have here a tight tin box, and in this pan some lumps of quick-lime. Now if I pour some water on the lime, the water will enter into chemical combination with the lime, and will be solidified—giving out its 142° of latent heat. I will put this ground coffee into this cold water, and set the dish into the box. I will also place some eggs and oysters in this pan and place the pan in the box. Now if I pour some water upon the lime and close the lid of the box, I think we shall find that the water in solidifying will give out sufficient heat to cook the eggs and oysters, and to draw the coffee. Though the lime absorbs the water it exhibits no appearance of moisture. The water becomes as solid and as dry as the lime. [A great cloud of steam arose from the box, and at the close of the lecture the food was found to be cooked.] Water in changing from the liquid form to the gaseous, absorbs and renders latent not less than 1,000° of heat. The law applies to all substances; in changing from the solid to the liquid form, or from the liquid to the gaseous, they absorb and conceal a quantity of heat; the quantities varying with the several substances."

CARBONIC ACID.

"I have in this glass-beaker some marble dust. It is the carbonate of lime—composed of lime and carbonic acid. If I pour some sulphuric acid upon it, the stronger acid will seize upon the lime and the carbonic acid will be set free in the form of an invisible gas. After the beaker is filled, as the gas continues to be generated, it will be forced over through this curved tube into this large glass vase. As the carbonic acid is as invisible as air, we will test its presence by lowering into the vase a lighted candle, which will be extinguished as soon as it enters the gas. You see the vase is about half full. As soon as the vase is filled I will demonstrate that carbonic acid gas is heavier than air by pouring it down this trough." [A light wooden trough some ten feet in length, with a hopper at the upper end, was inclined from the stage down towards the audience, and the assistants lighted a series of short candles and fixed them along the bottom of the trough. The lecturer then placed the brim of the large vase over the hopper, and inclined the vessel in a way to pour its contents into the hopper. As the invisible gas flowed downward along the trough, all of the candles were in succession extinguished. This striking experiment elicited universal applause.]

THE CONDENSATION OF CARBONIC ACID.

"At ordinary pressures carbonic acid retains the gaseous form; but under a pressure of about 900 lbs. to the square inch, it is condensed to a liquid. In this strong wrought-iron vessel, I placed a quantity of carbonate of soda, and filled a copper tube within the vessel with sulphuric acid. Then after the vessel was very securely closed, it was inclined on its trunnions, so as to pour the sulphuric acid from the tube into the carbonate of soda. The carbonic acid from the soda was set free in such quantities as to raise the pressure to the point of condensation. The liquid was then discharged into another similar vessel, which I have here surrounded with ice. By repeating the process several times, I have collected about a gallon of liquid carbonic acid. I have a little in this small strong glass tube. You see that it is as pellucid as water, and more fluid. If the tube should be cracked, or even scratched, an explosion would follow, and the liquid would suddenly expand into a gas. If we allow a portion of the liquid in this iron vessel to escape into the air, part of it will expand into gas, and in the act of expanding it will absorb so much latent heat as to freeze the rest of the liquid that escapes, and we shall have solid carbonic acid." [The assistants then opened the stop-cock a little, a sound like escaping steam was heard, and presently they brought forward a stout cotton bag which contained a pound or two of a white, snowy-looking substance which was solid carbonic acid.]

FREEZING MERCURY.

"If we place this carbonic acid on some mercury, and dissolve it with ether, as it assumes the liquid state, it will absorb so much heat from the mercury as to freeze that liquid metal. [A couple of pounds of mercury were poured into a wooden mold, and covered with the solid carbonic acid, upon which was then poured some ether from a bottle. In two or three minutes the lecturer turned the mercury from out the mold in the form of a solid bar, which he threw down upon the floor without breaking it.] This solid mercury cannot be less than 40° below zero and it is probably 60° or 70°. If touched to the wrist it will freeze the skin instantly, raising a blister as quickly as if the skin were touched with a red-hot iron. Any one who chooses may try the experiment."

