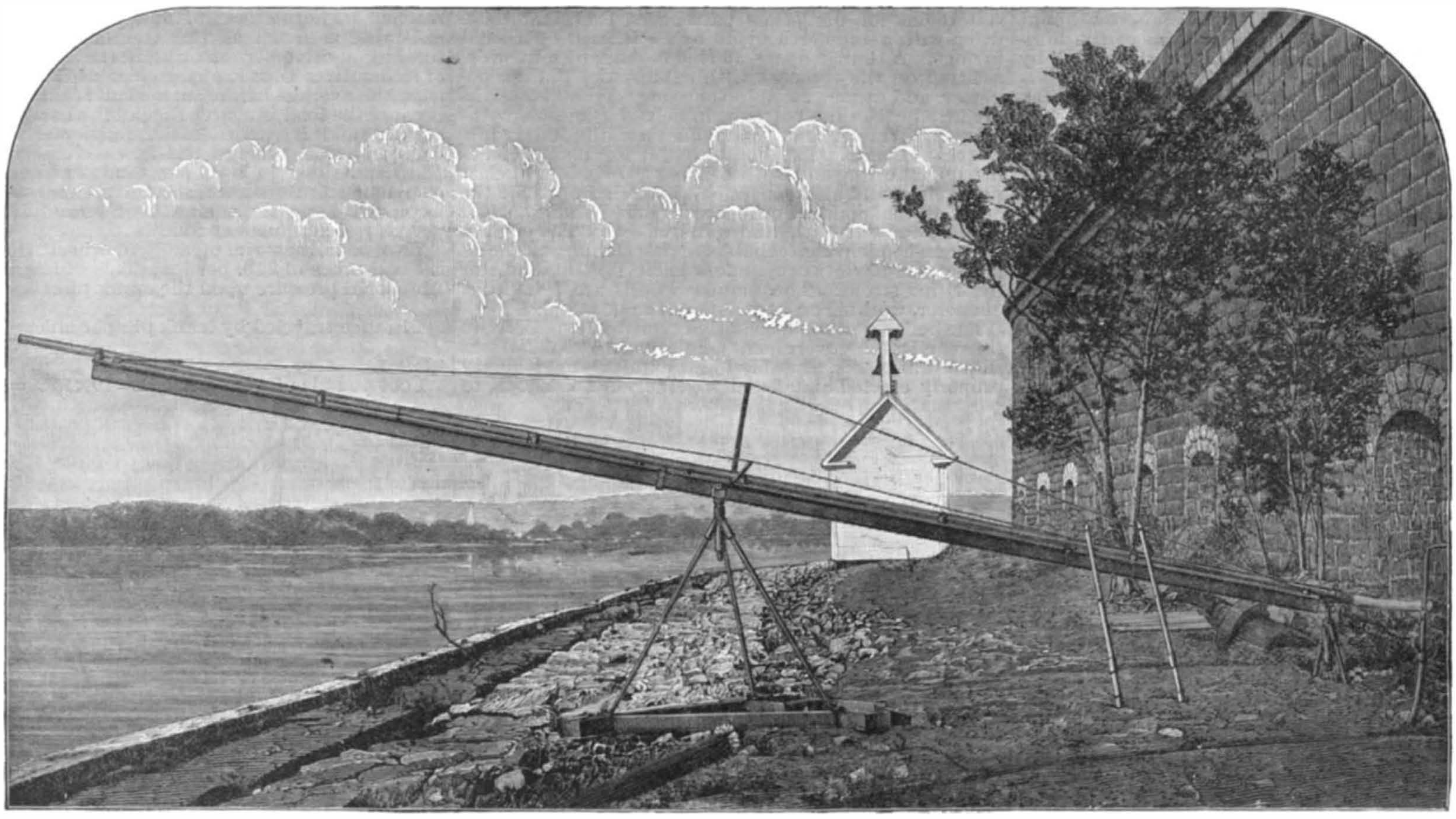


Fig. 1.—2 INCH DYNAMITE GUN.

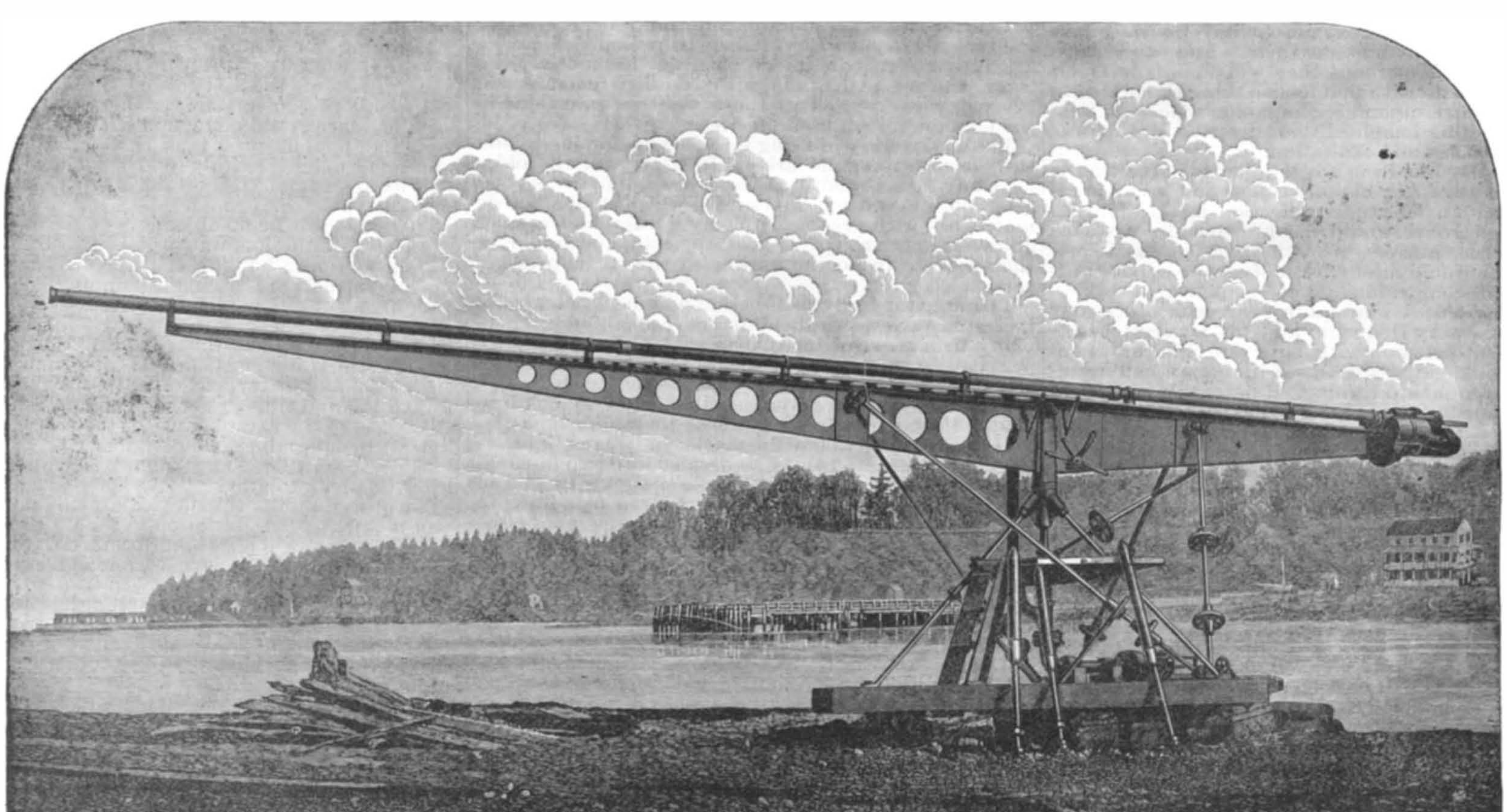


Fig. 2.—4 INCH DYNAMITE GUN.

the range attained variable. The experiments, however, determined that the system was safe and, within its limits, practicable. The projectiles used consisted of a light brass tube (of slightly less diameter than the bore of the gun), containing the explosive, capped at the forward end by an ogival head and finished in the rear by a stick in the shape of a frustum of a cone fitted to the diameter of the barrel. A range of about 2,100 yards was repeatedly obtained with an accuracy and precision surprising when the crude method of determining the amount of air used at each shot was taken into account, the variation being largely due to the personal equation of the gunner in handling the valve. (Fig. 1.)

greater uniformity was obtained in the amounts of air delivered, but the personal equation of the gunner was not eliminated, neither was the amount of air to be discharged for varying ranges under complete control. Its target record, however, was far in advance of the 2 in. gun. The practicability of safely throwing dynamite at even a pressure of 1,500 pounds was settled beyond dispute. Meanwhile, an electrical fuse developed by Lieut. Zalinski made the gun an efficient weapon by rendering the explosion certain, and due to detonation, not impact, thus realizing the full value of the charge. The fuse rendered the control of the instant of discharge in relation to the position of the charge and the target possible, and effected the initial explosion at the base of the shell, at the point farthest removed from the target, a method found to greatly increase the useful effect.

By actual experiment it was found that the explosion of the charge was progressive from the end at which detonation took place, and not as a whole, simultaneous; that when the initial explosion occurred at the end of the charge nearest the target, the effect was to interpose a part of the explosive force between the target and the remainder of the charge, the reaction of the initial explosion serving as a cushion, in a measure protecting the target from the final explosion. Whereas, when the order was reversed and the initial discharge took place at the end farthest removed from the target, the reaction set up acted as a tamping and rendered the total explosion much more efficient.

The great differences in useful effect, due to proper fuse action, as to time of and point at which the charge is exploded, can best be judged by comparing four shots fired from the 4 in. gun under the same conditions of pressure and delivery of air, equal weights of projectiles and distance from target.

No. 1. A standard shell loaded with sand, total weight 30 pounds, penetrated a built-up target composed of ⅝ in. plates to the depth of 2½ in.

No. 2. A standard shell same as above, loaded with dynamite, without fuse, exploded by impact upon the target, penetrated only one plate of the target, producing actually less damage than the first shot, having *no* explosive charge.

No. 3 Standard shell loaded with dynamite, with fuse in front of charge, produced slightly better results than No. 2.

No. 4. Similar to No. 3, but with Lieut. Zalinski's electrical fuse arranged to close the circuit when the body of the shell was ⅛ in. from the face of the target, and explode a primer placed at the base of the charge. Premature explosion from impact was guarded against by a layer of cotton waste placed over the dynamite in the head of the shell. The resulting explosion was by far the most effective of the series, six plates of the target aggregating 4½ in. being broken through and indented in an area of about 18 in. diameter, the stone wall acting as a backing of the target also being considerably shattered.

The weight of the explosive used each time was only 6 pounds, on account of the proximity of dwellings to the place of trial, the balance of weight being made up with sand.

The results of a long series of experiments demonstrated the fact that to the local action of the explosive at the point of impact was to be added the shattering effect upon distant parts of the target by which pieces were cracked and broken completely off. In one instance the explosion of a 3 pound charge against a forging 5 in. × 8 in. in cross section merely bent it at the point of impact, but broke off sections 2 ft. long from each of its extremities at points removed 6 ft. and

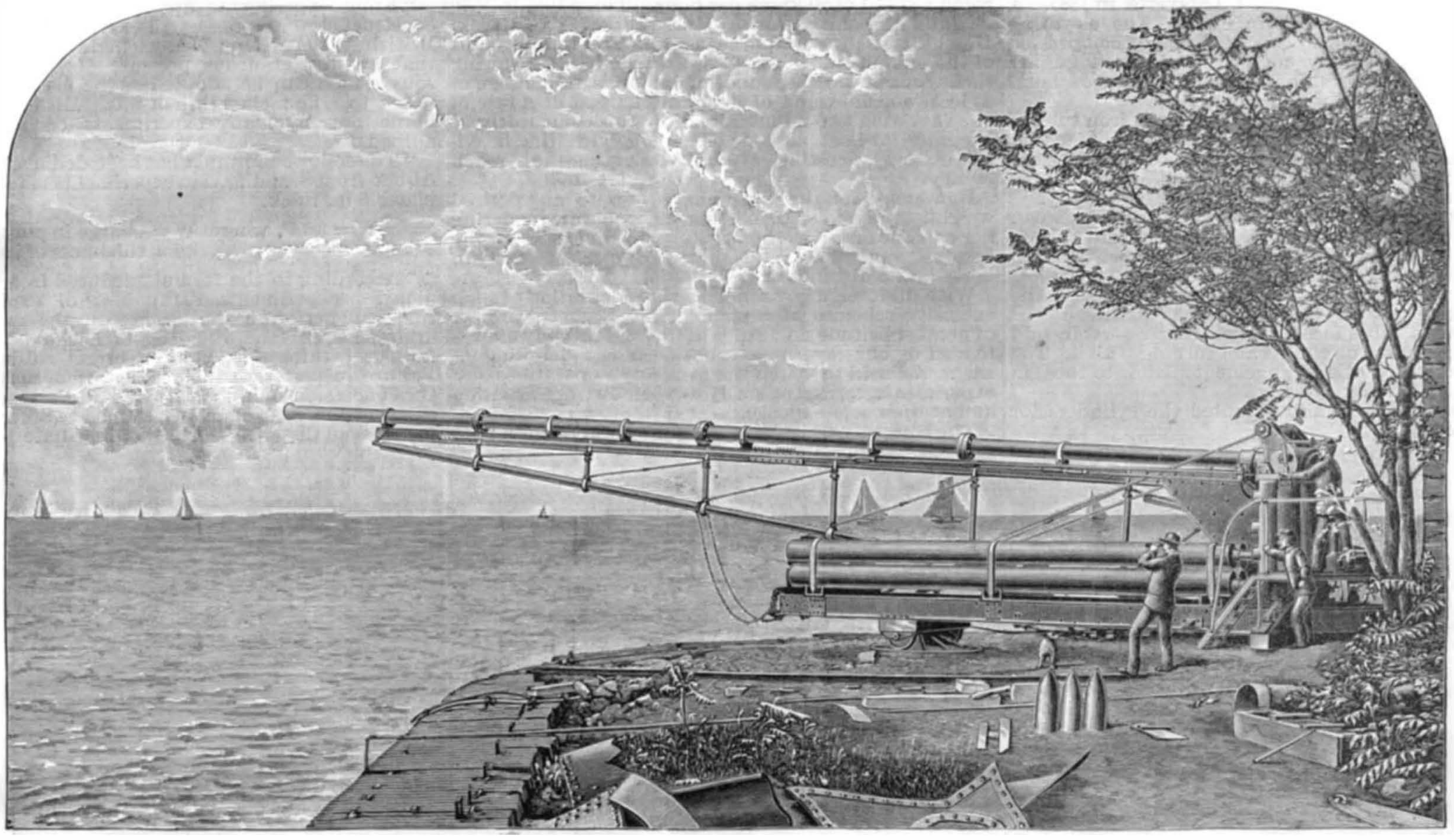


FIG. 3.—FIRST 8 INCH DYNAMITE GUN.—Taken from Instantaneous Photograph. (Shot shown.)

The gun presented an extreme example of recent developments in ballistics, *i. e.*, a very slow powder, but a very long gun. The compressed air replaced the slow burning powder, and though the initial pressure was comparatively low, it was continued through a longer period of time, and the fall in pressure was much less rapid.

Encouraged by the success of the experiments with the 2 in. gun, it was decided that a 4 in. gun, to be fired at 1,000 pounds pressure, should be built, the design to cover the following points, found desirable when conducting the experiments on the 2 in. gun. (Fig. 2.)

1st. The valve to be automatic in its action and capable of delivering uniform amounts of air.

2d. The length of the gun to be as great as could be conveniently trained and elevated.

3d. The volume of the firing reservoir to be moderately large compared with the volume of the bore of the gun.

With these points in view, a 4 in. gun was built from designs furnished by Mr. Geo. H. Reynolds, at the Delamater Iron Works, New York.

With this gun many valuable points were decided,

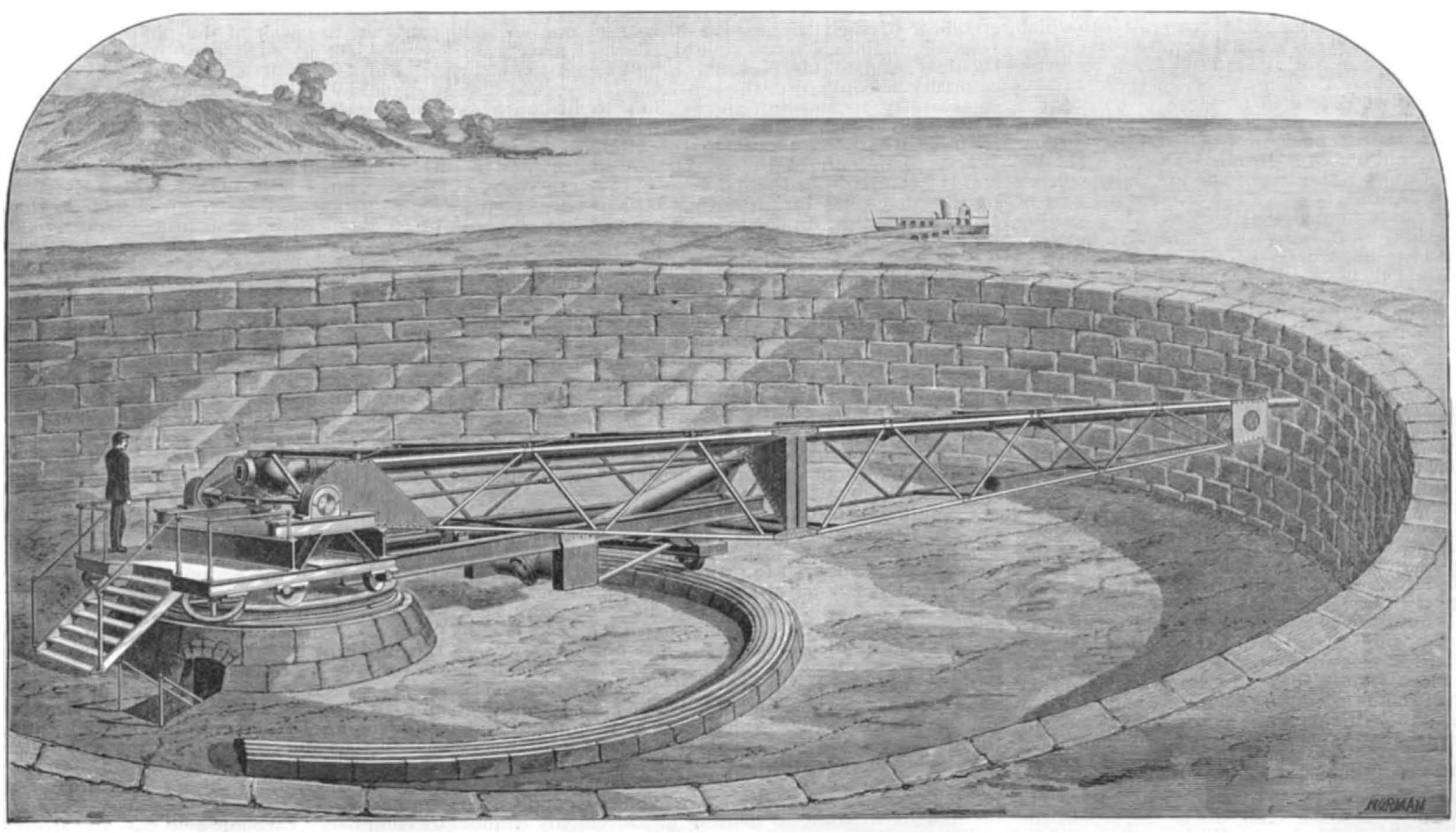


FIG. 4.—NEW 8 INCH GUN, DEPRESSED.

8 ft. from the point of impact, besides developing serious cracks in other portions.

The success attained at this point in the experiments led to the formation of the Pneumatic Dynamite Torpedo Gun Company, to whom all rights in the inventions were assigned, and they immediately undertook the construction of an 8 ft. gun capable of throwing a shell containing 100 pounds of explosive to a distance of at least two miles, with an air pressure of 1,000 pounds—the extreme range of the largest movable torpedoes, such as the Sims electrical torpedo. Competitive designs for this gun were called for, the one selected being that submitted by Mr. Nat. W. Pratt, mechanical engineer, of the Babcock & Wilcox Co., of New York and Glasgow, and led to his being engaged as mechanical engineer by the gun company. This gun was built and mounted at Fort Lafayette in 1885. A general view of it is shown in Fig. 3. The elevating and training of the gun are accomplished by compressed air, and are immediately under control of the gunner standing in firing position, through means of hand wheels at the side of the firing lever.

The gun barrel is a brass lined, wrought iron tube of 8 in. bore × 60 ft. long, secured at its breech end to a trunnion casting. Through one of these trunnions the air from the firing valve is admitted; the breech opening being closed by a simple gate opening inwardly.