FREEZING MERCURY IN A RED-HOT CUP.

"The extremes of heat and cold may be exhibited in a very striking manner, by means of solid carbonic acid. This platina cup [holding about a gill] you see is red-hot. I will fill it with some fragments of this solid carbonic acid, which I will wet with ether. If I now introduce this thimble-full of mercury into the middle of the mass, it will soon be frozen. A portion of the carbonic acid takes the spheroidal state, which prevents its contact with the heated platina, and thus the cup continues red-hot, while the mercury in its middle is freezing." [In about two minutes the thimble was withdrawn, and the solid lump of mercury was knocked out of it upon the table!]

GODWIN'S PATENT LUBRICATOR.

The object of this invention is the admission of oil or melted tallow to the cylinder and other parts of the

steam engine under steam pressure, in such a manner that it cannot escape during the admission of the lubricating substance.

The inventor says:—"It is evident that every arrangement to effect this object must consist of two chambers or reservoirs, with two valves so connected and operated that one valve shall always be closed to prevent the escape of steam while the other is open for the passage of the lubricating substance, and that these offices should be alternately performed by each valve. This lubricator will accomplish the object in a manner at once simple, convenient and effective."

In the engraving A represents a combined feeding cup and stuffing-box screwed to the top of the reservoir, B. In the lower part of the reservoir a tube, D, rises, through which a channel communicates with the machinery to be lubricated; the top of the tube forming the seat of the lower valve, C. A boss (not shown in the engraving) also projects downward from the top of the reservoir, B, and is provided internally with a screw thread, which receives the hollow vertical shaft, E. This shaft is tubular from the top to a point near its bottom. The bore within it communicate with the cavity of the reservoir, B, by the holes, *b b*, and with the open feeding cup, A, by means of the apertures, *a a*. F is a screw plug and handle movup and down in the shaft, E, and opening or closing the apertures *a*. The threads by which this screw plug moves in the shaft, run in an opposite direction to the threads by which the shaft is moved up and down in the boss on the upper end of the reservoir. The lower end of the shaft is seated upon the upper end of the tube, D, forming a closely-fitting valve.

The operation of this lubricator is as follows :—By turning the handle, F, in one direction the screw plug attached to it descends upon its seat, inside and just below the holes, *a*, closing the apertures, *a*, the motion of this handle is thereupon communicated to the whole shaft, E, which, held by screw threads running in an opposite direction to those of the plug, begins to move upward and opens the lower valve, C. Upon reversing the motion of the handle, the shaft, E, screws back again, closing the lower valve, C. The moment this is done the motion of the shaft stops, and if the movement of the handle, F, be continued, the upper valve plug rises again, opening the apertures, *a*, as before. By grasping the milled collar, H, the lower valve may be screwed down upon its seat independent of the use of the handle for that purpose.

The object of the tube, G, is to prevent the condensed water from being fed through to the machinery; besides this, the oil rises above the condensed water and flows into the tube, F, thereby making a most complete and accurate self-feeding cup, regulated by the quantity of steam admitted into the reservoir ; for as the steam condenses and the water accumulates, the oil must pass out through D. The water may be drawn off by the tube, G, or by a small cock at the bottom of the reservoir.

This lubricator is an improvement on one which was patented on Nov. 3, 1863, by T. W. Godwin, of Norfolk, Va. For further information address Hayden, Gere & Co., 84 Beekman street, New York, who have the article for sale.

POLYTECHNIC ASSOCIATION OF THE AMERICAN INSTITUTE.

This Association held its regular weekly meeting in its room at the Cooper Institute on Thursday evening, Feb. 11th ; the President, S. D. Tillman, in the chair.

The chairman presented the following summary :—

OCCULT POISONS.

Prof. Letherby, of London, has ascertained that nitro-benzole and aniline in their free states are powerful narcotic poisons. As these substances are produced in the process of making coal-tar dyes, persons engaged in that manufacture should be on their guard. Nitro-benzole may remain a long time in the system before producing any effect, and then, after exerting its fatal power, it is so changed as to leave scarcely any traces of its presence.