To secure rigidity of barrel it is mounted on a truss, the whole turned upon the breech trunnions in the act of elevating by means of a ram acting against the heel plate of the truss. The trunnions rest in two hollow upright castings supported upon the chassis. The castings also act as air connections between the 8 12 in. × 22 ft. tubes forming the firing reservoir, said tubes being secured on chassis and turning with it. The chassis is a front pintle arrangement similar to those in use for heavy powder guns.

Upon the chassis are also mounted the cylinders for giving side train.

The air supply from the magazine reservoir into which the compressors deliver is carried through the pintle around which the gun trains, into the firing reservoir mounted on the chassis.

The firing valve, placed in the head of one of the trunnion supports, is capable of adjustment, to cut off the air at any desired point in the barrel for varying ranges. It should be borne in mind that at each discharge only a small per cent. of the air in the firing reservoir is used, and if desired the original pressure of 1,000 pounds can be immediately restored while loading for the next shot, by opening the connection between the firing and the magazine reservoirs, the latter always being maintained at a higher pressure. By this method the firing can take place as rapidly as the shell can be loaded and the gun aimed, the best record for speed to date being the discharge of five projectiles in nine minutes and forty seconds.

The system is also capable of greater accuracy (within the limits of its range) than powder guns; the initial pressure in powder guns varying with the condition and age of the powder and temperature of gun at instant of firing; whereas, in the pneumatic gun, with a known initial pressure and point of cut off, the resulting range must necessarily be constant for any given weight of projectile and degree of elevation.

The fact that the gunner has under his immediate personal control all movements necessary to bring the gun to bear on the enemy without removing his eye from the sight, increases the speed with which accurate shots can be delivered. The 8 in. gun has been worked constantly, for experiment and exhibition, at 1,000 pounds pressure for the past 16 months, delivering in that time a greater number of shots than it would be possible to fire from a powder gun without either destroying or rendering it unserviceable, and is in as good condition for further work as when first erected.

At an elevation of 35°, shells containing 60 pounds of explosives have been repeatedly fired 2¼ miles; and at an elevation of 33°, shells containing 100 pound charges have attained a range of 3,000 yards. Fig. 3 shows a design in which the firing reservoir is inclosed in the chassis. Fig. 4 shows a design in which the firing reservoir and firing valve are placed beneath the ground to protect them from the enemy's fire, and in which the guns are located in sunken emplacements, as recommended by Lieut.-Gen. Sheridan, to conceal and protect them from the enemy's fire, rising above it as in Fig. 5 when being discharged.

A central compressing plant, located in any position best protected from the enemy's fire, serves to supply a battery of several guns.

NAVAL ARMAMENT.

For naval armament these guns present the advantage of greatest power combined with least weight. Fig. 6 is from the designs submitted to the United States government for a dynamite cruiser 246 ft. long. 26 ft. 6 in. beam, 7 ft. 6 in. draught, to have 3,200 h. p., and to reach a speed of 20 knots per hour. Three 10½ ft. × 70 ft. guns, all pointing forward, are the means for attack, Hotchkiss shell and rapid firing guns also forming part of the armament. These guns are capable of throwing shells containing 200 pounds of explosive to a range of at least one mile, and of being discharged at a rate of one shot each two minutes, making this comparatively insignificant boat capable of coping with the heaviest ironclad, costing at least four times as much money.

Bow guns, for throwing charges up to any desired weight, can be fixed in existing men of war, rendering her capable of delivering a blow far in excess of the heaviest ram afloat, and that with perfect safety to herself, at a distance of 1,000 yards.

With all foreign governments the elaboration of such extensive schemes of armament has been the object of great solicitude and expense, whereas the only aid extended by our government has been the detailing of Lieut. Zalinski to watch the company's operations and experiments, carried on solely by their own organization and at their sole expense.

The company have been exceedingly fortunate that an officer of such progressive ideas, and one so well versed in high explosives, should have been assigned to the duty, and to his personal interest and skill the company not only owes the controllable electrical fuse, so necessary to absolute success, but to his untiring efforts in many other directions. The following extracts from his exhaustive report to the Hon. Secretary of War as to the value and effectiveness of high explosives, and the comparisons therein made between the various successful systems for projecting large masses of such explosives against an enemy, will supplement the preceding description of the pneumatic dynamite torpedo gun, the latest development in that line, and give a just idea of the results which may be attained by its use:

"As a rule, high explosives are capable of a number of orders of explosion, depending upon the character of the initial shock and the degree of initial resistance or confinement. Partially from this arises the very different estimate made of the value of their force when exploded. Both confinement and a *detonation* are required to afford an explosion of the *first* order. The more insensitive the explosive to shock, the more powerful the detonation required to procure the maximum results.

"Fulminate of mercury appears to be the most powerful detonator. But fulminate of mercury is more sensitive to shock than any of the high explosives, so that, if it is desired to throw any of the high explosives, they must be accompanied by a detonator to whose greater sensitiveness the shock of propulsion must be tempered, *or premature explosion ensue.* Simple heat applied does not produce first order explosion, as with gunpowder. The explosives, instead of flashing, as does the latter, will burn comparatively quietly for some time, and unless the mass is considerable, there will be no explosion. On the other hand, the heating of the explosives, even to a comparatively low degree, makes them extremely sensitive to explosion by concussion.

"The relative force of the high explosives appears to be difficult to state, as definite measurements cannot well be made except for *small* quantities, and I believe that this does not indicate their nature when properly exploded in *large* quantities.

"The most definite and reliable measurements and values have been made by General Abbot, Corps of Engineers, U. S. A.; these being the force developed in *submarine* explosions.

"The following are the values obtained by him, dynamite No. 1 being taken as standard at 100:

Nitro-glycerine	81
Compressed or granulated guncotton	87
Rackarock (best formula)	104
Atlas powder, grade A	100
Forcite gelatine	133
Explosive gelatine, 4 per cent. camphor	117
Explosive gelatine, uncamph	142

"From experiments upon an iron pontoon target constructed to represent the cellular bottom of the British ironclad Monarch, General Abbot concluded that an instantaneous pressure of 6,500 pounds per square inch can be adopted as the measure of a fatal shock to a first class ship of war. His conclusions are borne out by many experiments on vessels made abroad.

"The followed formula has been deduced by General Abbot from Scandinavian experiments made upon iron plates 5 in. thick.

$W = 3\ 3d^2$, where W = charge in pounds.
d = thickness of iron.

"According to the formula deduced from the Scandinavian experiments, 100 pounds of explosive gelatine will perforate the decks of the most heavily armored ships (and the deck of a vessel presents by far the greater portion of a target subject to fire). Failure to perforate the heavier armor may ensue, yet the concussion and shock will doubtless be felt in the disarrangement of machinery and breaking of weaker parts some distance from the immediate point of impact, not to speak of the physical effects of the enormous shock upon the crew in the vicinity.

"But failing to strike the ship, the fuse of the dynamite shell is now so arranged as to produce an explosion after being fully buried in the water. Here an explosion anywhere within 21 ft. would be fatal, according to General Abbot's formula. This adds a very large area of vulnerable parts to that of the already large area of the deck. Even if exploded some distance greater than 21 ft. from the vessel—say up to about 35 ft.—the effect would probably be injurious to the propelling machinery, and practically paralyze the ship.

"In order to safely propel charges of the high explosives against the submerged portions of an enemy's ship, a number of complicated and expensive propelling torpedoes have been devised. The one most generally used is the Whitehead fish torpedo. This has been adopted by all governments but our own, and large numbers have been purchased. The propelling power is carbonic gas or compressed air stored in a reservoir contained in the torpedo, and operating Brotherton or similar engines for propulsion. They have automatic attachments for steering to attain and maintain any desired submersion. The maximum speed attainable is 27 knots for 200 yards, and 24 knots for 600 yards. That is, it will take 13 seconds to attain 200 yards and 44 seconds to attain 600 yards; meanwhile, it is subject to the action of currents and waves, besides its own inaccuracies. The charge carried is very small. That in the largest type does not exceed 100 pounds of guncotton. It may be stopped by nettings. If expended without effect, a very considerable plant is thrown away. Its maximum range in which it has any chance to strike the target is not more than 800 yards, and 200 yards is the most that can be counted upon as approaching certainty of action. The largest weigh several tons and cost several thousand dollars.

"Another class of torpedoes are those which are directed throughout by an operator on shore or on shipboard. Of these are the Lay torpedo, propelled by compressed carbonic acid gas, and steered and fired by means of a connecting cable. The extreme range

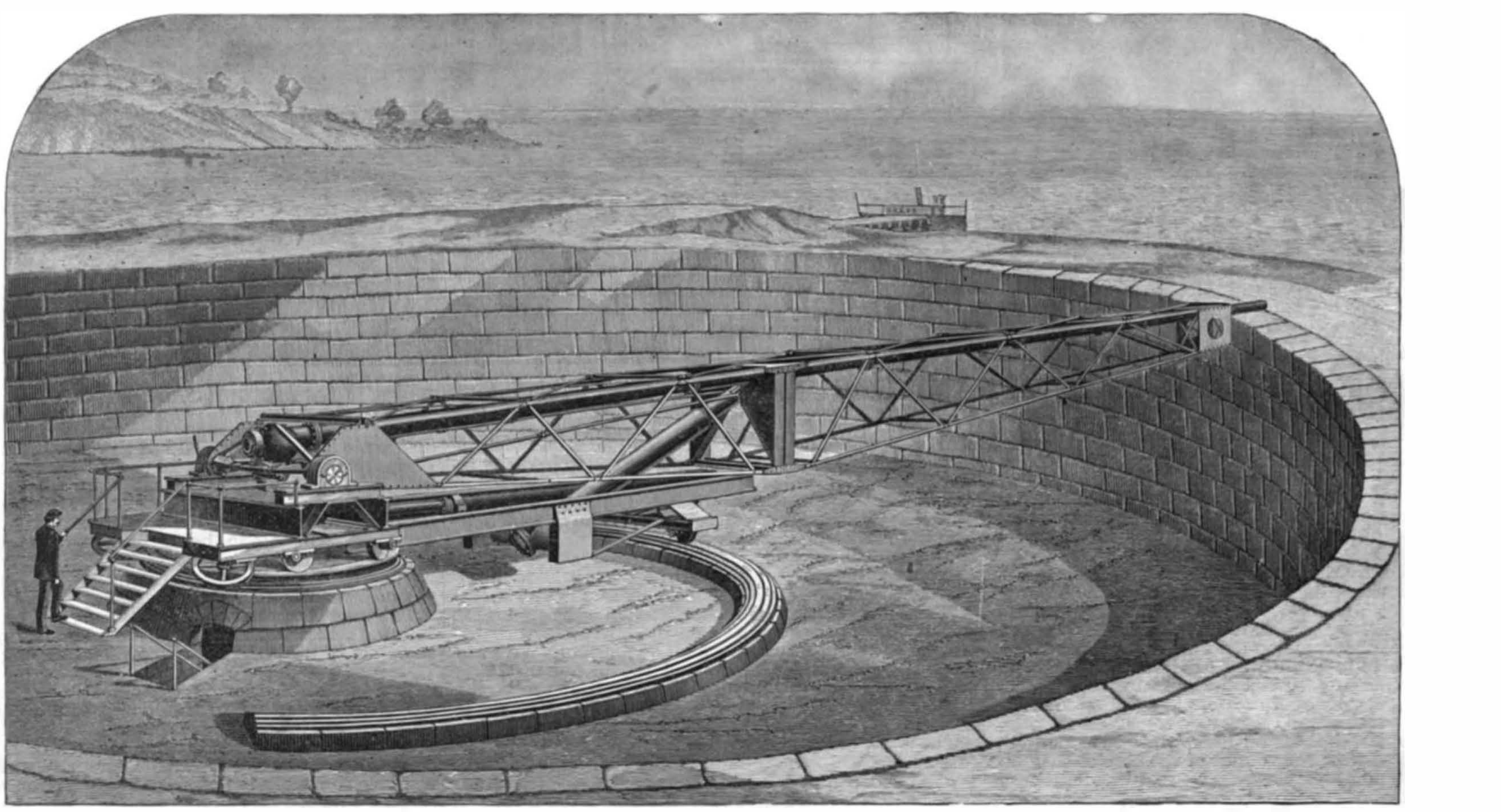


FIG. 5.—NEW 8 INCH GUN, ELEVATED.

of these is not greater than two miles, and the mean speed for such distance is probably not more than 13 knots. A speed of 20 *miles* per hour has been obtained for a distance of one mile, by the modified torpedo known as the Patrick torpedo. This weighs 4,700 pounds and carries a charge of 125 pounds. The charge can, however, be somewhat increased, but probably at the expense of speed. This is propelled without submersion. It has the advantage over the Sims torpedo, that it can be operated from on board any small launch, or even row boat, no engine being required to generate the power while it is being used.

"The Sims electrical fish torpedo is propelled by a current from a dynamo on shore or on ship board, and is steered from there. This torpedo moves completely submerged, it being kept at the desired depth by means of a float to which it is rigidly attached. The float is of copper, filled with material which will maintain the buoyancy of the float even if repeatedly perforated. It has the advantage of not being limited as to the amount of propelling power stored up in it, and as much can be transmitted as the cable used can safely carry. Its machinery and charge are protected from any ordinary fire. But on the other hand, it has the disadvantage of low speed, as it must drag through the water the float as well as itself. The largest one constructed as yet has a range of about two miles, and a speed of about eleven knots. Its weight is about 4,000 pounds, it carries a charge of 300 pounds. In almost every respect I consider it the best movable torpedo in use. But it, as well as the Lay torpedo, *must be seen throughout its course* to strike the enemy. This is a matter of no little difficulty when the water is rough. It is an object which can hardly be followed by the eye beyond half to three-quarters of a mile, except under the most favorable conditions.

"To attain the two miles will require from eight to ten minutes. Meanwhile, even if they can be directed all the way, there is no guarantee that the enemy will quietly await the approach of the torpedo. If the torpedo can be seen by the *operator* the *two miles*, the *enemy* can surely discover it when within *half a mile.*

"While doubtless having some value, I question whether either is all-sufficient for defensive purposes. All of the movable torpedoes can be stopped by netting properly placed.

"The torpedo shells projected by the pneumatic torpedo gun can attain the range of two miles in about twenty-two seconds, and they can be directed at the enemy much more accurately than appears possible with the others. If missing the target, the only expenditure is the shell and its charge, and a large number can be showered upon the enemy in a short period of time. A much larger number can be stored and carried than of other torpedoes. As an auxiliary arm, placed for defense of harbors and fortifications, they can be brought into use at the time when the enemy's fleet come to closer quarters, that is, within its effective range of, at present, two miles. It is hardly questioned that the course of an action may bring the combatants to such close quarters. In addition to this, these torpedo shell-projecting machines may be placed on board of swift moving boats, which could approach a beleaguering fleet within a mile and deliver a most damaging fire. Where the enemy has succeeded in removing existing torpedo obstructions, these machines can shower its pathway with torpedoes which, when the depth is suitable—say 50 or 60 feet, or less—can be arranged to explode either directly upon reaching the bottom or at any desired interval.

"On the other hand, in making an attack on a port, torpedo boats armed with the pneumatic gun could strew the channel through which it is desired to advance the fleet, with the torpedo shells arranged to explode, some after reaching the bottom, others when fully submerged. These being dropped at short intervals would inevitably break up any system of torpedoes which can be planted. Not alone would it break up and explode the torpedo cases, but would very probably break up the operating cables connecting the torpedoes with the operating stations. The mechanical mines, not depending upon shore connections, would be exploded by the shock of the explosion of the shell, even if distant 60 ft. or 70 ft.

"In warding off an attack on a ship by any of the movable torpedoes, if they should be discovered approaching, I can think of nothing which has so many chances of success as a torpedo shell projected from the pneumatic gun. The success of the attempt to ward off the blow is not dependent alone upon striking a very small object. But the explosion of the shell is far-reaching, covering a considerable area of effective shock, which would either break up the machine or deflect it from its course.

"It is not claimed that this appliance of war has attained its maximum development, either as to range or size of charge to be projected. As to the last, it is only necessary to indicate the magnitude of the charge deemed sufficient, and such charge could be thrown. A gun of 12 in. caliber could readily throw 500 pounds, and if needed, a gun capable of throwing 1,000 pounds could be constructed.

"These machines can be constructed without demanding a very large special plant, a very short period of time after the design and patterns have been made. The construction could go on in any of our large machine shops."

In his letter transmitting Lieut. Zalinski's report to the department, Col. John Hamilton, commanding at Fort Hamilton, emphasized the points made by Lieut. Zalinski in such pithy sentences as the following:

"As this question of the utility of continuing investigations with the pneumatic gun, and incidentally with high explosives, involves my original and continuous personal approval, I take the opportunity to say that it was directed that the experiments should be under my supervision.

"Those who reject the idea of the pneumatic gun are still active in devising means to get large charges of high explosives to a target. The objections are not against the explosives, but they deny the practicability of effectively reaching the point of attack with a low velocity as against above-water targets, or for subaqueous discharge.

"With a pressure of 1,000 pounds, a missile of 210 pounds and an elevation of 35°, the pneumatic gun made a range of 2¼ miles *cerc.*

"With a charge maximum of 35 pounds of cannon powder, a missile of 183 pounds, and an elevation of 10° 30′, our 8 in. converted rifle gave a range of 3,712 yards.

"When this shot got to its targets, it had only its pounding or penetrating power as an offense.

"When the pneumatic shell got to its destination, it had a hundred pounds of gelatine for explosion.

"All attempts to throw dynamite or practically useful gelatine by gunpowder have been failures, except in newspapers. The gun bursts after two or three rounds, *which have done no injury to the target.*

"No powder gun has fired dynamite or gelatine by a man at the lanyard.

"Lieut. Zalinski has fired, with his own hand at the valve, numbers of missiles carrying from 25 to 100 pounds of gelatine, charged with fuses to produce 'first order' explosion."

Briefly stated, the advantages of the pneumatic torpedo gun system over automobile torpedoes are: their ability to deliver an equal weight of explosive to the same distance, in one-twentieth of the time, and at one-fiftieth of the cost, joined to an ability to maintain a rapid rate of firing with an accuracy dependent solely upon the skill of the gunner.

As compared with high-power powder guns, the torpedo gun attains greater accuracy within the limits of its range; it can be fired with greater rapidity, and the total force of the explosive used is available for destructive work upon the enemy, whether it reaches its target as a point blank or a spent shot.

The maximum work in the powder gun is developed at the instant of explosion of the charge, the larger portion of such work is lost, and the balance, stored up in the shot, is rapidly expended in long ranges.

When a pneumatic torpedo carrying a charge of uncamphorated explosive gelatine explodes, all of its force is expended in useful work upon the target.—*American Engineer.*

Regarding the origin of this gun, Lieut. Zalinski recently said:

"I have repeatedly denied the statement that the gun is of my invention. I have, however, given direction to its development as a practical military appliance. I am not a mechanical engineer, and could not have worked out the mechanical details unassisted. This has been done by Mr. Nat. W. Pratt, of the Babcock & Wilcox Company, mechanical engineer of the dynamite gun company. Mr. George W. Reynolds and Mr. Charles Emery, both distinguished in their profession, have aided very materially in bringing about the sum total of the success attained. The electrical fuse alone I claim as my personal invention."

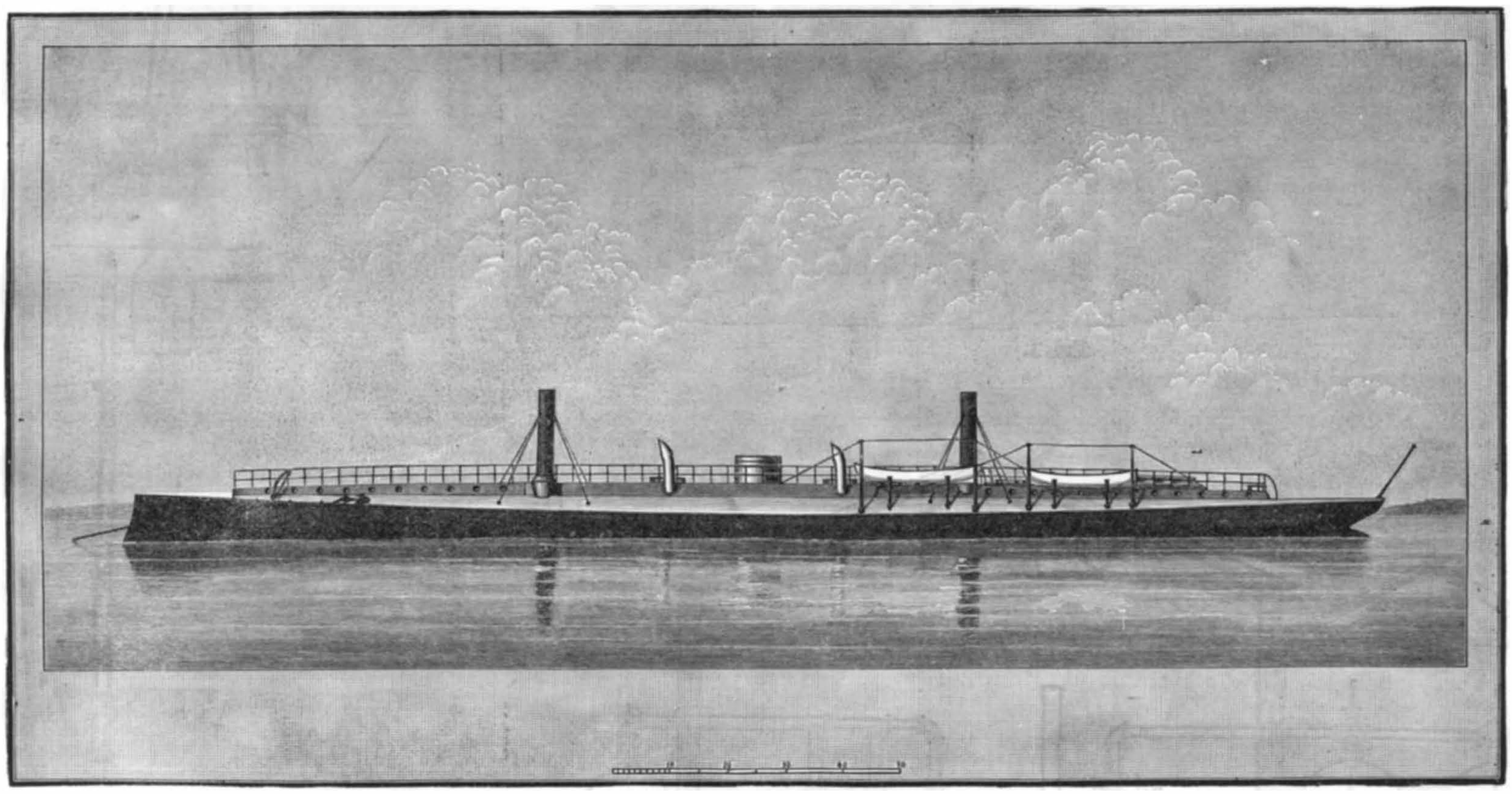


FIG. 6.—DYNAMITE CRUISER.

MILITARY AERONAUTICS.

A QUESTION recently asked in the House of Commons elicited in reply the assurance that the subject of fuller development of the use of balloons in military operations was still actively engaging the attention of the authorities at Woolwich. Further evidence that endeavors are being made to attain practical success in this direction is afforded by the fact that very recently two balloons, constructed specially for military purposes, have been supplied to the Chinese government, properly instructed persons having been sent out to China to direct the officers of the celestial army in their use.

It is a good many years since the probable useful employment of balloons in warfare began to occupy the attention, not alone of our own War Department, but of that of nearly every country of the Continent of Europe, as well as of those of North and South America. In France, special attention has been directed to this branch of military service, and we have heard from time to time of alleged successes in the steering of balloons achieved by a special commission of French officers. But, nevertheless, in spite of all the endeavors made, but very little seems to have been really accomplished. We seem to be as far off from securing the main *desiderata* of a military ballooning service as we were on the day that the question was first started.

Until the leading obstacles which oppose themselves to the full solution of the problem set can be overcome, the use of balloons in war must be of very limited and, comparatively, valueless application. Hitherto, it may be strictly said, we have not advanced beyond the mere possibility of viewing an antagonistic position by the means of captive balloons. No doubt, under many circumstances, such a facility is valuable, but it is far below the full standard of efficiency that is aimed at. Now, to secure that standard much yet remains to be done that must prove to be most difficult of accomplishment, even if it may not prove to be wholly impossible of ultimate attainment. Until the power of steering some sort of aerial machine under conditions which shall always render it safe from the effects of hostile attack is secured, so long must a military balloon be held to be only and solely a sort of elevated watch tower. In that capacity, as we have said, they will undoubtedly be of service. But it cannot be kept out of view that even that service will always be one exposed to very considerable risk.

For in these days of rapid improvement in the arts of military and naval attack and defense, it is sufficiently evident that the attainment of the former quality more than keeps pace with that of the latter. Guns, hitherto, have overcome all armor that can practically be applied—at least to ships—while their power of future development is to all intents and purposes unrestricted. This cannot be said of the armor designed to withstand them. Its use is circumscribed by considerations which do not limit the development of the attacking arm. The same relations appear to us to hold good as regards military balloons. These may be said to be mainly—so long as they are what they are—instruments of statical defense only; as much so indeed as if they were solid watch towers of great height. Against them may be employed the marvelous powers of modern artillery, and a single lucky shot may at any time deprive an army corps of its means of aerial observation. As long as power of control of movement is denied to us, so long must military balloons—at all events while operating in the neighborhood of a hostile force—remain captive during their use. It is an old saying that "history repeats itself."

In the naval warfare of our preceding generation the most efficient projectile was what was known as "chain shot." With it was accomplished what in the days of sailing vessels of war was the main object of attack—

the destruction of masts and spars. Similar projectiles discharged from the long-range guns of modern times would have a great chance of severing the rope by which a balloon is held captive; or should this not offer sufficient resistance to enable it to be cut through, the balloon must at least be overset, and its occupants thrown to the ground.

Balloons are costly things, and no more than a limited number of them can be expected to be in reserve. We may be sure that while attempting to perfect balloons as means of observation, sight will not be lost by military men of the means whereby they may be crippled. Attack will probably—following the rule we have pointed out—become the superior of the defense.

Now, so far as we are able to judge, there has hitherto been in the construction of balloons for military purposes an absence of all consideration of this postulate. With existing examples of these, if attack is successful, there is no escape for the occupants of the machine. They must either be carried away to within range of an enemy's influence, or must incur a certain and frightful death. Means of escape for them from either one or the other alternative, unless the power of immediate descent is provided before the force of the wind carries the balloon outside the circle of protection, there is none. We would suggest therefore that those charged with our military balloon experiments now being carried out should turn their attention to some means of provision for escape. Parachutes ready for the use of each individual in the car might at least be provided. But the time during which escape might be possible would probably be very limited. Means, we think, could be devised whereby the severance of the rope holding a balloon captive would at once simultaneously free the globe from gas and convert the collapsed silk into a parachute of sufficient size to insure a safe and nearly vertical descent to the earth. For we can scarcely afford to restrict the ascent of balloons of observation to the existence of conditions which must invariably render then safe from attack. To do so would be greatly to diminish their usefulness. So long therefore as we are debarred from controlling the movements of free balloons, so long must we anticipate the result of attack, and be prepared by every means possible to obviate its worst effects.—*The Engineer.*

GOLD MINING MACHINERY.

JORDAN, SON & COMMANS and Robey & Co., London, have recently shipped considerable installations of plant for the reduction and treatment of gold-bearing ores to the Transvaal, and are now manufacturing for Australia, Hungary, and other places. In view of the increasing demand for this class of machinery, we present particulars with illustrations of this mining plant, which embodies all the latest improvements. Special attention has been given to the requirements of the Transvaal ore, which has until lately proved somewhat difficult to deal with. The first batteries erected by the firm near Barberton and elsewhere are already reported to be giving much satisfaction. The engines and boilers manufactured by the firm are so well known in the diamond fields and generally in the Transvaal that we need not call special attention to them. So with re-

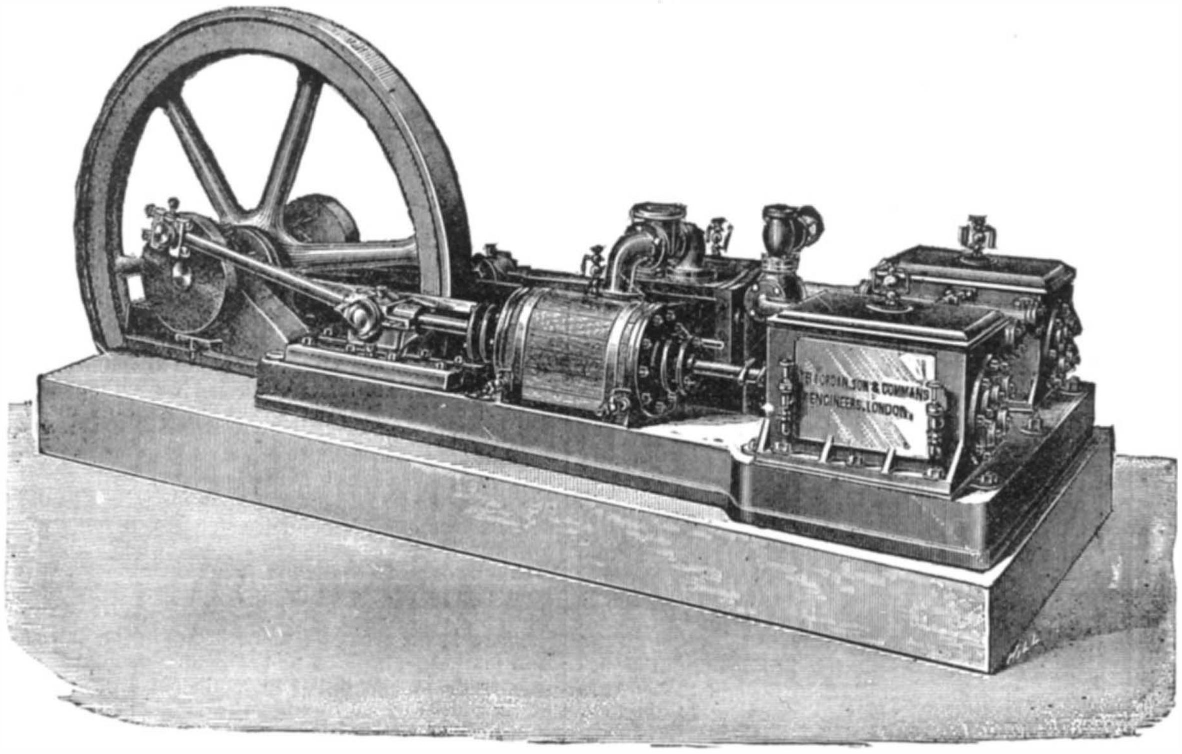


FIG. 1.

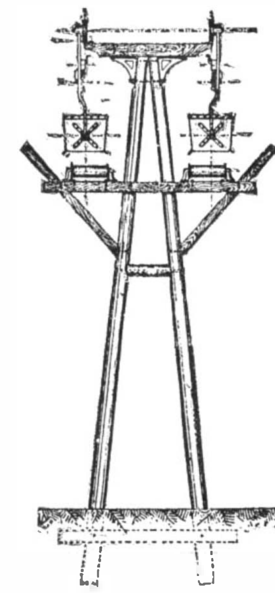


FIG. 4.

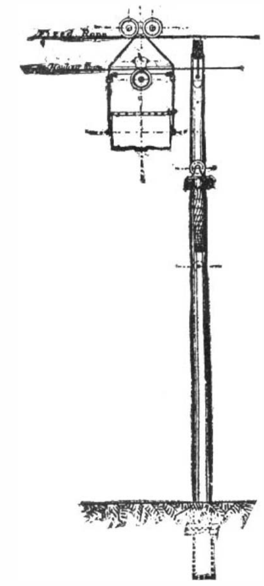


FIG. 5.

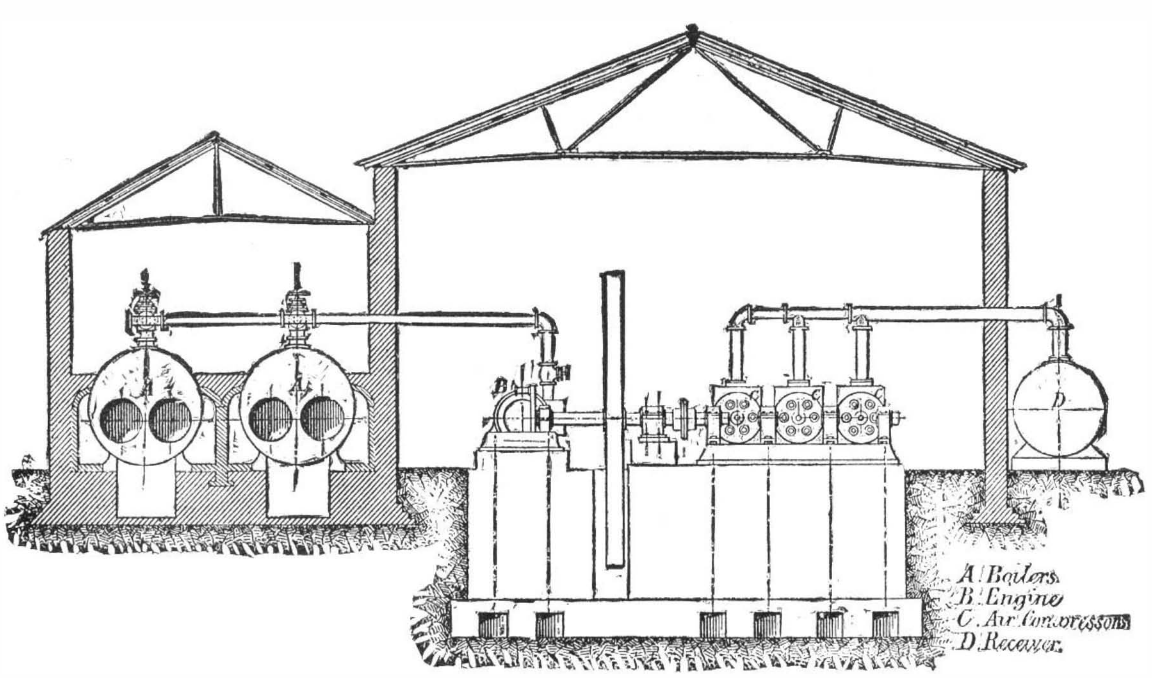


FIG. 2.

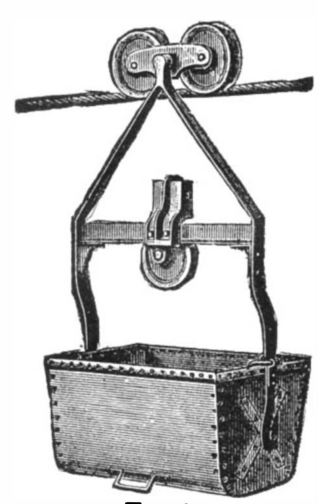


FIG. 6.

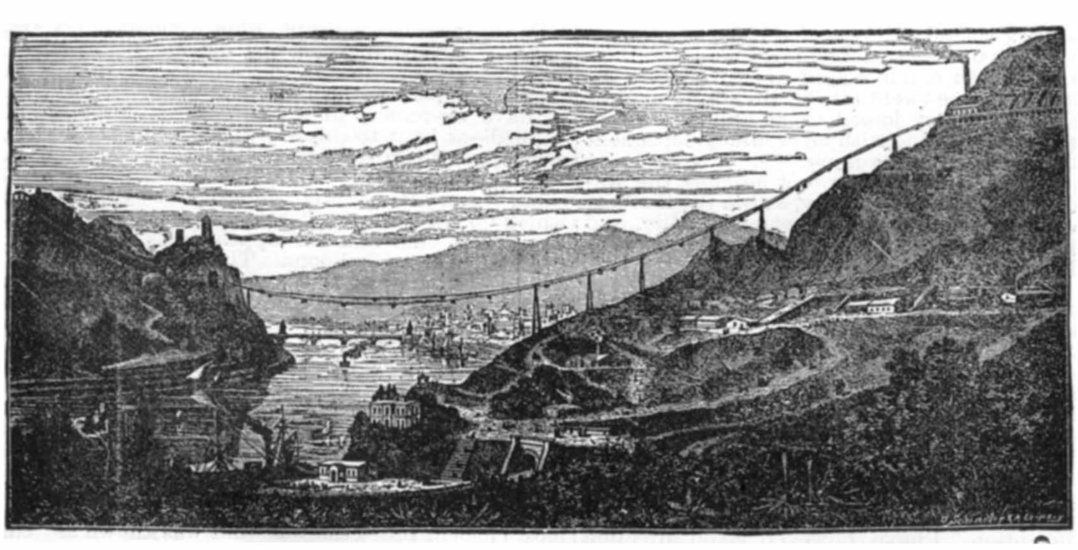


FIG. 3.

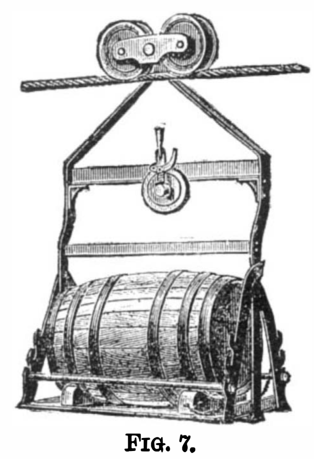


FIG. 7.

GOLD MINING MACHINERY.

gard to the Adelaide rock drill, which machine has been described and illustrated by us. We may mention that this drill has been adopted by the contractors for the Panama canal, and is largely used in this country for mining operations. The Adelaide drill has but one moving part, viz., the piston, and no complicated arrangement of reciprocating valves and tappets. One great feature in this drill is the arrangement by which the air is cut off and used expansively, thereby effecting a great saving. Another equally important feature is the great freedom of the exhaust, the exhaust port of a 3½ inch drill being over 13 inches long.

Referring to the engravings, Fig. 1 is the double cylinder Adelaide air compressor, which is constructed in tandem form, with direct acting steam cylinders, double or single type, with air cylinders mounted on separate bed plate, to be driven by belt gear or clutch, as shown in the general arrangement of compressing plant seen in Fig. 2. The next element of usefulness in mining plant is the wire ropeway, the general application of which is illustrated in Fig. 3. The construction of wire ropeways is generally carried out as follows.

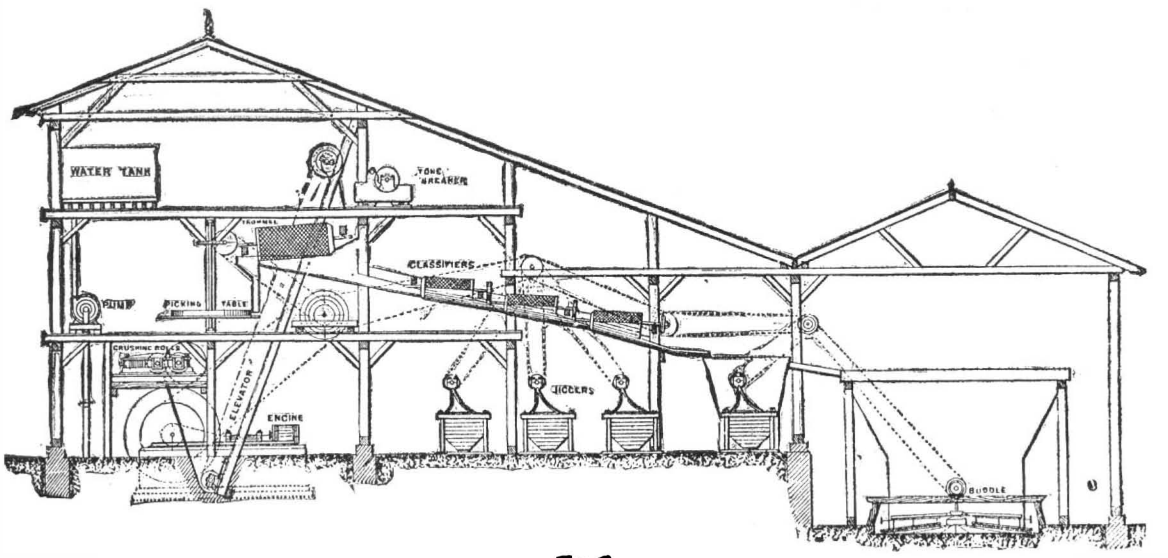


FIG. 8.

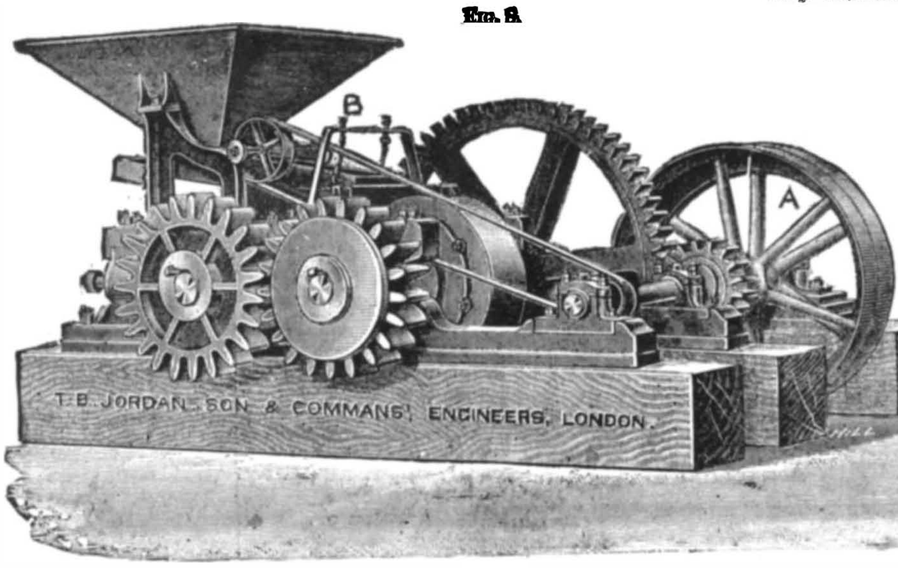


FIG. 9.