THE WEATHER AND WEATHER PROPHETS.

Sir John F. W. Herschel has an interesting article under this head in *Good Words*. He says that it is ascertained that the winds in their changes have a tendency to "follow the sun," that is to so change as to turn the vane through the south, west, north and east in the northern hemisphere, and the opposite way in the southern hemisphere. Mr. Dove has connected this with that great fact which underlies so many other phenomena—the rotation of the earth upon its axis.

TYPHOID FEVER.

Prof. Sigri, in a memoir to the French Academy, states that the infusoria, *Bacteriums*, were found in the blood of a man who died of this disease at the hospital of Sienna. It has long been suspected that malaria is an animal or vegetable organism.

A PARASITIC PESTILENCE.

Van Rundoff Leuchart states that one-sixth of the annual deaths in Iceland are owing to a little parasitic animal living in the dog. The larva if kept in an undeveloped condition grows to a large size. These larvae infest both men and cattle.

TIDE WAVES AND WIND WAVES.

This being the regular subject of the evening, it was next taken up.

The Chairman :—"The self-registering tide-gauge used in the U. S. Coast Survey was invented by Joseph Saxton. One of the most interesting cases o the use of this instrument was that of the great earthquake in Japan, on the 25th of December, 1854. The tide-gauge at San Diego, in California, registered unusual curves, and the officer at the post, Lieut. Trowbridge, expressed the opinion in his report that it was caused by a submarine earthquake. This proved to be the case, and the wave came clear across the Pacific Ocean—5,000 miles! From the curves of the tide-gauges at San Diego and San Francisco, Prof. Bache calculated that the rate of motion of the earthquake-waves was from 365 to 370 miles per hour, and that the average depth of the ocean on the San Francisco path was 2,500 fathoms, and on the San Diego path 2,100 fathoms."

Mr. Wiard:—"Speaking of the action of the tide on wheels, a singular incident happened, a short time since, on board a small steamboat that I had charge of, while anchored off the Battery. (New York.) The pumps had been in use, and during the night the tide turned the wheel, and pumped the tanks full of salt water. Had the boat been neglected, she would have pumped herself full of water and gone to the bottom."

Several other speakers made interesting remarks, but we believe not new to our readers.

Correspondence

Firing Cannon under Water.

MESSRS. EDITORS:—I beg leave to forward for insertion in your valuable journal (which I always read with much satisfaction) a short history of some experiments made in the spring of 1862, in firing shots under water, from a gun, the muzzle of which was 5 feet, more or less, under water. The recoil appeared to be entirely controllable; and in experimenting with the same gun after the tide had left it dry, it was said by Mr. Woodbury that, with the same charge, the recoil was actually greater than in the experiments where the gun was fired below the surface. As I was not present, and had no one acting for me to note the result, I cannot vouch for this; but I have no reason to doubt the fact. The only solution I can give is that a gun fired above water displaces instantly a column of air from the bore of the gun, and the atmospheric pressure added to the force of the explosion adds also to the recoil by suddenly filling the vacuum; whereas, when a gun is fired under water, the return of the water to the bore is not so sudden as that of atmospheric pressure, or air, and therefore there is less recoil. I do not make this suggestion as an expert in hydrostatics or philosophy; but if the fact *be* a fact, how can you account for less recoil? On the other hand, why should there be more recoil to a gun fired under water? R. B. FORBES.

Boston, Mass., Feb. 3, 1864.

SUBMARINE ARTILLERY.