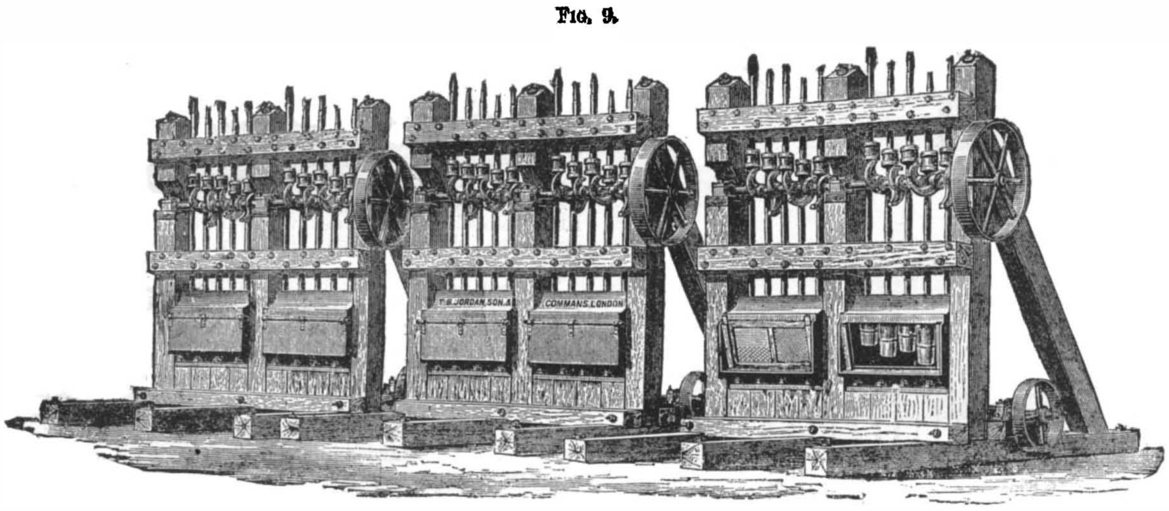


FIG. 10.

GOLD MINING MACHINERY.

Strong wire ropes, called carrying ropes, resting on supports of wood or iron, are stretched between the points to be connected, the wire ropes themselves being kept taut by means of weights, in such a way that they are free to expand or contract with variations of temperature.

Round bar iron is sometimes used in special cases instead of wire ropes. The supports may be from 90 to 1,500 feet apart, according to local conditions. For the haulage of the trucks there is a special light endless rope under the carrying ropes—called the hauling rope. This is constantly in motion and forms a complete circuit. At the end stations it is carried round horizontal grooved pulleys, one of which is driven by a motor. For continuous working two carrying ropes are required; these run parallel to each other on cast iron shoes fixed to the ends of cross timbers on the top of the supports, as seen in Figs. 4 and 5.

For periodical working only one carrying rope is required. Along these carrying ropes the material is hauled, in specially designed skips, suspended by means of a light iron framing from a small truck or runner with grooved wheels, which run on the rope in such a way as to clear the rope supports. The form of bucket or skip can be varied to suit different materials or objects as in Figs. 6 and 7. For the transport of ore, coal, stones, etc., the buckets are rectangular, open at the top, and suspended on trunnions, so as to enable them to be easily and quickly tipped; a stop arrangement preventing their turning over accidentally. For barrels and other goods, they are made as in Fig. 7. The advantages of wire ropeways are too well known and too widely recognized to require insisting upon here. We need only point out that in some cases where they have been introduced they have paid for themselves in a few months.

We now come to the continuous ore-dressing plant, as seen at Fig. 8, which illustrates a complete dressing floor, fitted with the most modern and approved types of ore crushing and dressing machinery, and capable of treating from 20 to 30 tons of ore per day. The ore is first reduced by the stone breaker, the whole of which passes through a trommel for the purpose of separating the finer particles, which are then conveyed direct to the classifiers, the coarse product of the breaker going to the picking table or direct to the crushing rolls. The crushing rolls reduce the ore to the required sizes, allowing its produce to fall into the elevator pit, from which it is raised to the trommel for further separation. The portion that is sufficiently fine passes down the launders to the classifiers, and the coarse residue returns to the rolls to be crushed. The classifiers separate the crushed ore into different sizes, each size passing to a jigger working at a suitable speed and stroke, and having suitable "bottoms." The more perfect this classification or sizing, the more effectively is the ore separated from its gangue. The separation takes place in the jiggers, which deposit the ore through the bottoms and sieves into the hutches, the gangue or waste being carried off over the surface by side outlets into trucks or pits. The slimes are again classified, and pass to various forms of buddles or shaking tables, by which all the finest residue of the various processes are finally treated. Water under a slight head conveys the crushed ore through launders to the various machines, and is allowed to pass away through settling pits. In these pits any metallic substance of value escaping the system of plant will collect, and may from time to time be extracted and rebuddled. The stone breakers are strong and massive, and, when necessary, are constructed in parts not weighing more than from three to four hundredweight, for convenience of transport. The continuous jiggers are perfectly automatic and sensitive in their action on material the particles of which have the slightest variation in specific gravity. They are, therefore, capable of dressing ores up to a high percentage without waste. It will be seen that the arrangement of plant described renders it perfectly automatic, and the only attention required in the operation of it is that necessary to start the ore on its course, by feeding the breaker, and to remove the finished product from the various hutches.

Fig. 9 represents improved rolls for crushing ore and all kinds of minerals. These rolls are self-contained, require but slight foundation, are most efficient, and take much less power to drive than the old form of Cornish rolls. They are fitted with rubber or steel buffer springs, which allow them to adjust themselves to their work without the jerk and strain attending the use of levers and weights, and which so often cause a breakage, and further entail a much more substantial mounting and foundation. The amount of compression, as also the space between the rolls, can be regulated with facility. The action is very steady, the shafts carrying the rolls being coupled by long toothed wheels, insuring a better grip of the material than is the case where the one roller simply drives the other by friction. The larger sizes for coarse crushing are driven by means of counter gearing, and have chilled iron or steel shells, which can be easily replaced when worn out. The smaller sizes are driven direct, and the rolls are solid.

The stamping machinery is seen at Fig. 10, which represents a 30 head stamp battery of improved construction, with ten heads in one frame, and independent shafts and pulleys. This battery is designed with a view to securing the greatest strength and durability, at the same time reducing as much as possible the amount of dead weight, thereby effecting a saving in the cost of freight, and facilitating the transport up country. These stamps are supplied with five, ten, fifteen, or twenty heads to a battery, according to the amount of ore to be crushed. Each stamp consists of four parts, the stem, tappet, head, and shoe, and is raised and simultaneously revolved by means of a cam in rolling contact with a tappet keyed to the stem, which can be raised or lowered according to the required height of fall. The revolving of the stamp insures the even wear of the shoes and dies, greater efficiency, and considerable saving in power. The mortar boxes are of varied construction, according to the nature of the ore, and to suit wet or dry crushing. When they have to be transported to districts difficult of access, they are built up in sections bolted together by turned bolts. Solid boxes are, however, preferable where circumstances admit of their use. The screens, which are usually of best Russian sheet iron or steel wire gauze, are arranged so as to give the greatest possible area of discharge. Splash boards are provided, and fingers for holding up the stamps when not working. There is also an efficient belt-tightening gear to each driving pulley, and a cam platform is provided for giving access to the working parts. The quartz is fed into the mortar box automatically, and in sufficient quantity to form a thin layer above the dies, thus increasing the crushing efficiency, and enabling one man to take charge of a number of stamps. Each lift weighs about 750 lb., and is capable of crushing from 1½ tons to 2½ tons per day of twenty-four hours, making from eighty to ninety drops of ten to twelve inches per minute. All the parts are interchangeable. It is best to have the shoes, dies, heads, and cams made of steel, the extra first cost being well repaid by increased durability and security from breakage.

We next come to the crushing, concentrating, and amalgamating machinery for gold and silver ore. The methods of working both of these ores and the treatment adopted for the extraction of the precious metals depends so much upon local conditions and the nature of the ore that it is only possible here to give an outline of the general principles of the processes now commonly in use, and the ordinary plan and arrangement of the machinery employed. Where gold exists in a free or metallic state, it readily amalgamates with mercury. The process is, therefore, a simple one, and of all the cheapest and most economical. Fig. 11 shows the arrangement of machinery for this purpose. The ore as it comes down from the mine is either tipped from the trucks alongside the stone breaker and shoveled into the self-feeders, or, if the site will allow of the necessary fall, is tipped over an inclined screen of iron bars, through which the smaller pieces fall directly into the ore feeder bin. The larger pieces, sliding down over the screen, are reduced to a suitable size in the stone breaker. The finely broken ore in the self-feeders is evenly and automatically delivered into the mortar boxes, water being introduced at the same time. The falling stamps crush the ore into a pulp, which, when sufficiently fine, passes out through perforated screens in the sides of the mortar boxes, and flows in a thin film over gently inclined tables, covered with amalgamated copper plates, the pulp in its passage over these plates yielding up a large portion of the fine gold it contains. Amalgamation is often begun in the mortar box, in which quicksilver is placed, the amalgam being collected on copper strips fixed inside the box. From the inclined tables the pulp passes on through one of Jordan's hydraulic amalgamators, which secures any remaining free gold, stray amalgam, or quicksilver. The tailings flow away over concentrators, which further separate from the pulp any gold which, from its combination with other minerals, has no affinity for mercury. In many mines a large proportion of the ore is of this refractory nature, and the concentration of the rich metallic particles and sulphurets is of the highest importance, and this concentration is effected on Frue vanning machines, the general arrangements respecting which are seen at Fig. 12. The vanner itself will be illustrated and described later on. These concentrates, according to their nature and value, are, after being roasted, subjected to further treatment for the extraction of the precious metals—either reduction and amalgamation in grinding pans, chlorination, or some other method determined by the character of the ore and the locality in which it is found.

For ore in which silver occurs in a free or metallic state, the arrangement shown in Fig. 13 is the one most commonly used, and, as far as the crushing is concerned, is similar to that for gold ores. The pulp, after passing

the screens, flows down launders to a series of settling tanks, from which it is dug out and removed in trucks to the grinding pans, where water is added till it is of a proper consistency for amalgamation, which is effected by the introduction of mercury. From this set of pans the pulp is run off into settlers, where a further dilution takes place, and the earthy matter is washed away, leaving the amalgam and quicksilver behind. This then collects in a bowl at the side of the pan preparatory to being strained and retorted. In many cases where natural facilities for smelting exist, concentration of the mineral and subsequent smelting is more profitable than pan amalgamation.

If the ore is of a complex and refractory nature, it is stamped dry, having been dried on a hot floor or in a furnace, previous to being fed into the battery. The mortar boxes are closed in to keep the dust from flying about, and the fine powder, as it escapes through the screens, is transported by a worm conveyer to an elevator, as shown in Fig 14. The elevator discharges the finely crushed ore into a revolving roasting or chloridizing furnace, where it is roasted with salt, and prepared for the subsequent pan amalgamation, which is the same as that for free silver ores. Some ores admit equally well of pan amalgamation or concentration, whereas others are more satisfactory and economically treated by first concentrating the rich metallic particles, and afterward subjecting these either to a smelting process, as in the case of silver lead ores, or the dissolving out and precipitation of the gold and silver by the chlorination or some other chemical process.—*Iron.*

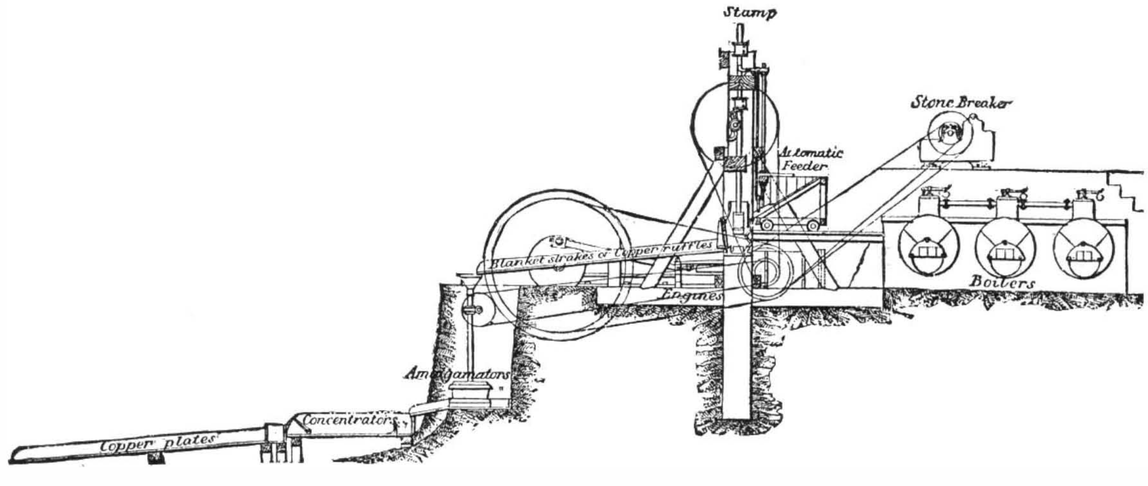


FIG. 11.

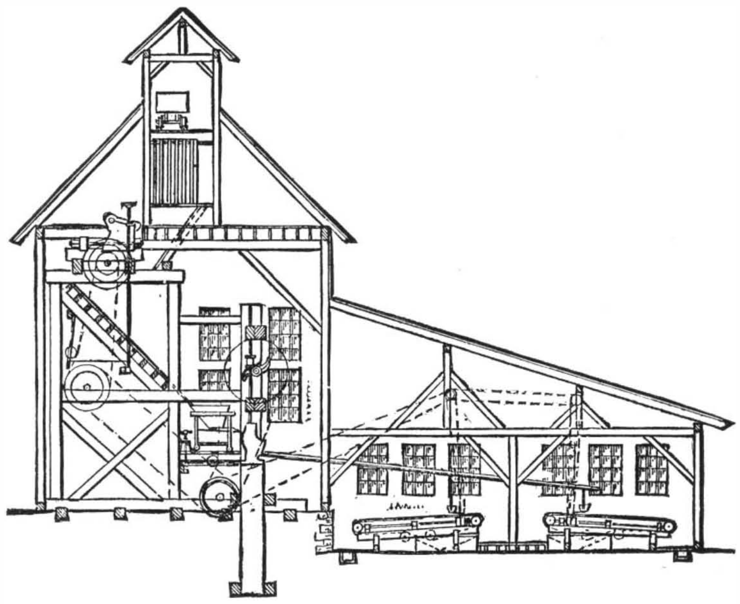


FIG. 12.

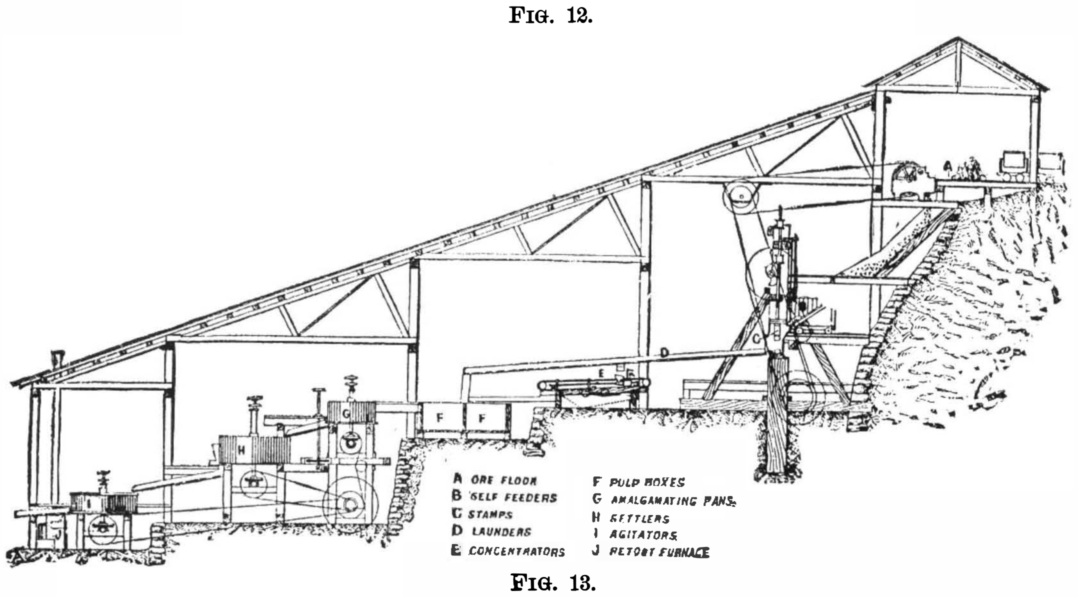


FIG. 13.

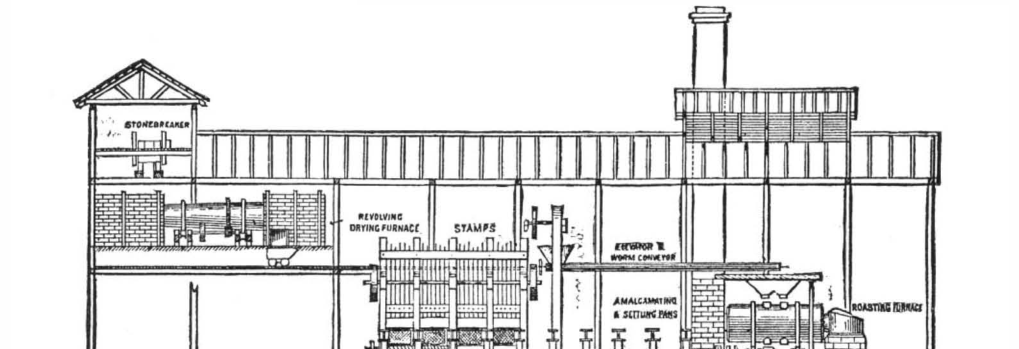


FIG. 14.

GOLD MINING MACHINERY.

HOW TO PRESERVE EGGS.—To each pailful of water, add two pints of fresh slaked lime and one pint of common salt; mix well. Fill your barrel half full with this fluid, put your eggs down in it any time after June, and they will keep two years if desired.

GUN STEEL.

AT a recent meeting of the Institution of Civil Engineers, a paper was read on "The Treatment of Gun Steel," by Colonel Eardley Maitland, R.A., Assoc Inst. C. E., Superintendent of the Royal Gun Factory, Woolwich. In the course of his remarks, the author stated that gun steel as used in England, and practically by the other gun-making nations, was a ductile material, a test specimen of which broke under tensile strain at about 30 tons per square inch in the soft or annealed state, and at about 45 tons per square inch when hardened by being plunged, at a temperature of 1450° F., into a bath of cool oil. It contained from 0·25 to 0·5 per cent. of carbon, and from 0·8 to 0·05 per cent. of manganese. The author proceeded to describe in detail the successive steps by which he had sought to estimate the value of oil hardening. From a comparison of thousands of results, he had formed the opinion that, taking the breaking strain after oil hardening as the datum, the limit of elasticity in the unhardened state rose with the proportion of manganese, and that the effect of hardening in oil increased with the proportion of carbon, raising both the elastic limit and the breaking strain more than in the case of steel with a higher proportion of manganese. The condition of strain, however, of pieces tested in the machine differed from that experienced by the metal when built up and used as a gun. It had been noticed that in cases of bursting, the fracture, whether the gun were of cast iron, of wrought iron, or of steel, was invariably short and granular. It was formerly assumed, in explanation of this, that the slow pull of the machine did not at all represent the sudden strain put on the material when used as a gun.

In order to test the truth of this assumption, a test specimen was screwed into blocks, one above and one below, so that the system falling a short distance, the top block was arrested, and the weight of the lower one subjected the specimen to sudden tensile strain. The result of several experiments was that the elongation, instead of being about 27 per cent., as was expected, was about 47 per cent.

This unexpected result determined the author to try the result of explosives. A strong tube was prepared by being accurately bored, and furnished in the middle with a radial vent and a radial crusher gauge. Plugs of steel, fitting the bore of the tube, were screwed on to each end of a specimen. These plugs were passed into the tube, the annular space around the specimen being filled in some cases with quick-burning powder, and in others with gun cotton, air spaced. On the charges being exploded through the vent, the plugs were driven violently out of the tubes, in opposite directions, each carrying one half of the specimen. The elongations under these tests varied from 47 per cent. to 62 per cent., the fracture in all cases being silky and fibrous. With the largest charges of gun cotton tried, the specimens in several cases broke in two places, the central piece being cigar shaped.

The results of these and of other trials with tube shaped specimens, and with steels of soft, medium, and hard quality, had convinced the author that the remarkable shortness of fracture noticed when a gun burst was a false indication of the quality of the metal. The true indication would be obtained by putting together the pieces, and measuring the stretch. Passing from the testing room to the works, the author proceeded to consider how the required material might be produced, so as to be of the most uniform quality, and in the best state for the purpose. The mode of treating the ingot before forging was described, as also the method of making the tubes and hoops.

The subject of erosion of the bore had been engaging the attention of the officers of the Royal Gun Factory for the last two years, and a great number of experiments had been made, to ascertain the qualities of steel best suited to resist it. The general result was that thorough forging was required to insure the best resistance to erosion, and that it was necessary to put three units of forging work into the metal, taking the unit of work as that done in doubling or halving the length of a forging. A fibrous condition was thus induced. Further, it appeared possible that gun steel, breaking at about 40 tons per square inch in the specimen, oil hardened at 1450° F., was best suited to bringing to this fibrous condition, although it mattered little whether the steel were high, medium, or low, compared with the great differences due to much or to little forging.

The author then described in detail a long series of experiments, made with the view mainly of determining the tensile strength of specimens cut from ingots hardened in oil, and unhardened, with and across the grain, and submitted in the ingot to varying amounts of work. Judging from the behavior of specimens, there appeared to be a decided benefit to the steel in oil hardening and annealing, even though the annealing undid the hardening. And as every nation making great guns used the oil hardening process, it must be assumed that there were strong reasons for its adoption. Nevertheless, with forgings of large size, the oil hardening was far less active, and very far less uniform, than with test pieces; and it became a serious question whether the double process of hardening and annealing acted so beneficially on the steel as to compensate for the risks incurred in setting up internal strain.

The oil hardening of gun steel at the St. Chamond Works, in France, where the forgings were annealed three times, was described, and the practice at Terre Noire was referred to. On a review of the results obtained, the author, having seen so many instances of fracture of steel, sometimes spontaneous, and sometimes under stresses quite inadequate to produce the result, was of opinion that internal strain was the gun maker's worst enemy, and that it was a question of great moment whether it was worth while to incur the risk of setting up such strain by oil hardening at all. In conclusion, the paper described the process of building up the complete gun by shrinking. The formulæ used at the Royal Gun Factory for this purpose were, in the author's opinion, thoroughly practical and trustworthy. They were based on investigations by Lane and by Rankine, and were sensibly identical with the rules and formulæ published by Virgile in 1874. As an illustration of their application, an example was worked out of the shrinkage which should be given to the jacket of a 5 in. gun.

THE LEWIS-BARTLETT PROCESS OF LEAD SMELTING.

By Professor WILLIAM RAMSAY.

IN all the ordinary processes of lead smelting, one difficulty with which the smelter has had to contend has been the escape of lead fume. The high temperature which it is necessary to employ in order to insure the reactions between the oxide, sulphate, and sulphide of lead, resulting in the production of metallic lead,

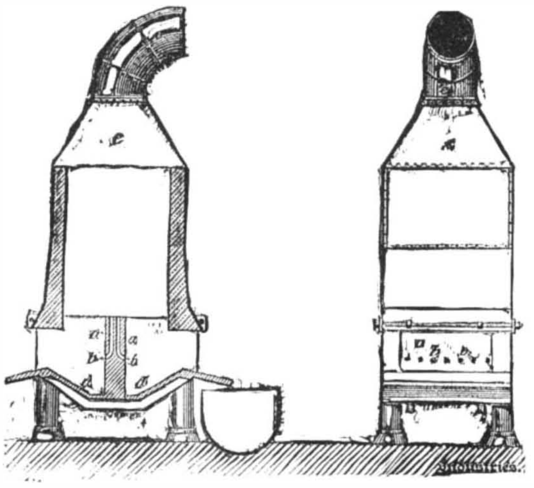


FIG. 1.

causes the volatilization of the metal, which in the state of vapor easily oxidizes; and the resulting oxide partly combines with the sulphur dioxide and oxygen to produce sulphate of lead. This mixture of oxide and sulphate is named lead fume. It is an impalpable powder, the settling or condensation of which is extremely difficult to insure. Numerous patents have been taken out with the view of minimizing the loss of lead, by condensing the fume; and many lawsuits have been the result of the deleterious action of lead fume on the cattle and sheep grazing in the neighborhood of lead works. Among the processes employed for the condensation of the fume may be mentioned the use of enormously long flues, with occasional chambers, designed to allow the fine dust to deposit. It is sometimes made to traverse "bafflers" or wooden gratings kept wet with water; and the specialty of

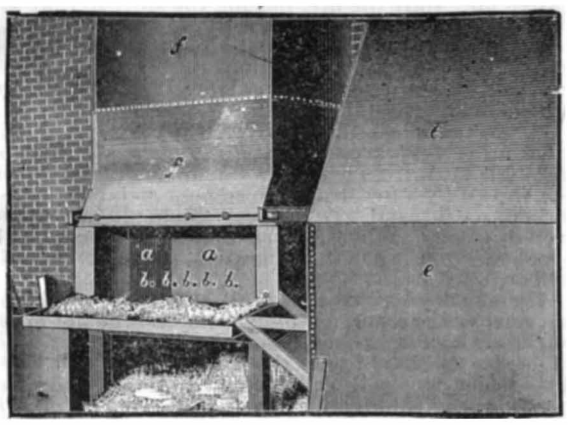


FIG. 2.

many patents is that the fume is forced or drawn below the surface of water, and thus more or less perfectly trapped. Some processes rely on mixing the escaping gases with steam, and subsequently condensing the steam; and the latest proposal, recently put into practice, and suggested by the beautiful discovery of Mr. Aitken and Professor Lodge that an electric discharge causes dust to settle, is to electrify the fume by exposing it to the discharge from a number of pointed conductors, and thereby to cause it to settle on the conducting walls of the chambers through which it passes. All these processes are imperfect, and many are very costly. An entirely new light has been thrown on this problem by Mr. Eyre O. Bartlett, the inventor of the process named the Lewis-Bartlett process of lead smelting. Mr. Bartlett conceived the idea of utilizing the fume as a paint, and instead of trying to avoid its formation, to aim at its production in as large amount as possible. The original thought of employing the fume as paint is no new one. In 1778, Bishop Watson, who wrote a remarkable essay on lead smelting, recom-

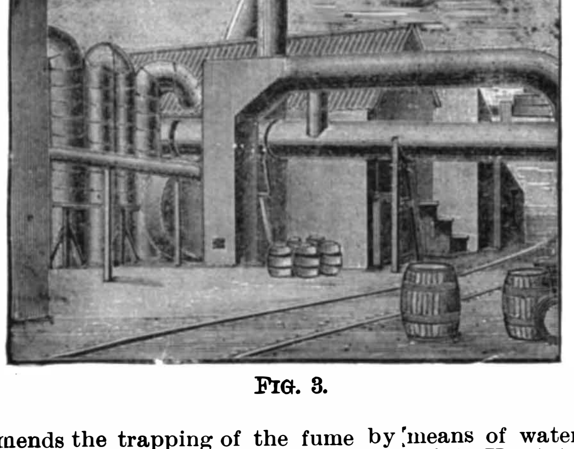


FIG. 3.

mends the trapping of the fume by means of water, and utilizing the recovered fume as a paint. He states that "this sublimed lead is of a whitish cast, and is sold to the painters at £10 or £12 a ton." But to Mr. Bartlett is due the credit of making the fume the main product; resubliming it to render it perfectly white, and collecting the lead itself as a by-product. The process was adopted by Mr. George T. Lewis, of Philadelphia, and introduced at the Lone Elm Works, in Joplin, Jasper County, Mo., U. S. A., in the year 1876. Its special feature is the manner of collecting the lead fume by the use of flannel bags, into which all the gaseous and volatized products from the furnaces are forced. The gases find an easy passage through the flannel, while the solid particles are retained. Even this part of the process is not a new conception. In Percy's "Lead," page 449, experiments by "an experienced British lead smelter" are described, in which the following sentence occurs: "I am convinced from many other experiments that, except for the difficulties arising from the heat and sulphurous acid, it would be possible to construct some textile fabric through which

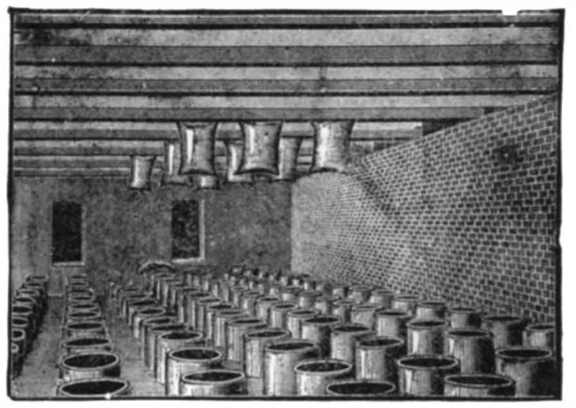


FIG. 4.

the smoke might be slowly forced or drawn, leaving the bulk of the fume on one side." The Lewis-Bartlett process has made this forecast a commercial success. This process is now in active operation at the works of the Bristol Sublimed Lead Company, preliminary experiments having been made at the works of Messrs. John Hall & Sons; and the following description of the process is due to their kindness. It is substantially what is practiced at the works, between Shirehampton and Avonmouth, near Bristol.

THE "JUMBO" FURNACE.--The lead ore at present used consists of washed galena, containing from seventy-nine to eighty per cent. of metallic lead. It is first smelted in the "Jumbo" furnace, the nickname given by the American workmen to an ingenious modification of the Scotch hearth. Its construction is

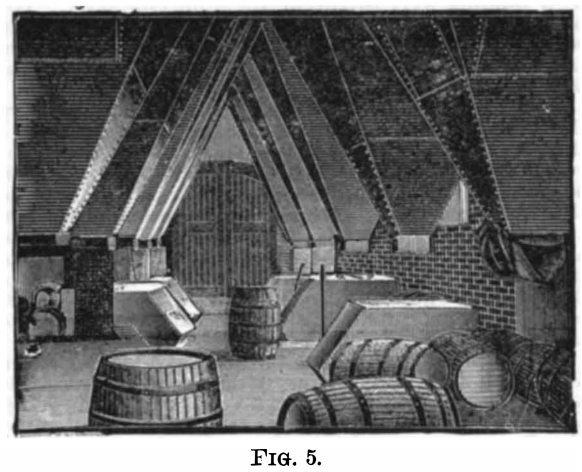


FIG. 5.

shown in the annexed engraving, Fig. 1, and a view, taken from a photograph of the furnace while out of action, is given in Fig. 2. Fig. 1 exhibits a sectional elevation of the furnace and a front elevation. The following description will render the drawings intelligible: *a a* is a hollow cast iron back, perforated with five or six holes at *b b*. This single back serves for both sides of the furnace. The lower part is a dam of cast iron, which reaches to the bottom of the basin, except where it is cut away at one corner, to allow the metal to be drawn off from one side. Being hollow, this dam

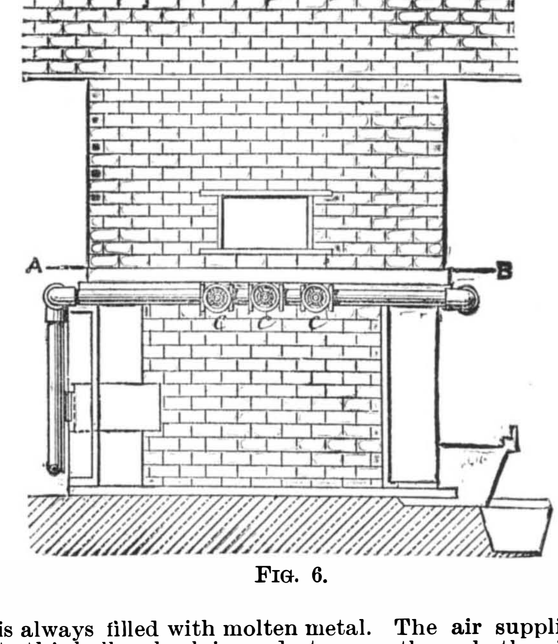


FIG. 6.

is always filled with molten metal. The air supplied to this hollow back is made to pass through the side walls of the hearth, in order to heat it. The basin, *d d*, is shallow, only eight inches in depth, and the lead running out of the overflow is drawn from the bottom of the bath by a tapping pipe reaching nearly to the bottom of the basin. The ore is fed on to the hearth, mixed with a small amount of coal and lime. In practice, to one ton of ore a quarter of a cwt. of lime and one cwt. of coal are used. The blast is supplied by means of a Baker blower, and as the lead is melted it runs over into a receiver, from which it is cast into pigs, which are afterward desilverized. The slag, which is not fused, is raked into a sheet iron box, from which it is transferred to the slag hearth, subsequently to be described. The chemical reactions which here take place are the same as those occurring in the usual Scotch hearth, and need only be mentioned here. The

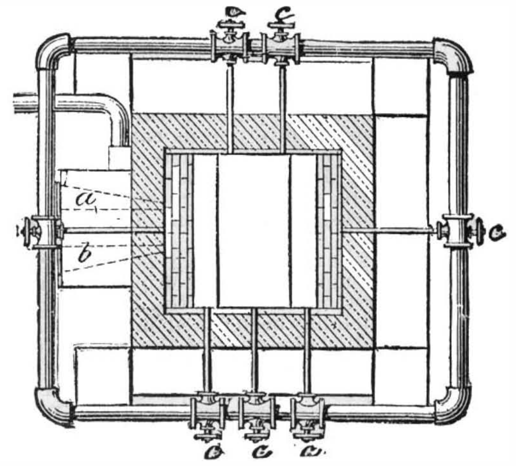


FIG. 7.

galena, or sulphide of lead, is partly oxidized to sulphate, which reacts with the unaltered sulphide, giving metallic lead and sulphur dioxide. The lime that is added stiffens the charge, and keeps it open, and soaks up the slag into balls, from which the semi-fused galena may be broken and returned to the furnace. It has probably little action, if any, on the ore. The

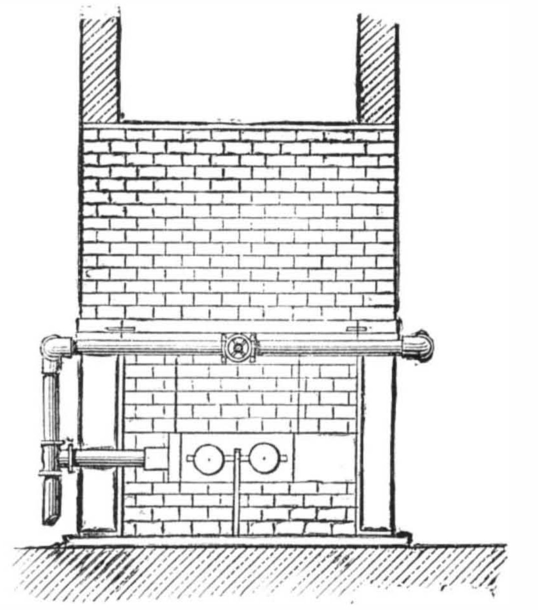


FIG. 8.

peculiarity of this process is that it makes comparatively little difference whether the lead is obtained in this or in a subsequent operation. A hot and strong blast can therefore be used, and labor is greatly economized. Four men, two on each side, can smelt seven tons of ore in eight hours; or twelve men, working three shifts, can put through twenty-one tons in twenty-four hours. An additional man can bring all the coal and lime required. By the Scotch hearth process, a similar yield would have required the labor of thirty-two men. The labor also is easier, and less skilled men may be employed; moreover, the physical strain on the men is not nearly so great.

THE "BLUE CHAMBER."—The fume produced during the smelting is drawn by means of a wrought iron fan through the hood, *e*. This fan has protected bearings, so that they are not injured by heat from the fume. The fume and gases are projected into a chamber, where it settles out, and then through a long iron pipe, named the "goose-necks," of which a view is given in Fig. 3. It is there cooled by the air, and

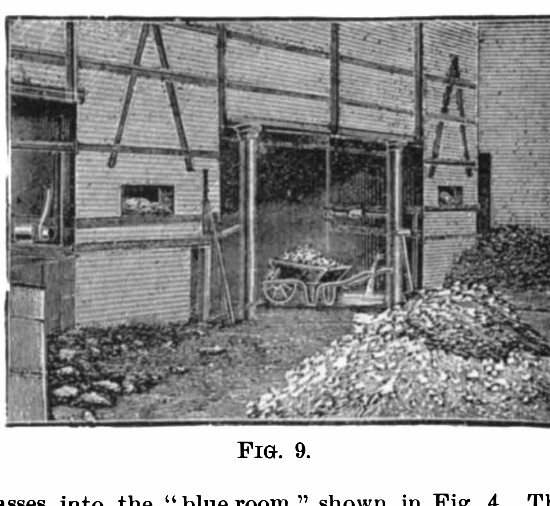


FIG. 9.

passes into the "blue room," shown in Fig. 4. The cut shows the iron tubes to which the flannel bags are attached. This wood cut represents a number of iron pipes, each about two feet in diameter. When in working order, each pipe has attached to it a flannel bag, about thirty feet in length, which is closed at its upper end and is suspended from the roof of the build-

ing. These bags are kept inflated by the fan. The gaseous products of combustion, sulphur dioxide, and nitrogen, and excess of air, pass through the pores; but the solid fume is completely retained. The pipes, to which the lower ends of the woolen bags are attached, pass through a sheet iron floor into the room below, and communicate with iron hoppers, in which the fume is collected twice in twenty-four hours. To collect the fume, the blast is stopped, and the bags are shaken by men who wear respirators, when the fine powder falls into the hoppers. A view of the hoppers is given in Fig. 5. They have the shape of the inverted frustum of a four sided pyramid. The fume has a bluish color, and has been used directly as paint for ships' bottoms, iron work, etc. It consists of sulphate and oxide of lead, mixed with a little sulphide, to which its bluish color is due. It is usually set on fire, when it smoulders, the sulphide burning to sulphate, forming a yellowish white porous caked mass. As a rough estimate, for every fifty parts of metallic lead produced by the "Jumbo" furnace, fifteen parts of fume and fifteen parts of slag are obtained. At the Shirehampton works, about 130 tons of ore can be put through per week.

THE SLAG HEARTH.—The slag hearth, or "slag eye," furnace is employed in smelting the fume obtained by the first operation in the Jumbo, together with the slag, which has been raked into the slag box of sheet iron standing alongside of the Jumbo furnace, and is shown in Fig. 2. The slag hearth, which is fully shown in Figs. 6, 7, 8, and 9, consists of a square shaft of brick of 2 ft. cross section inside, provided with a tuyere box set on a level with the bottom of the furnace, through which two tuyeres (*a* and *b*, Fig. 7) pass entirely, and four tuyere boxes provided with tuyeres, *c c*, which completely encircle the furnace at a level with the charging floor. There are two of these furnaces. The charging doors are on the front, and the tuyeres and tapping holes are directly under the flue. They are shown in Fig. 9. This furnace, as its name implies, is employed in smelting the slag from the previous operation, together with the fume condensed in the blue room.