This mode of warfare seems to be attracting much attention, at this time, both here and abroad. Many years ago the firing of guns under water was successfully tried by Robert Fulton. In the spring of 1862 I tried some experiments tending to show that guns can be fired under water, with effect, without bursting. The guns—one a brass smooth-bore weighing about 1,800 lbs, caliber 12 lbs; and the other a rifled iron gun, of about the same weight and caliber—were mounted on a cannon-truck carriage, in an ordinary box dock at East Boston; the muzzle protruding through a small hole, on the outside of which was a port, made water-tight and so arranged that it could be opened and closed at pleasure. When the gun was loaded and the muzzle for a space of two feet "woulded" with strands of rope and greased, the gun was run out through the tube; the muzzle itself being stopped with a tin cannister projecting about a foot outside the muzzle and luted with tallow, so as to effectually exclude the water. The water-line being five feet above the hole or port, it follows that some water came into the dock; but when the gun was run out quickly very little entered, the hole or port being deep enough to permit the same to be plugged by the gun simultaneously with the raising of the lid or shutter from the outside by a rude lanyard or tackle.

A target—consisting of spruce plank well trenailed together, about 8 feet square and 2 feet thick—was suspended at a distance of 11 or 12 feet from the muzzle of the gun. As many persons predicted that the gun would burst, or the dock be stove in, a wide berth was given to the vent by attaching a long string to the primer. The gun was loaded at first with 2½ lbs of powder, and an elongated "shenkle" projectile weighing about 17 lbs. The report and the recoil were very slight and the projectile striking diagonally only penetrated some 6 or 8 inches, nearly burying itself but no more.

The second fire, made under similar conditions but with increased charge, say 3 lbs—drove the projectile about twenty inches into the target; the recoil was 7 or 8 feet, and less than was expected.

The rifled iron gun was tried under similar circumstances and with similar results—it being fully demonstrated that an ordinary iron or wooden ship can be easily penetrated by a small projectile fired from an indifferent gun, 5 feet or more below the surface, at the distance of about 12 feet from the muzzle of the gun.

The experiments would have been more extended but for the fact that the old and shaky dock gates were strained and made to leak, and it was quite clear that prolonged firing would very soon entirely demolish them. The experiments were made under the immediate superintendence of Mr. J. P. Woodbury, who claims to be the inventor of this mode of warfare. Robert Fulton suspended his gun in the water and fired it by means of a tube leading to the vent. In the case above described, the dock was intended to represent the hold of a ship, and the rude and leaky port and shutter were intended to represent or take the place of fixtures which need not be fully described here, but which the exercise of ordinary ingenuity would make so mechanically perfect as to exclude from the ship the inroad of an inconvenient quantity of water. It will be enough to say that in a vessel built to fire guns under water, it would be necessary to have regular stuffing boxes, and the recoil of the gun so regulated by compressers or other usual means as to keep the muzzle end of the gun in the stuffing box, after firing, long enough to close the outer part of the hole or port, or stuffing box; then when the gun is run in still further in order to load, all the water that would enter the ship would be the capacity of the bore of the gun, and this would be of no consequence. In running the gun outward, the muzzle being stopped effectually by a cannister, the gun enters the stuffing-box and plugs it tight enough to keep out the water; then the outer port is raised and the gun run out to battery, ready for use. It is fully believed that a gun of heavy make, of 6-inch bore, throwing a well-fitting elongated projectile, would do considerable damage at a distance of 30 or 40 feet, and possible much further.

The writer of this article actually made a contract with the Navy Department for the construction of a gun-boat, partially plated, to mount a gun such as is above alluded to; and she would have been built but for the fact that a sudden rise in materials and labor rendered it inexpedient to go on.

The dock experiments were made under great disadvantages, in consequence of the weakness of the gates, the angle of which presented a much larger surface for the action of the submerged gases than the sharp bow of an iron steamer; and the target, being suspended and consequently movable, did not present so rigid a surface as the side of a ship.

About the time of Mr. Woodbury's experiments an engineer of New Bedford—Mr. Durfee—brought to the notice of the writer another mode of carrying out the same object; and he submitted to the Navy Department a very elaborate drawing of his process—indeed, several plans for submarine firing were brought out in this country, and one at least in Europe about the same time. But the Navy Department, having very small means for testing similar experiments, could do nothing in that way; and thus sub-marine firing seems to have slept until quite recently. Congress should give the Navy Department a considerable sum to test similar inventions.