The usual proportions of the charge are 2 cwt. of very hard coke, 15 cwt. of fume and slag, and less than half a cwt. of lime. The tuyeres conveying hot air, arranged at the bottom and all round the top, give every opportunity of oxidation, so that none of the fume escapes in the form of lead sulphide. This furnace is attended by two men on every twelve hours shift; one shovels in the charge, while another looks after the blast, keeps the cinder nozzle clear, and occasionally casts the molten lead. The action of this furnace is continuous; the lead rises into a casting basin, while the slag, melted in this furnace, and not caked, as in the Jumbo, flows continually into a pit of water (see Fig. 9). The yield from this furnace is approximately 50 per cent. lead and 50 per cent. fume; but rather more fume is usually obtained than lead. The blast for these furnaces is produced by Baker blowers. The fume is cooled, as in the former operation, by passing through goose necks, and enters the "white room," fitted like the "blue room" with flannel bags. The hoppers, however, are of wood, lined with iron, and discharge into wooden bins placed beneath them to collect the perfectly white fume. Before the bins are opened, a loose flap of canvas is dropped down over the front edge of the bin, covering the open top, to prevent the escape of dust. The white lead is then packed in barrels. As it is not a definite chemical compound, it varies somewhat in composition. An analysis of it showed it to contain 70 per cent. of sulphate of lead, 23 per cent. of oxide of lead, and 7 per cent. of oxide of zinc; its composition, of course, varies with the nature of the ore. As the Shirehampton works have not been running for a very long time, it is not possible to give an account of the total produce of lead and paint which may be expected from the process. In 1884, however, the American works at Lone Elm were run for six months with the following result. The amount of galena purchased was 7,119,665 lb., and of slag 390,000 lb.; the produce of pig lead was 4,698,000 lb., and of white lead, 1,685,000 lb. Supposing the slag to be equivalent to $\frac{5}{11}$ of its weight of galena, 177,273 lb. must be added to the galena treated, making the total quantity 7,296,938 lb. The pig lead obtained amounts to 64·38 per cent. of this weight, and the white lead to 23·92 per cent., making the valuable product a percentage of 88·3 of the raw material. With the ordinary furnaces, the yield is 75 per cent. But 23·92 per cent. of paint may be considered to contain 17·11 per cent. of metallic lead, giving a yield of 81·49 per cent. of metallic lead, out of a total possible yield of 86·6 per cent. This is equivalent to obtaining all the lead from a galena containing 94 per cent. of pure galena. The works at Shirehampton are capable of treating 130 tons of ore per week. The blowers and other machines are driven by a compound horizontal engine of 60 h. p. The gases which escape into the "blue room" through the bags consist of nitrogen, carbon dioxide, and sulphur dioxide. These gases are driven into bafflers, where they come in contact with water, and find their way into the River Avon, which is there tidal. The disagreeable effect of the sulphurous acid is thus avoided. Very little sulphurous acid escapes into the "white room," and the atmosphere there is quite endurable, though certainly not pleasant. The paint produced by this process is said, by competent judges, to be equal in covering power to ordinary white lead. It is certainly not distinguishable from white lead by the ordinary observer. It is thus seen that this process presents very great advantages over the old ones in economy of labor, in avoiding the escape of pernicious fumes, in the greater health of the workmen, and in the production of a marketable paint direct from the ore.—*Industries.*

TUNGSTIC ACID AS A SUBSTITUTE FOR CHROMIC ACID OR BICHROMATE OF POTASH FOR PRIMARY BATTERIES.—Dr. Eisenmann, of Berlin, has found that an acid solution capable (when used in a zinc battery) of being regenerated by mere exposure to the air may be obtained by forming a solution of 30 gr. of tungstate of soda and 5 gr. of phosphate of soda, dissolved in 350 gr. of water, with the addition of a small quantity of sulphuric acid. The phosphate is added merely to increase the solubility of the tungstate.

PARISIAN CARPET LOOM.

IN the manufacture of Smyrna or Turkish carpets, the pile is formed by short pieces of wool weft looped round the warp threads in such a manner that they cannot be pulled out, and consequently the carpets are very durable, and retain their patterns till the pile is completely worn off.

In tapestry velvet carpets, on the other hand, the pile is formed by short lengths of warp threads, obtained by cutting the loops formed in weaving over wires, and these short lengths are not secured either to the back warp or weft and are held simply by their friction, so that they can be easily pulled out, especially in carpets of light make with comparatively thin pile yarns and loosely beaten up weft. The same drawback applies to those portions of Brussels velvet carpets where the same thread is lifted for a number of wires in succession.

The object of the arrangements introduced by Mr. Dusquesne is to obviate this drawing out and slipping of the pile, so that the carpet may wear longer without showing bare places or strings, and to obtain a soft and

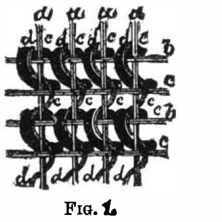


FIG. 1.

FIG. 2.

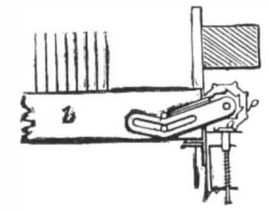


FIG. 5.

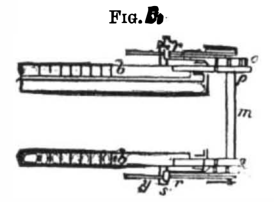


FIG. 6.

elastic carpet by enveloping the back by the woolen pile warp, which he effects by adopting a kind of gauze weave. The carpet, christened "Parisian" by the inventor, has a back composed of two jute, hemp, or cotton warps, one of which contains the straight threads and the other the twisted threads of the weave, which latter are alternately drawn to the right or left of the foundation warp threads, and secured in these positions by a binding weft thread of the same character. The pile is produced by a woolen pile warp, the threads of which also are raised alternately to the left and right of the straight warp threads, but in reversed order of the back warp.

Figs. 1 and 2 show in plan and section along the warp the enlacement of the threads. After having passed to the left under the foundation warp, *a*, and under the twisting warp, *d*, the pile threads, *c*, are secured in this position by the weft threads, *b*, and are then drawn to the right by passing again under the warp threads, *a*, and the twisting threads, *d*. After cutting the loops produced in this way the latter form on both sides of the weft threads, *b*, tufts which form the velvet face of the carpet, while the under part of the same tufts covers the back, producing thus a carpet very soft to the feet, the pile of which is very fast.

For the production of a close and heavy fabric, woven with thick and fluffy yarns, it naturally is impossible to employ the ordinary doups for producing this gauge or twisted weave, and the special means invented by Mr. Dusquesne to obtain this weave constitute the novelty of his method, which we proceed to describe by the aid of the illustrations, for which we are indebted to our contemporary, *L'Industrie Textile.*

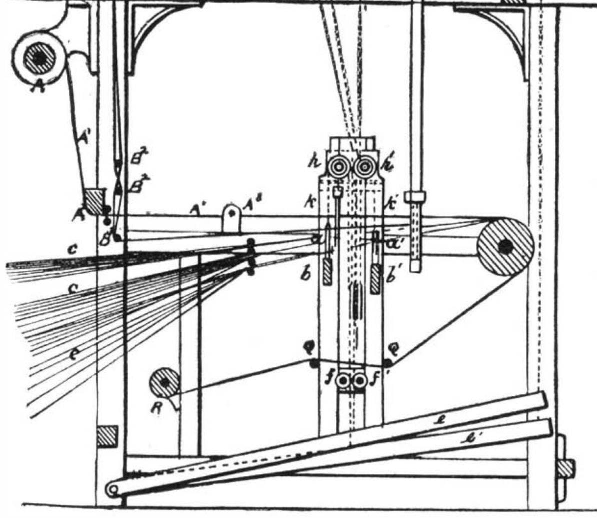


FIG. 3.

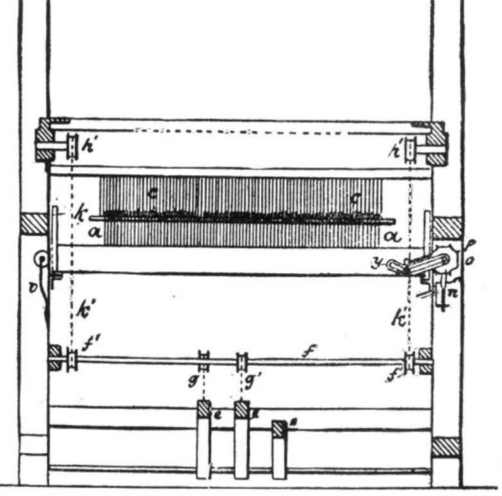


FIG. 4.

PARISIAN CARPET LOOM.

Fig. 3 shows a longitudinal and Fig. 4 a cross section of the loom. The pile threads, *c c*, are warped on separate bobbins mounted on a creel, not shown on the illustration. Each bobbin is pressed by a spring brake and the threads themselves are weighted to maintain a uniform tension. The foundation warp threads, A^1, are warped together on a beam, A, placed at the back of the loom, near the top. On their way to the reed the threads are passed through a back comb, A^2, and under a tension rod, A^3. The twisting or binding warp, B^1, is warped on a beam, B, placed above A, and the threads are drawn through the reed of the slay as those forming the foundation warp.

But before this they are passed separately through eyes in the ends of a row of needles or wires inserted in a cross bar, *b*. The pile threads, C, coming from the bobbin creel are passed between guide rods, c^1, and then through the eyes of the needles in a second cross bar, b^1. The eyes of these needles are oblong, to allow the easy passage of several threads above one another. The general direction of the three warps is maintained by means of a guiding reed, *c*, placed between the two needle bars, *b* and b^1. As the carpet is formed it passes round the take-up roller, P, covered with pins, and past the guide rollers, Q Q, to the cloth beam, R, on which it is lapped.

In order to make the binding and pile warp threads pass alternately above and below the weft, to the right and left of the foundation warp threads, the two needle bars, *b* and b^1, are actuated with two distinct alternating movements, one of which is vertical for the formation of the shed, and the other horizontal. The first is obtained by means of the treadles, *e*, e^1. The former actuates the shaft by means of a chain, *g*, and determines the lift of the needle bar, *b*, the latter being connected by chains, *k*, passed over the pulleys, *h*, to the shaft, *f*. In the same way the treadle, e^1, actuates the needle bar, b^1, through the shaft, f^1, chains, k^1, and pulleys, h^1. The Jacquard machine or other shaft machine is actuated by a third treadle and the cord, F. The mechanism for producing the lateral movement of the needle bars is shown by Figs. 5 and 6. A small shaft, *m*, placed horizontally, carries at either end a ratchet, *o*, and an octagonal cam, *p*, which are loose on the shaft, *m*, but themselves connected. When, during the lift of the needle bar, *b*, the pin, *s*, slides in the link, *y*, it lifts the pawl, *r*, and turns the octagonal cam by an eight revolution, during which the corner of the cam bears against the needle bar and pushes it to the left. When the weaver takes his foot off the treadle the needle bar drops, and a spring brings it back to the right, while a foot held up by a spiral spring keeps the cam in its position. The other needle bar, b^1, is actuated by an exactly similar mechanism, the only difference being that the link, *y*, is made longer, so as to allow for the varying lift of the needle bar, which depends on the lift of the Jacquard and the number of pile threads drawn through each eyelet, the latter being made oblong for the same reason. With these arrangements the loom is suitable for weaving tapestry with plain or printed pile warps, as well as carpets, in which the patterns are produced by the Jacquard machine.—*Textile Manufacturer.*

BALLOON VARNISHES.

FIRST procure a large kettle of cast iron or enameled iron. Place it, *out of doors*, on a stove (having several lengths of stove pipe). The kettle should have a close-fitting cover, to be used only in an emergency. Fill the kettle *one-third to one-half* full of *pure* natural *linseed oil*; start the fire, placing the stove so that the wind will waft any fumes from the oil away from the fireplace of the stove. Raise the heat until a slender stick of dry pine wood is charred, or becomes carbonized on its surface, when thrust into the oil to stir it. Watch the oil carefully, and if it takes fire, extinguish by covering the kettle quickly. It is well to set the cover on at first, keeping it *loosely* covered. Boil, at this high heat, from one to two hours and until the oil —as shown by a few drops cooled on a metallic plate— is thick, viscid, and *very stringy*. It should have a red brown color. When quite cold, a sample of this "cooked" oil should somewhat resemble India rubber.

When sufficiently treated with heat, extinguish the fire, remove the cover, let the sun shine on the hot mass, let the air cool it, and let it settle. After a short time, while it is still hot, decant the clear portion, and when this—which we will call "*varnish gum*"—becomes merely warm, thin it with recently rectified *oil of turpentine* until it has the consistency of a suitable varnish. Mark this "*Balloon Varnish No.* 1." This is the varnish used by John Wise, the experienced aeronaut, and others.

The regular varnish makers can readily do the above described work, having all the appliances, but some of them will adulterate the linseed oil or not give proper care and attention to the process.

Second.—Take pure caoutchouc (India rubber) and with a wetted knife cut it into shreds, which let dry overnight or, more quickly, in the sun. Dissolve this caoutchouc in hot, recently rectified *oil of turpentine*, to the consistency of paste. It is well to let the rubber lie in the cold turpentine a day or two before warming it. Heat in a water bath.

To a quantity of "*Balloon Varnish No.* 1," containing 100 ounces of the aforesaid "*varnish gum*," add a quantity of the rubber turpentine paste containing five ounces of pure caoutchouc; place on water bath, and thoroughly incorporate by stirring. Mark this "*Balloon Varnish No.* 2." It was used by Giffard in

constructing his great captive balloon at the Paris Exposition of 1878.

It is better to give three or four coats of thin varnish than two or three of thicker varnish, because the pores of one coat will not coincide with those of another, and the fabric is therefore less permeable to gases.

It is recommended that the cloth for the balloon be given one coat of "*Balloon Varnish No.* 1," used thick (but thin enough to readily impregnate the cloth), or, better, *two* coats of the varnish used thinner; then one or two coats of "*Balloon Varnish No.* 2." In each case the drying of each coat should take place in warm sun light and a *dry* day; when the air is not moist or "muggy" is best.

[Continued from SUPPLEMENT, No. 592, page 9461.]

CLIMATE IN ITS RELATION TO HEALTH.*

By G. V. POORE, M.D.

LECTURE I.—CONTINUED.

HAVING considered the atmosphere—its gaseous and watery constituents—in its relation to climate and health, we now turn to something which is, as it were, outside of and independent of the atmospheric garment in which the earth is clothed, but which influences us mainly through the instrumentality of the atmosphere. I allude to temperature.

The main source of the earth's heat is the sun, which is distant from us some 92,000,000 of miles, and it is worthy of remark that, owing to the elliptical orbit of the earth, we are about 3,000,000 of miles nearer the sun at our midwinter than we are at our midsummer. It is evident, therefore, that the seasonal variations of temperature do not depend on the varying distance of the sun.

The seasonal variations of temperature depend on the verticality or obliquity with which the sun's rays strike the surface of the earth, for the more vertical is the path of the sunbeam the more concentrated is its effect, and the thickness of atmosphere which it has to traverse is at its minimum. When the sunbeam falls obliquely its effect is more dispersed, and the thickness of atmosphere which it has to traverse is at its maximum. Therefore, when the sun is most vertical, *i. e.*, at midsummer and at midday, we derive most heat from it, and when the sun is "low in the heavens," as at midwinter, and at dawn and evening, we derive less heat.

Much of the radiant heat of the sun is absorbed by the watery vapor of the atmosphere before it reaches the earth. The greater part of this absorption takes place in the lower strata of the atmosphere, and it is well known that, as we ascend out of the lower strata into the dry rarefied air of high mountain ranges, the radiant heat derived from the sun is excessive.

The direct radiant heat of the sun passes through the atmosphere without materially raising its temperature, but the temperature of any solid upon which the heat rays fall, such as the soil, the human body, or the blackened bulb of a thermometer, is materially raised. In this country temperatures of 150° Fahr. have been marked by blackened thermometers *in vacuo*, and in situations where the atmosphere is very dry and very rarefied, "as at Leh, in Ladakh, to the north of Cashmere, at an elevation of 11,000 feet, the readings have gone up to 214° Fahr., and even higher." (Scott, "Elementary Meteorology," p. 56.)

"It is a well known phenomenon that, at considerable elevations above the sea level, where the denser and damper portions of the atmosphere are beneath us, the direct effect of solar heat is quite disproportionate to the temperature of the air. In such localities, as for instance at Davos, in Switzerland, at the level of 5,000 feet, you can sit in the sun comfortably without a greatcoat; while in the shade close by, the temperature is several degrees below the freezing point. In high latitudes the same paradox is observed, where the extreme dryness of the atmosphere is due to intense cold.

"The observation is as old as the time of Scoresby, that on board a whaler you may see the pitch bubbling out of the seams of the ship where the sun shines on them, while ice is forming on the side of the ship which is in the shade." (Scott, *loc. cit.*)

In this damp climate we have hardly any knowledge of the difference which may exist between the temperatures of sunshine and shade, and the difference is one of the first novel experiences of those who visit sunny, dry climates, whether at great elevations or elsewhere. In the south of France, along the Riviera, where the air is much drier and the sun more powerful than here, during the prevalence of the dry, cold mistral, to step from sunshine into shade is almost like stepping into a cold bath. And at Marseilles, on one occasion, I well remember standing with my back to the sun until the calves of my legs were fairly scorched with the heat, while my toes, which were in the shadow of my legs, were uncomfortably nipped with the cold.

It is evident that British visitors to these climates run great risks of catching cold, because the sudden alternations of temperature are phenomena to which they are entirely unaccustomed. They are apt to be too lightly clad, and to forget that while the direct rays of the winter sun afford a temperature which reminds us of our July, cold as severe as that which we experience at home is lurking in the shade.

The most characteristic feature in the dress of the inhabitants of Southern Europe is the loose, full cloak, so arranged that it may be discarded or made to closely enwrap the body at a moment's notice. Necessity is the mother of invention, and this cloak has been necessitated by climates in which the alternations of temperature are sudden and severe.

Since radiant heat experiences most difficulty in traversing the damp lower strata of the atmosphere, it follows that its effects are less felt in the neighborhood of large surfaces of water, where the air is always humid, than elsewhere. And insular climates are, as a rule, less hot than the climates of adjoining continents.

The radiant heat having penetrated the atmosphere in greater or less quantity, according to circumstances, some of which we have alluded to, what becomes of it?

1. Some of it is absorbed by the surface upon which it falls.

2. Some of it is reflected back, and these reflected rays, added to the direct rays, very much increase the heat of solid bodies exposed to them.

* Three lectures before the Society of Arts, London. From the Journal of the Society.

The power of the earth to absorb heat varies very much, according to the nature and aggregation of the soil. Assuming the maximum absorbing power to be equal to 100, then Schubler has calculated that the absorbing power of—

Sand, with some lime	= 100
Pure sand	= 95·6
Light clay	= 76·9
Heavy clay	= 71·11
Fine chalk	= 61·8
Humus	= 49

Herbage of all kinds lessens the heat-absorbing power of the soil.

Color makes a difference to the absorbing power also, and, generally speaking, dark colored soil and surfaces absorb much heat. Soil and surfaces not only absorb heat, but reflect it also, and it may be said that the amounts of heat absorbed and reflected by any surface bear an inverse proportion to each other. Among reflectors of heat which will occur to all are snow, water, and white chalk cliffs and rocks of all kinds. The presence of these reflectors necessarily intensifies the power of heat upon an individual, or any object capable of absorbing it.

Soils and other surfaces which have been warmed by absorption of heat during the hours of sunshine lose this heat again by radiation during the night. Radiation is helped by a clear, dry atmosphere, and is impeded by a moist atmosphere or by a canopy of cloud, which checks it almost entirely. As a rule, it may be said that soils lose heat by radiation sooner than they gain it by absorption. Soils and solids generally are quickly heated, and quickly cool again.

With water it is different, and seeing that this earth's surface is mostly water, it is very important that we should consider the effect of heat upon water.

In the first place, the atmosphere over the sea or large sheets of water is always more or less charged with moisture. Hence the heat rays have some difficulty in penetrating the atmosphere to reach the water, and the water, when once heated, experiences from the same cause, so to say, a difficulty in losing its heat by radiation. Again, much of the radiant heat which falls upon the surface of the sea is reflected, and not absorbed.

Thus we have given two reasons why the surface of the sea is not so readily heated as the surface of the soil. Further than this, we have to consider that the heat rays penetrate to a considerable depth into the water, some 600 feet, and do not, so to say, waste all their energies upon the surface.

Lastly, and most important, the specific heat of water is very high, about four times greater than that of land. And for the heating of equal bulks much larger quantities of heat are necessary in the case of water. The heating of water is much slower than the heating of land, and it loses its heat by radiation much more slowly, and for the following reason: As the layers of water on the surface cool, they get heavier and gradually sink, and warmer water rises to the surface. Hence it follows that the sea never gets heated to an excessive extent, and, on the other hand, owing to the circulation of the fluid, it never gets chilled to an extent at all equal to the neighboring land. In polar regions, when water ceases to be liquid, these conditions cease. The sea is, therefore, a great cause of equable temperature, and on its surface and by its shores it may be laid down as a rule that extremes are moderated.

The temperature of the surface of the sea in the tropics reaches about 85 deg. Fahr. as a maximum, while the surface temperature in these latitudes fluctuates between 60 deg. Fahr. as a maximum and 35 deg. Fahr. as a minimum. If we change the temperature of part of a volume of water, we cause changes of density, and, as a consequence, movement of the mass. Hot water rises, cold water flows in to fill its place. What happens to the oceans which lie between the blazing tropics and the frozen poles? These great masses of water obey physical laws, and there is a constant stream of cold water at the bottom of the ocean, flowing from the poles to the tropics, and, broadly speaking, a flow of warm water on the surface in the opposite direction.

The heated water of the surface not only flows to take the place, as it were, of the sinking cold water of the poles, but it is blown by prevailing winds, and gets a direction in this way or that by the shape or bendings of neighboring coast lines. In these islands we ought to be deeply grateful to ocean currents. The general oceanic circulation, and the so called Gulf Stream, which is, in fact, a part of it, laps our coasts in warm water, and prevents us from experiencing the wintry rigors which are felt in upper Canada and central Russia, places in the same latitude as ourselves.

With this short review of the causes of variations in temperature, we may now particularize a little, and discuss the causes which affect the temperature of localities.

1. *Latitude.*—The length of daily exposure to the sun's rays, and the degree of obliquity or verticality at midday, are important elements in determining the temperature of a place. If the surface of the earth were uniform, then latitude and temperature would be in exact relation, but this we know is very far from being the case.

2. *Elevation above Sea Level.*—As we rise above the surface, the temperature of the air falls about 1 deg. Fahr. for each 300 ft. of ascent. Hill stations are, therefore, always cooler than stations situate in the plains of the same latitude.

3. *Amount of Cloud and Moisture in the Air.*—These serve as curtains against the sun's rays, and depress the temperature while the sun is shining. On the other hand, they check radiation when the sun has set, and preserve the warmth at night.

4. *The Nature of the Surface.*—Land heats and cools far more readily than water, and, therefore, in the center of great continents extreme fluctuations are common. The nature of the soil is of importance, as we have seen. The sea moderates temperature, preventing excessive heat and the extremes of cold. The stretch of water between these islands and the poles helps to keep them warm and moderates the bitterness of northern winds. The warm currents from the equatorial Atlantic help also to keep us warm. In Canada and Russia, which enjoy neither of these advantages, the winters are in great contrast to our own.

5. *Prevailing Winds.*—In this climate the southwest winds, laden with rain, are a great cause of warmth, and produce the high winter temperatures of Valentia, on the west of Ireland, of Scilly, and of the islands on the west of Scotland. As a contrast to these places in our own country, let us take the city of Turin, which enjoys a greater sun exposure, it is true, but which is exposed to the bitter winds blowing from the snow-clad Alps, and where the serene skies of winter allow uninterrupted radiation of terrestial heat.

6. *Position of Hills and Mountain Ranges in respect of Locality.*—If the hills are between the locality and the sun, they help to depress temperature. We all know the difference between a northern and a southern exposure. If the hills protect the locality from cold winds, and help to reflect the sun's rays, then they increase the temperature of the locality.

Having got so far, it will be well to take a familiar example, and inquire the cause of the climate of one very well known place.

Let us look at that favored spot in the south of France known as the Riviera, where our countrymen flock in search of pleasure and of health, of warmth, sunshine, and natural beauties. The climate of this spot, be it observed, is warmer and more equable than that of places farther south, such as Florence or even Naples, so that its climatic advantages are by no means entirely due to latitude. The sun is more powerful than with us (for the locality is some eight or nine degrees south of London), and in the winter remains somewhat longer above the horizon, so the intensity and the length of sunshine is greater than here. There is far less cloud, and the prevailing winds are less moist, so that the power of the sun's rays to penetrate the atmosphere is greater than here. The soil is dry, and this aids in producing a comparatively dry air, the moisture amounting to about 70 per cent., as against 90 per cent. in London. At a varying distance from the shore are the lower spurs of the range of hills known as the Alpes Maritimes. These serve a double object: (1) they protect the locality from the cold winds which blow from the ice fields of the Alps; and (2) they reflect the sun heat, just as a plate warmer before the fire reflects the heat upon the plates. This is a great cause of the warmth of this favored district and of the lovely semi-tropical vegetation which there abounds.

Another important fact is the proximity of the land-locked Mediterranean Sea. In this sea are no polar currents, although there is doubtless some circulation and some warm surface currents blown from its southern shores. The deep sea temperature of the Mediterranean is over 50° Fahr., while that of the Atlantic outside the straits of Gibraltar is only 36° Fahr. In this spot several of those conditions which conduce to a warm temperature come together, and its popularity with physicians and the public is not to be wondered at.

There is no such thing as a climate which any of us would ignorantly and selfishly call perfect. Even the favored Riviera has its drawbacks, and the staple of conversation among the more delicate of the frequenters of this part of the French coast is the "mistral," the northwest wind, dry, cold, and boisterous, which, after traversing the center of France, forces its way through the gorges and round the spurs of the Alpes Maritimes and sweeps rudely into the sacred warming pan which lies between Toulon and San Remo. When the mistral blows, the sky is clear and bright, the air is dry and crisp, and, if escape can be found from the clouds of dust which it raises, it is stimulating, and not unpleasant to a man in good health, who is able to move about and warm himself by exercise. The mistral is most intolerable in a town, where it sweeps down the streets and round the corners with a fury positively dangerous to feeble people, and accompanied by clouds of dust which must be not bad imitations of the dust storms of the desert. The mistral is very chilling, and very irritating to persons with weak lungs, and the only thing for invalids to do while it is blowing is to sit indoors, and if they have sunny windows facing the southeast, they will much enjoy the bright sky and warmth, and will not feel the wind.

The mistral, as I have previously hinted, is probably one of the best friends of this coast. It must be the most potent scavenger, drying up filth, holding putrefaction in check, and purging many a foul corner of its dangerous accumulations. Another drawback to the Riviera is the wide range of temperature, which is a snare to the unwary. Between sunshine and shade there is often a difference of 73° Fahr., and between midday and midnight the difference is equally great. Insufficient clothing, and careless exposure after sunset or to night air, has cost many an invalid his life.

The extremes of temperature which may be encountered on the globe are very remarkable. The average temperature for the month of May at Massowah, in the Red Sea, is (according to Scott) 99° Fah., while the winter average for Werchojansk, in Siberia, is —56° Fahr. There is, therefore, a range of 155 degrees between the hottest month at Massowah and the coldest month in the heart of Siberia.

Sir John Herschel has recorded a temperature of 159° Fahr., observed on sandy soil at the Cape of Good Hope, and the lowest actually recorded temperature is —81°, observed by Gorochow, in Siberia. As to the endurability of these extremes, Scott quotes Dr. Moss, who, in his "Stories of the Polar Sea," says:

"Many a time the relative merits of Arctic cold and tropical heat were warmly canvassed. Many of our officers and men had lately returned from the Ashantee campaign, and they could speak with authority. There was one thing clear, one could sometimes get warm in the Arctic, but never cool on the coast."

Nothing is more calculated to rouse our admiration and amazement than the manner in which the animal body accommodates itself to extremes of temperature. Men will go from tropics to pole and from pole to tropics, and maintain a fair level of health at both, and we may well pause to inquire how this is managed.

Life in the tropics is a simple matter. There is no necessity for clothing or firing, and a handful of dates will almost supply the food wants of the individual. Protection from wild animals and from fellow men is almost the only thing necessary to preserve life.

A naked animal like man could hardly move far from the tropics until he had learnt a little tailoring, and had found out how to turn the skins of the lower animals to his own account. The art of building huts or tents would enable him to move still further north, but without the great discovery of fire he could hardly

have penetrated into cold climates, and still less could he maintain an existence there. The great trouble in the Arctic regions is to keep up the animal heat, and this is only to be done (1) by the adoption of every kind of artificial protection against cold, and (2) by the supply of sufficient food, which is often no easy matter. Food in abundance is most important, as without it the temperature of the body cannot be maintained. The Esquimau will consume ten pounds of animal food per diem. Food is the fuel which we put into the internal furnaces of our bodies. In a week or two the lambing season will begin, and many of us will wonder how the delicate younglings manage to support so much cold and exposure; but the farmer will tell us that, provided there be food enough for his ewes, and, by consequence, milk enough for the lambs, he has no fear of snow and cold, at least in moderation.

One advantage of an Arctic climate is the total suppression of putrefaction and the inability of animal and vegetable parasites to get a hold of our bodies.

The effects of temperature *per se* upon the animal body are very difficult to determine, as it is almost impossible to separate temperature from other conditions which follow in the wake of, or accompany, extremes of temperature.

If the temperature of the blood be raised higher than 113° Fahr., life is scarcely possible, because at that temperature myosin coagulates and the muscles become rigid. Although in the tropics the direct rays of the sun may raise objects upon which they fall to a temperature not far short of that of boiling water, yet the blood temperature is not raised to any great extent above normal (98·4° F.), so delicate is the machinery for regulating the temperature of the animal body. When the temperature of the body is raised, it is probable that the conducting power of the nerves is lowered, and this again is a source of danger to life. When the direct rays of the sun fall upon the head and the nape of the neck, it occasionally happens that the heat-regulating machine of the body is paralyzed, and then we get what is known as sunstroke or heat apoplexy. The same accident may occur in the shade when the temperature of the air is high. It is a great question whether high temperature *per se* is sufficient to produce heat apoplexy or sunstroke. This accident has often been associated with conditions which induce foulness of the air as well as heat, and Dr. Parker points out that sunstroke and heat apoplexy are very rare at sea or on mountain heights, notwithstanding that the effect of the sun's rays is very intense in these situations. Very often clothing and dirt seem to have conspired to render the victim intolerant of heat, and unable to regulate the temperature of his body.

There is some evidence to show that when an inhabitant of a temperate climate voyages to the tropics, there is slight elevation of body temperature, which, however, at the most is less than 2° Fahr. After a short time the increased action of the skin equalizes the temperature, which is maintained at about 99° Fahr., a heat which appears to be that which is most favorable for the performance of vital functions. Dr. Rattray has shown that the respirations in the tropics become slower and somewhat deeper, and that the respiratory function is lowered to the extent of about 18 per cent., so that if a man gets rid of ten ounces of carbon by the lungs in a temperate climate, he will only eliminate a little more than eight ounces in the tropics.

Parkes and Francis have both noticed that the lungs of Europeans dying in the tropics become lighter and weigh less than the normal *post-mortem*. Not only is the respiratory function lessened, but the amount of oxygen per cubic foot of air is lessened also, as we have seen. This lowered respiratory function must have the effect of lessening heat production.

Heat increases the action of the skin, but is said to lessen the activity of the heart and kidneys, to lessen the digestive power, and to lower the nervous energy of the body. Rattray's observations on naval cadets show that in the tropics the increase of height was considerable, but notwithstanding this most of the lads under observation (48 in number) lost weight.

Cold.—How little effect mere cold has upon the health is shown by the interesting but trying experiences of the crew of the Eira, the yacht which was fitted out by Mr. Leigh Smith for the purposes of Arctic exploration in the year 1881. The Eira, it will be remembered, left Peterhead on June 14, 1881 When she had reached Cape Flora, in Franz Josef Land, a point near the 80th parallel of north latitude, the yacht was nipped in the ice pack, and quickly sank. The crew and a good deal of the cargo were got on shore. The account given by Dr. W H. Neale, the medical officer of the expedition, is full of interest. This gentleman says, in a communication to the *Lancet* in August, 1882:

"I am afraid there is very little to say, in a medical point of view, with regard to the late Arctic expedition of Mr. Leigh Smith, its great characteristic being the singular absence of disease among a crew of twenty-five men, during a sojourn of fifteen months in the Arctic regions."

Two men who were invalids before they started, and who ought not to have been allowed to join the expedition, remained ill the whole time, and returned home invalided, but beyond this there was no sickness worth speaking of.

A considerable quantity of preserved provisions was saved from the wreck, together with tea, tobacco, and rum, and, luckily some firearms and ammunition were also saved, so that there was no lack of fresh meat, chiefly walrus and bear. There was no lack of food. They were able to have, collectively, from 25 to 50 lb. of fresh meat every day, together with 12 lb. of tinned vegetables, tea night and morning, one ounce of rum, and a quarter of a pound of flour made into a "dough-boy." Thus there was no question of scanty rations. The meat was made into soup, and to the soup some of the blood of the animal was added, and this, it is said, greatly improved its quality. If, however, the dietary was passable and endurable, what were the other conditions? A hut was built of stone and turf, 38 ft. by 12 ft., and with an avarage height of 5½ ft. This was divided into three compartments by canvas partitions. One of these, containing about 1,250 cubic feet of space, served as the forecastle, and here twenty men slept with a little more than 60 cubic feet of space each.

The middle compartment, containing about 660 cubic feet of space, served as the kitchen, and the third compartment, with about 594 cubic feet, served as a store-room for provisions, etc., and as the sleeping apartment for Mr. Leigh Smith, Dr. Neale, the ice master, and the two invalids. In planning the hut, the ventilation had been carefully considered. The doorway opened into the middle compartment, and was approached by a long porch (seventeen feet long), and opposite the door was the kitchen fire. A sail served as a door, and through this door there came a free current of air, and ventilation was further provided for by putting some old meat tins through the roof, the lids being put on or taken off the tins at pleasure, and according as the weather and snow permitted. Notwithstanding that the ventilation had been so wisely provided for, it is evident, considering the small cubic space per man and the excessive coldness of the incoming air, that the supply of fresh air must have been almost incredibly small. The temperature of the outside air was —43° Fahr., and often lower than this for hours together. Sixty-five degrees of frost! We are told that a temperature of 20° Fahr. was considered warm in the captain's sleeping apartment, and that the thermometer often stood at zero Fahrenheit on the ground in the kitchen.

"Our clothing," continues the narrative of Dr. Neale, "was scanty, consisting of woolen and flannel garments. No skins or furs of any kind were worn, and I do not think they are necessary, unless one is sledging, or obliged to go out in all weathers to make observations."

For ten long months these men led this life, enduring the intense cold and the prolonged darkness. At the end of it they bore the hard work of a six weeks' journey across the ice, and were ultimately picked up by Sir Allen Young, all sound and well.

There was no trace of scurvy to be found in any of the crew, a fact attributable to the daily supply of fresh meat. One man had an attack of bronchitis and pleurisy, which kept him to the house for three weeks, and another was ill from bronchitis for a fortnight. This was the sum total of lung disease, and, be it observed, recovery took place at least as rapidly as, if not more so than, usually is the case in London. There were slight cases of frost bite, easily cured, but no severe cases. There was some trouble with the digestive organs at first, but when the men got accustomed to their novel diet, this at once subsided. When the sun appeared in the spring, snow blindness was troublesome. In short, when they were picked up by Sir Allen Young, they were all well and ruddy, and Dr. Neale notices it as worthy of remark that the almost total lack of light in the winter had no effect in producing pallor.

It is also a remarkable fact that, although washing was impossible for weeks together, there was no appearance of vermin upon the heads or bodies of any of them—a fact which seems to show that a temperature of minus forty-three is not favorable for parasites.

I had the pleasure of meeting Dr. Neale, within a few days of his return to London, and he looked, as one would say, "the picture of health," ruddy and plump.

This interesting narrative shows that the extremes of cold and darkness do not necessarily of themselves endanger life.

THE SCALLOP AND ITS FISHERY.

By ERNEST INGERSOLL.

THOUGH it had long previously been enjoyed by the shore towns in New England, the introduction of the scallop as an edible into the New York markets is as recent as 1858 or 1859. Now the annual product of the fishery, which is restricted in area and subject to much variation, amounts to something like 75,000 gallons in all, worth from twenty-five to thirty thousand dollars at first cost, and New York receives and dispenses about three-fourths.

The species of scallop in question is *Pecten irradians*, which is common in suitable places all along our coast. Besides this, there are half a dozen other varieties, living at more or less depths, in the western Atlantic, one of which, the great *Pecten tenuicostatus* of the coast of Maine and the Bay of Fundy, was formerly highly valued by the people of that region, but now is too scarce to appear on the tables of even "the rich," except at rare intervals.

The fishery and methods of preparation for market of our scallops present several features of general interest, and I believe that in my study of the matter, a few years ago, as an agent of the Census Bureau, I was able to learn some new and suggestive particulars as to the habits of the mollusk.

Though occurring in a scattered way far to the northward, it is only between Cape Cod and New Jersey that any commercial scallop fishery exists, save at a few points on the Southern coast, as at Morehead City, N. C., for a small local trade. Even along this limited extent the fishing is not continuous, but can be followed with regularity only in restricted areas of Buzzard's Bay, Mass., Narragansett Bay, R. I., in Peconic Bay, at the eastern end of Long Island, and at a few minor points on the New Jersey coast. Long Island Sound, New York Bay, Sandy Hook, and much of the Jersey shore, have been so thoroughly depopulated that any fishery for scallops there has been abandoned. Occasionally a supply appears at this or that point, but uncertainly and temporarily. I was told, for example, by the oyster planters on the north shore of Long Island, that scallops were tolerably plentiful there (particularly at Northport) once in five years. Such a statement is puzzling, and leads to a study of the habits of the scallop in search of an explanation.

The proper home of this species (*P. irradians*) seems to be in fairly deep water on a firm bottom—either sand or tough mud. Yet in many localities grassy beds (*i. e.*, eel grass—Zostera) are resorted to by it, especially when young. The general habits and behavior of our American scallops, such as living in companies or "schools," moving about and darting to the surface of the water by a quick opening and shutting of the shells, to sink down again along an inclined plane forward, are familiar to all readers of natural histories, and closely similar to those of the European "St. Jacob's shells."

The spawn of our scallop is thrown out in early summer, and so much of it as becomes fertilized, and is able, "catches" or "sets" on stones, sea weeds, and other firm supports, from the sheltered tide pools down to a considerable depth. By the middle of July this "seed" is about as large as the head of a lead pencil, and it does not drop from its support for two weeks or more. The growth is so very rapid that the young scallops have attained about half their size by the time cold weather checks their advancement.

In November the young scallops, spawned the previous June, will be found in great numbers all along the clean shores of Narragansett Bay from an inch to an inch and a half in diameter, and moving about very actively. Where eel grass grows in great quantities, however, the young keep among it, clinging to the stalks until, by their weight, they bend them down to the bottom or break them off, and are swept away with the grass when it goes adrift in the fall. Should such a tenanted raft of sea weed drift into a bay and rest there, as frequently occurs in Long Island Sound, that spot will be colonized with scallops, even where none had existed before.

Great numbers, however, forsake the protection of the eel grass, when old enough, and go "dancing" about the neighborhood till they hit upon the right kind of bottom, when they come to anchor, and stay there unless driven away by extraordinary winter storms. Under such an accident thousands of bushels may sometimes be driven upon the beach, where all are pretty sure to die by freezing. Referring to this point, a Sag Harbor man told me that if possible, when driven before a storm, they will work to windward, and he assured me that he had seen them swimming in schools ten feet deep. These movements are all within narrow limits, however, for the restricted bounds of the fishing grounds are pretty nearly the same from year to year, though often it is impossible to see why the scallops should not extend their range. The young are far more active and swift than the older mollusks. Late in the fall, however, there is reported to be a regular migration of adult scallops toward the shore, whereupon the fishing begins. But this statement is not well substantiated, I fear.

The size of the young scallops is little increased during the cold months, but in the spring a new period of speedy growth begins and maturity is said to be reached within a year. At any rate, these mollusks will produce spawn in the June following their birth, and are ready for market the subsequent autumn. The rapidity with which they enlarge their bulk, but more especially their fatness, or proportion of flesh to shell, is remarkable. Thus a bushel of these mollusks will yield only about two quarts of "meats" in October, whereas a bushel from the same locality at Christmas will turn out a gallon.

The fishermen believe that scallops never spawn but once, and die before they reach the age of three years. I am not at all sure this is a fact to the extent alleged, but if so, it presents a case where the generations follow one another so closely that there are never two ranks or generations in condition to reproduce at once (except in rare individual instances), since all, or nearly all, of the old ones die before the young become mature enough to spawn. If such a state of affairs exists, of course any catastrophe, such as a destructive winter gale or the freezing over for a long period of the water wherein they lie, by killing all the tender young in a district, will exterminate the breed there, since, even if the older ones survive such a shock, they would not live long enough or, at any rate, be able to spawn again, and so fail to start a new generation.

Similarly, an unusual attack by natural enemies, or excessive dredging by men, might in one season extirpate the scallops of a whole bed or bay. To its active powers of movement and its migratory habits, the scallop must mainly trust for preservation as a race, and to the fortuitous drifting in of young upon rafts of sea weed most depleted localities chiefly look for rehabilitation.

Whatever the explanation, the supply has certainly decreased along our coast during the past thirty years, even though at certain points—as in the Peconics—there seems no diminution. The huge, smooth shelled *Pecten tenuicostatus* of the North, as big as a fruit plate, which formerly abounded on the cost of Maine, has now become so rare as to be a prize in the cabinet of the conchologist rather than an edible commodity—a result unquestionably due to over-greedy catching, an effective reply to those men who told me that they thought the more the scallop beds were raked the more plentiful the mollusks became. Long Island Sound no longer affords profitable fishing, and the depletion there is attributed by the local fishermen to the fact that in culling their dredge loads the little ones were not thrown back. The same story belongs to New York Bay and much of the New Jersey coast. The irregularity in respect to plentitude, and also of the size and fatness of these mollusks in the three localities—Buzzard's Bay, Cowesett Bay (R. I.), and Long Island—where they are still regularly taken, is steadily complained of.