R. B. F.

Strength of Steam Boilers.

MESSRS. EDITORS:—On page 71, present volume of the SCIENTIFIC AMERICAN, a tabular rule is given to find the safe pressure in cylindrical boilers, of any diameter or thickness of iron. A diameter of 1 inch, and ⅛-inch iron forms the basis of the table; a pressure of 2,500 lbs. to the inch is assigned to that diameter and thickness of iron. This view supposes a pressure of 2,500 lbs. is sustained by each ring of the cylinder of 1 inch in width. For larger cylinders, reduce the pressure by dividing the 2,500 lbs. by the diameter, and to the quotient add any increase in the thickness of the iron. Hence, with a 40-inch diameter, and a ¼-inch iron, the indicated pressure would be 125 lbs. to the inch, which, multiplied by the diameter of 40 inches, gives an expansive force of 5,000 lbs. on each ring of 1 inch width.

The error pervading the above formula consists in taking the rings of the cylinder as of sufficient strength and stiffness to retain their shape if the continuity of the circle were cut. The piston of a steam engine is unyielding in its form, and the area of its base determines the force. But the shell of a boiler is flexible in form and material; and the force to rend it asunder with steam of a given density is as the semi-circumference and not as the diameter. The "diameter theory" places and limits all the forces to part the boiler at right angles to the diameter, and ignores other effective directions of the steam pressure. Hence it follows that the boiler would be torn apart at two opposite points only; each half retaining its original shape unimpaired, and excluding all outward explosive force.

The error thus noticed is general, and has been (and may still be) the cause of numerous explosions. The true explosive force, with steam of a given density, is 52 per cent greater than has been estimated, or as the semi-circumference is to the diameter. T. W. B.

Cincinnati, Ohio, Feb. 10, 1864.

Heating Feed-water for Steam Boilers.

MESSRS. EDITORS:—As everything that assists in reducing the consumption of fuel in steam boilers is a great object at any time, but especially now that the price of coal is so high, and as it is well known that, during the injection of cold water, extra firing is required, I herewith send you a description of a method of heating the feed-water, which I adopted some years ago, with the greatest success and with a considerable saving of fuel.

Procure or construct an iron tank of sufficient size and of any convenient shape; attach at opposite sides, close to the top, the exhaust steam pipe from the cylinder. Between this tank and the cylinder—at any handy place, but the nearer the cylinder the better—insert in the top or side of the exhaust pipe another smaller pipe, through which the cold water is to pass into the exhaust steam, thereby partially condensing it, but effectively heating the water, which drops on its way into the tank, when it is ready to be pumped into the boiler. The cold-water pipe is better if made to run down inside the exhaust pipe a few inches and have a rose head on the end to spread the water amongst the steam. The following hints to those adopting this plan will not be out of place here:—Be careful that the exhaust pipe inclines downward (if only slightly) from the place where the cold water enters, to prevent any returning to the cylinder in case it is not turned off when the engine is stopped. The tank must not be below the level of the feed pump, as it will not raise water of this temperature; and an overflow cock should be fixed on the tank, on a level with the bottom of the exhaust pipe, which may be always open, and will tell when to stop the supply of cold water, as well as prevent accident. Unless the exhaust pipe is at present extra large, a length with a larger diameter should be put in where the cold-water pipe and the rose are inserted.

WM. TOSHACH.

Schenectady, N. Y., Feb. 10, 1864.

[We are obliged to our correspondent for many letters containing useful information, and we shall be pleased to hear from him again.—EDS.

THE steam boiler of R. S. Harris, illustrated on page 96, present volume of the SCIENTIFIC AMERICAN, was described as being well suited to factories and saw-mills; the proprietor thinks we should also have stated that it was adapted to steamers and locomotives as well. We add this, and also say that it is a most excellent boiler, and we have no doubt that our readers are fully aware of its good points.