Scallops are caught by hand dredging from small sail boats. The dredges are about thirty inches in width, have a scraper blade upon the bottom, and in favorable weather several may be thrown over from each boat. In shoal water an iron framed dip net is sometimes used on calm days. It is pretty hard work, and entails exposure to very severe weather.

The only edible part of the scallop is the squarish mass of muscle (the adductor) which holds the shells together, and this part is skillfully cut out by "openers," who have their houses at the landing places where the dredgers take their cargoes to be sold. It is the buyer, not the dredger, who "opens" or "cuts out" the meat and prepares it for market. In some places men alone are employed in this work; at others women and girls for the most part, and they will earn from eighty cents to $1.25 a day. The work is performed with great dexterity. The motions of an expert opener are but three after the scallop is in hand. The bivalve is taken in the left hand, palm up, with the hinges of the scallop toward the opener's body. The knife—a simple piece of steel ground sharp, and with one end stuck in a wooden handle—is inserted in the opening of the shell furthest from the breast. The upper "eye" is severed through by this movement. A flirt at the same moment throws off the upper shell. The second motion cuts the lower fastenings of the eye to the upper shell and takes the soft and useless rim off. The last motion pitches the shell into one barrel and the soft and slimy rim into another, while the eye is thrown into a basin of yellow stoneware holding a gallon. They are then poured from the basin into a large colander, thoroughly washed, placed in clean boxes, and shipped to New York and Brooklyn. As

little fresh water or ice is placed in contact with the "meats" as possible, as it is thought detrimental to their firmness and flavor. As this is altogether a winter operation, the help of ice in transportation is not usually needed.

There is, or ought to be, no waste in the scallop fishery. On Long Island the refuse is taken by the farmers as manure. These seafaring agriculturists have always been accustomed to replenish their half exhausted lands with the scrapings of the beach and with the menhaden and other seine fish which could be caught plentifully enough for the purpose in the offing—much to the disgust of every stranger who found himself to leeward of their fields. This demand failing, there is always sale for the refuse to the regular fertilizer factories scattered along the shore.

The shells are preferred above all others by the oyster planters as "stools" or "cultch" to spread upon their deep water planting beds as objects upon which the oyster spawn may "set" and grow. This wise preference is due to the fragility of the scallop shell, permitting it to break into pieces under the strain of a growing cluster of oysters, each one of which will be benefited by the separation, which frees it from the crowding of its fellows and gives it room to expand by itself into comely and valuable rotundity, instead of remaining a strap shaped, distorted member of a coalescent group. All their shells, therefore, can easily be sold by the openers to the oystermen at from three to five cents a bushel.

The scallop fishery is of small moment in the United States besides the production for market of oysters and clams, and the statistics (for which I am chiefly responsible) are meager, and not later than 1881, though I doubt whether this year's figures would show much difference from the status of five years ago.

Briefly summarized, these show that about 250 men (and for a short season at New Suffolk, Long Island, about 470 women and children, according to Fred. Mather) are engaged in either catching or preparing scallops, using boats and apparatus worth perhaps $20,000.

The total product is from 70,000 to 75,000 gallons of the edible part, as marketed, worth at first hand from $25,000 to $30,000. About one-half of this comes from Peconic Bay and more than half the remainder from Greenwich, Long Island.—*Amer. Naturalist.*

THEATRICAL FIREARMS.

UP to the present, whenever a duel, murder, or battle in a play has necessitated the use of firearms, the latter have been loaded with powder. Now the drawbacks attending such a process are very numerous. The inconvenience to the audience is especially seen in military dramas, after great battles, where the auditorium becomes filled with a dense smoke and a very disagreeable, acrid odor, which makes people cough. Moreover, this process destroys the scenic illusion in consequence of the precautions that it necessitates, and which oblige the actor to fire, not directly at his adversary, but over his head, and, through an excess of precaution, often into the air. Again, accidents of a serious and fatal nature sometimes occur. Finally, this process is attended with the risk of fire through the projection of lighted wadding; and in cases of accidents of this kind an explosion of the powder supply is to be dreaded. The law indeed forbids the introduction into a theater of a larger quantity of ammunition than that required for one evening's entertainment; but the constraint that this ordinance imposes upon the directors, who, at Paris, for example, have to obtain their powder from Vincennes, may make it feared that they will store up a supply for several evenings, and hence a permanent danger for all the employes of the theater.

Impressed by such inconveniences, through experience, Mr. Edward Philippi, a dramatic author, and a gentleman likewise thoroughly versed in all questions of pyrotechny, has endeavored to produce a faithful imitation of the effects of firing guns (that is to say, the noise, fire, and smoke), while at the same time avoiding the dangers and annoyances that we have just pointed out. In this he has succeeded in an entirely satisfactory manner.

The charge consists of a small quantity of fulminate, prepared in such a way as to give a red fire and a light smoke which quickly clears away, and which, moreover, has no disagreeable odor and does not affect the throat. This preparation is held in a cavity formed in a small cork that is introduced into the extremity of the gun barrel. A firing pin, which passes through the barrel (Fig. 1, No. 4), causes the charge to explode through a simple blow. Three special arrangements, which are applied according to the arms to be transformed, are adopted for the firing pin.

In the wooden guns used by supernumeraries, and in the cardboard cannon, as well as in the transformed flint-lock or piston guns, the firing pin is actuated through a spiral spring. At the butt end it terminates in a hook which slides in a groove formed in the barrel, and which may be maneuvered by hand or through the intermedium of a cock in such arms as are provided therewith (Fig. 1, No. 2)

In modern needle guns—Chassepot, Gras, and others—the firing pin is simply prolonged to the extremity of the barrel.

Finally, the third arrangement consists in placing in the barrel a leaden slider, which is provided with a point, and the travel of which is limited by a ring fixed to the interior of the barrel. Upon quickly lowering the gun, in making believe take aim, the slider is thrown against the primer and produces an explosion (Fig. 1, No. 1).

Fig. 2 represents a mitrailleuse formed through the juxtaposition of a certain number of short barrels of thin copper constructed according to the first arrangement. The firing pins are left to the action of the spiral springs when the hooks, *a*, in which they terminate are driven from the catches by means of the slider, *c*, which moves along a rod placed back of the barrels, to which it may be affixed by a screw, *o*, in order to prevent its acting while the apparatus is being carried. A movable bar, M, prevents the springs from being set free while the charging is being done, and after they have been set. In order to manipulate the apparatus, after it has been charged, it is only necessary to raise the bar, M, unscrew *o*, and cause the slider to move along the rod. Firing by platoons is imitated with this instrument, and it permits of so accurately imitating detonations that it might be advantageously employed in orchestras.

The process under consideration is absolutely harmless. As soon as the cork makes its exit from the barrel it is thoroughly pulverized, and the discharges received at the end of the muzzle cause no inconvenience.

The first application was made in Le Fils de Porthos at the Ambigu, and the scenic effect was remarkable when the combatants were observed firing their guns straight at each other. Some of the Parisian stages, notably that of the Opera, have already transformed their guns in this way. Another valuable feature of the process is that it permits of reducing the number of supernumeraries. Formerly it was necessary to have as many of these persons as there were shots to be fired, and the guns had to be reloaded in the side scenes by an experienced man, while now a limited number of combatants suffices, since they can easily reload their own guns a certain number of times. At the Ambigu, for example, three hundred cartridges per evening were used, and the old system necessitated three hundred supernumeraries, while fifty men with six charges now suffice.—*La Nature.*

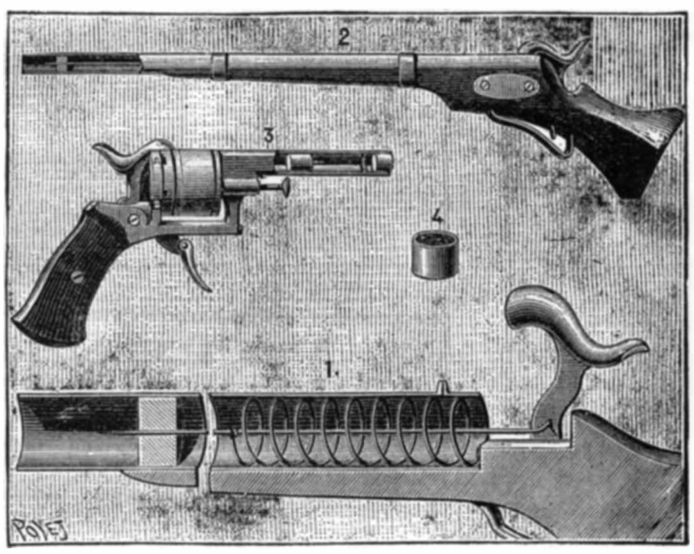


FIG. 1.—THEATRICAL GUNS AND PISTOLS.

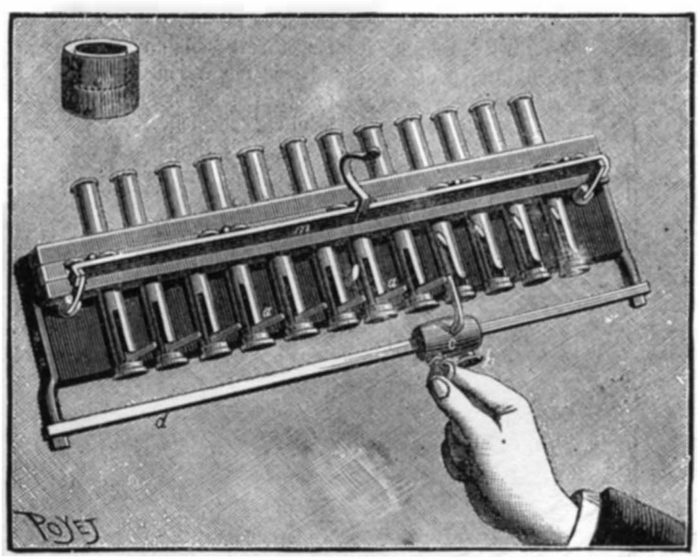


FIG. 2.—THEATRICAL MITRAILLEUSE.

A NEW STORAGE BATTERY.

RECENTLY we had an opportunity of examining the storage battery of the Union Electrical Power and Light Company, Limited. As usual, the cells are composed of peroxide of lead and spongy lead plates; but the novelty consists in the absence of any grid or supporting frame for the peroxide plates, which are simply homogeneous slabs, and are so compact that they give a metallic ring when tapped. The cells we inspected were wooden boxes lined with celluloid, and measured 11 in. long by 6 in. wide and 7 in. deep. The weight of each cell is about 20 lb. The six peroxide plates weigh 6¾ lb. and the seven spongy lead plates weigh 5½ lb., making a total of 12¼ lb. for the plates, while the remaining 7¾ lb. represent the weight of the box and electrolyte. The plates are 4 in. by 7 in., and the peroxide plates are carried in a light frame of celluloid, having a central web for the support of two thin platinum strips, by which the current is conveyed to and from the plate. The central web is held to the plate by two ebonite bolts and nuts, which also serve as distance pieces. The method of manufacturing the peroxide plates so as to form one homogeneous slab is kept secret, and the company claim that in their plates there is no need for any supporting grid of metallic lead for the purpose of distributing the current throughout the surface of the plate, because the plate itself is an excellent conductor. In this battery a very old idea has been resuscitated, viz., the delivery at the consumer's house of electrical energy in the same manner as other commodities are delivered. The famous box containing an electrical horse power, which was sent some years ago from Paris to Sir William Thomson in Scotland, will no doubt be within the recollection of our readers, and the company now propose to do what, in the early stages of secondary batteries, was attempted without success, viz., to deliver electrical energy from a central charging station, by means of their improved plates. The peroxide plates when charged can be sent dry, and can be stored for use at any future time; but the spongy lead plates must, on account of the hydrogen occluded in them after charge, be sent in water.

Since these plates are comparatively thin and quite flat, a large number of them can be packed in a small trough, and the extra weight of water would not materially increase the cost of carriage. The battery is intended for private installations, where the erection of a special generating plant would be inpracticable; but it can also be used as an ordinary secondary battery in conjunction with a dynamo machine. The company claim a capacity of 5 ampere hours per pound of battery, or about 100 ampere hours for each cell weighing 20 lb. Since the electromotive force, as in all secondary batteries, is about 2 volts, each cell would, therefore, have a capacity of a little over a quarter of an electrical h. p. hour, or 1 h. p. hour could be obtained with 75 lb. weight of cells—a most excellent performance, provided always that the batteries will, in actual practical work, come up to the expectations of their inventor.—*Industries.*

DETECTION OF CHLOROFORM.*

By CHARLES LUDEKING, Ph.D.

IN an important trial for murder recently held in St. Louis, the author of this paper made a chemical examination of the viscera of the victim, at the request of the coroner, and obtained very decided reactions for chloroform, notwithstanding the fact that the examination was not undertaken until about twelve days after death. The lungs, usually congested in case of death by chloroform, were selected as best suited for its detection. The great volatility of chloroform would seem *a priori* to preclude the possibility of its detection so long after death, and as at the time there was considerable doubt expressed as to the reliability and accuracy of the experiments, the author determined, once for all, to decide the matter by direct experiment, and so set to rest all doubts.

The literature was first scanned carefully to ascertain whether there were any prior experiments in this direction, but nothing could be found. My direct object was then to determine how long after death chloroform can, with certainty, be detected; as also whether or no any substances are generated by the process of decomposition which might give similar reactions to chloroform, and thus lead to erroneous conclusions.

The manner of experimenting was simple and direct. Dogs of from fifteen to twenty pounds weight were destroyed gradually by the administration of chloroform through the lungs, in from five to ten minutes. Then the carcasses were allowed to stand in summer's heat or the temperature of the room for different periods of time, and finally the lungs removed and tested for chloroform, by the Ragsky method.† In the following the experiments are briefly given:

Experiment I.—Carcass exposed on a dissecting table, during full summer's heat, for six days and ten hours. Decomposition far advanced and an exceedingly offensive odor given off. The lungs were removed, and, after having been finely minced and rendered *slightly* alkaline by means of sodium carbonate, were heated over a water bath in a flask through which a current of air was slowly passing. The escaping gases were sent through a Bohemian glass tube, which was heated to bright redness over a space of two inches. The iodized starch paper was five inches distant from this heated portion of the tube, and throughout the experiment remained perfectly cool.

A very strong bluing of the paper was observed, and the nitrate of silver solution was strongly precipitated.

Experiment II.—Carcass exposed during full summer's heat for ten days. It had then lost all solidity, the hair literally falling off by the slightest abrasion. The lungs were removed and examined as in Experiment I. A very decided reaction for chloroform was obtained.

Experiment III.—Carcass exposed during full summer's heat for fourteen days. The lungs then removed and examined as in Experiment I. The reaction for chloroform was very decided.

Experiment IV.—Carcass placed in an ice chest for three weeks, and then exposed for ten days during full summer's heat. The lungs were then examined, as in Experiment I., and a strong reaction for chloroform obtained

I do not hesitate to say that in winter chloroform could be detected without the slightest difficulty for many months after death.

Experiment V.—Carcass exposed in a room (70 deg. F., very constant) for three weeks and three days. The lungs were then examined, as in Experiment I., and very decided reaction for chloroform obtained.

* Presented before the St. Louis Academy of Science, June, 1886.

† *Erdmann's Journal*, xlvi., 170.

Experiment VI.—Carcass exposed in a room (70 deg. F., very constant) for four weeks. The lungs examined, as in Experiment I., and a decided reaction for chloroform obtained.

The question now arises whether there cannot be substances, formed by the process of decomposition, which, resembling chloroform in certain chemical reactions, might, therefore, lead to erroneous conclusions. Dr. Ragsky already partially answered this question experimentally. The author made three experiments to this end, which are herewith briefly given:

Experiment I.—The lungs of a slaughtered bull exposed during full summer's heat for ten days. Not a trace of reaction of chloroform could be obtained by the Ragsky method.

Experiment II.—The lungs of a slaughtered bull exposed during full summer's heat for fourteen days. Not a trace of reaction of chloroform could be obtained by the Ragsky method.

Experiment III.—Carcass of a dog destroyed by coal gas was exposed in a room (70 deg. F., very constant) for three weeks and four days. No chloroform reaction could be obtained by the Ragsky method.

CONCLUSIONS.

1. By the process of decomposition, no substances are generated which could vitiate the tests for chloroform by the Ragsky method.

2. Chloroform, when it has caused death by inhalation, can with certainty be detected in the body four weeks after death, and, notwithstanding its volatility, it is certainly retained in the viscera in large amount during this time.

In the case which was the cause of these experiments being undertaken, the victim had been dead at least ten days before the body was discovered, in high state of decomposition. On the strength of the Ragsky and Hofmann tests, the author gave it as his sworn opinion that the deceased had chloroform in his viscera, whereupon a charge of murder by chloroform was preferred. Maxwell, the culprit, finally, after the lapse of an entire year, made confession that chloroform had indeed been the cause of death.

It being certain, finally, that chloroform can be detected a long time after death, as evidenced by our experiments, we must next try to understand why this should be so. The following may serve to this end:

R. Dubois* finds that the vapor of chloroform penetrates into the interior of the tissues, and becomes substituted for normal water. This is not a phenomenon of desiccation or osmose. A true affinity comes into play, the protoplasm absorbing the vapor of the anæsthetic and expelling a certain quantity of water.

Chancel and Parmentier† have proved that chloroform has a very decided affinity for water.

The author allowed to stand open a flask containing water, holding a small quantity of chloroform in solution. After two weeks' time the chloroform reactions could still be obtained without any difficulty.

Add to the above that chloroform is a powerful preservative agent,‡ we have a collection of factors sufficient to enable us to understand the lengthy occlusions of chloroform in the animal body, though others of minor importance might be adduced besides these.

Grehaut and Quinquand,§ experimenting on dogs, find the amount of chloroform necessary to produce anæsthesia to be at least one gramme to every two liters of blood. On the basis of these results, the total quantity of chloroform in the blood of a man of 150 lb. weight would be two and three-quarter grammes approximately, when rendered insensible through its inhalation. The amount necessary to produce death would, under normal conditions, certainly not be less than this. Under the assumption that one-sixth of the entire quantity of blood circulating in the body is at all times passing through the lungs, the quantity of chloroform in the lungs of a man of 150 lb. weight, rendered insensible from its inhalation, would be about one-half gramme.

We desire to emphasize by this calculation that there is an abundance of material in the lungs for the detection of chloroform. The liver would undoubtedly also be very suitable for its detection.—*American Chemical Journal.*

* *Chemical News*, liii., 311.

† *Comptes Rendus*, c., 27.

‡ Robin and Augendre, *Comptes Rendus*, xxx., 52; xxxi., 679.

§ *Comptes Rendus*, xcvii., 753.

GIUSEPPE VERDI.

THE production of "Othello," the latest opera of Giuseppe Verdi, the great Italian *maestro*, created great excitement not only in Milan, where the work was first seen, but throughout Italy, and even in other lands the eventful evening was watched for with intense interest. All judges agree that in writing "Othello," Verdi has taken one step farther in the path on which he entered when he wrote "Aida," and which has raised him to the rank of the leaders of musical progress.

Very few composers of opera have shown such vigor and creative power in their old age (Verdi was born October 9, 1814). Among foreigners, only Auber and Cherubini can compare with him in this respect, while his countryman Spontini, who was greater than Verdi, never obtained a hold on the Italians, and soon lost the ground gained by him in France and Germany, dying in his old age unhappy in the knowledge that he had outlived his fame and was forgotten by his

VERDI.

contemporaries; Rossini spent years in retirement, trying to recover from the excitement of overwork; Bellini died just as he was beginning to enjoy his triumphs; and Donizetti was the pitiable victim of insanity. The fates treated Verdi better. He not only reached the highest place of earthly honor, but he has been able to maintain his position. He is the idol as well as the beloved master of the Italians, and his music has gained for him admirers everywhere. Works like Rigoletto have won international favor and a permanent place in the repertoires of European and American artists.

In reviewing Verdi's career as a composer of operas, three distinct stages of progress are discernible. In the first of these we find Lombardi, Oberto, and a dozen similar works, the music of which was of the sweet, bright, vivacious kind, no attention being paid to dramatic truth. As Verdi became more familiar with Meyerbeer's operas there was a perceptible change in his own creations. The Huguenots, the Prophet, and other similar operas helped him to better work than he had done before, and Rigoletto, Traviata, and other operas appeared, in which dramatic music was oftener found, but still there were many evidences of carelessness and many flights of fancy which were far from beautiful. In the third period of his career, Aida, Verdi's masterpiece, was produced. Here we find artistic refinement, the wild fire of his former works being subdued and purified; the struggle between undramatic Cantilene and dramatic situations is ended. All good things which can be said of this opera will apply also to the requiem written in 1875 and dedicated to the memory of Manzoni, and the quartet for string instruments composed in 1876.

In the past thirty years Verdi has risen like a giant from mediocrity. In a certain sense he is to his countrymen what Wagner was to the Germans, and to them look the youths in whose hands the future of music lies.—*Illustrirte Zeitung.*

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