above it. The upper end of the tube is corked with an India rubber cork, to which, by means of a piece of platinum wire, a thermometer is suspended. This hangs down within the tube above the solution, and may be assumed to give a very close indication of its temperature. The funnel holds some metallic mercury, which is used to insure the tightness of closing of the upper end of the tube.

The tube contains Sonstadt's solution. The same is placed in the cistern to a depth of about one inch, so as to cover the end of the tube. The Torricellian vacuum, less the tension of the vapor of water, exists above the solution in the tube, so that a true barometer is constituted.

The filling was thus effected: The tube and cistern were put in place, and the lower end of the tube was corked. Solution was poured into the cistern until the end of the tube was immersed. Next the solution was poured into the upper end of the tube until it rose in the funnel. After standing a sufficient time to be sure that no bubbles existed in the liquid, the India rubber cork, with the thermometer hanging from it, was introduced, the thermometer descending into the tube. As the cork was depressed, it entered the solution in the funnel, and while thus immersed was pressed hard into its seat. The long column of difficultly compressible liquid acted like a solid body and forced out the cork at the bottom, and the column at once dropped to the height due to atmospheric pressure. Some metallic mercury was poured around the cork, and the lower cork floating about in the solution was removed, the plate and cistern were adjusted, and the filling was complete.

The scale was determined by comparison with a mercurial barometer. An arbitrary scale of equal parts was first attached, and its readings were compared with those of a mercurial barometer. A great many readings were taken at varying heights, and from them two average readings for extreme height and depression were deduced. Not only did this give a ratio of parts, but it also fixed the initial point corresponding to thirty inches.

On the basis thus determined a scale marked as for inches and hundredths was constructed and put in place. A number of readings were taken, and an error constant in size, the readings being always too low, showed that the 30 inch point was wrong. The scale was then shifted a fraction of an inch, and a new series of readings were taken. These showed that the instrument was at last correct.

At first the thermometer was read at every observation, and corrections for temperature and tension of aqueous vapor were applied. But it was found that the slight discordance existing between it and the mercurial barometer was not lessened by this correction. Practically both instruments read alike, without any correction, so it came to be regarded as unnecessary.

It is proposed ultimately to cement the glass plate to the cistern and to fill with cement the joint between the tube and plate. Then a small glass tube is to be secured in a second hole in the cover, to the outer end of which tube an India rubber balloon is to be attached. This will exclude air and prevent all evaporation, and yet will allow the atmospheric pressure to act freely upon the liquid in the cistern.

By calculation from the relations of its scale to the true inch, the specific gravity of the fluid is found to be 10·51 that of mercury, or, referred to water, 2·662.

The method of construction adopted has been found exceedingly convenient. On one or two occasions it has been found necessary to open and refill the tube, but no trouble has ever been experienced in doing this. In a long series of readings the greatest difference from a mercurial barometer was 0·055 inch. The general error was about one-third this amount, and a number of readings practically coincided. These comparisons are made with the Draper registering barometer, which is also located in these offices.

TEN-TON LOCOMOTIVE CRANE.

The ten-ton permanent way locomotive crane which we illustrate on preceding page was constructed for the Swedish and Norwegian Railway by Grafton & Co., London. It is driven, says *Engineering*, by a pair of engines having cylinders 9 in. in diameter by 12 in. stroke, and fitted with link motion. The chain barrel is 11 in. in diameter and 4 ft. long between the flanges. The chain is of ⅞ in. iron, and was proved to 25 per cent above the Admiralty strain.

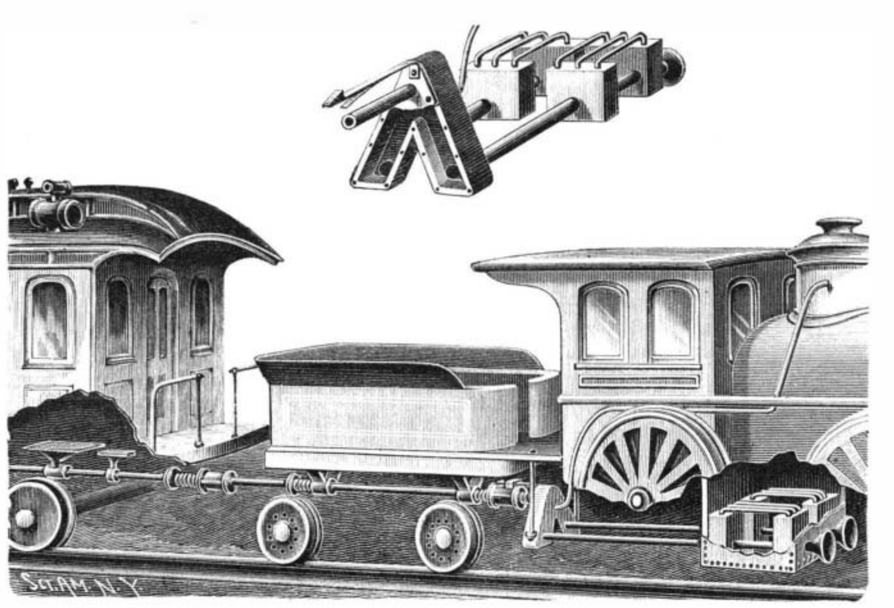
The slewing gear is constructed according to an arrangement patented by Mr. Alexander Grafton. The roller path and the toothed ring, or circular rack, are made in one piece, the anti-friction rollers running on its upper surface, while the pinion travels round its circumference. This combined ring is not fastened to the carriage, but merely lies on a circular turned surface, on which it is retained against lateral motion by a raised ring or flange which fits its interior diameter. When the slewing pinion is rotated, the ring remains stationary, since there is more friction between its lower surface and the carriage than between its upper surface and the rollers. But should any shock come upon the gear, as, for instance, if the jib of the crane should be struck by any moving object, or if the engines should be suddenly reversed in the act of slewing, then the ring will slip on the carriage, and the breakage of the gear, which would otherwise occur, will be avoided. The carriage is mounted on six wrought iron wheels with steel tires. The boiler is 4 ft. in diameter and 7 ft. 6 in. high.

Coal in the Argentine Republic.

According to a consular report, discoveries of coal have been made in the Argentine Republic. A company is now working the Dehera and Colorado coal mines, about sixteen miles from San Juan, in the province of the same name. It is stated that a seam nearly two feet thick has been discovered. Another bed has been discovered and works undertaken at Loude. It is reported that the coal is large, firm, and gives a great heat, suitable for the manufacture of coke and gas. This news has been received with satisfaction at Buenos Ayres, the want of coal in the Argentine Republic and the necessity to obtain supplies from abroad, chiefly in England, having been hitherto considered one of the chief obstacles to the establishment of a native industry able to compete with foreign products.

IMPROVED APPARATUS FOR HEATING CARS.

An apparatus designed to convey heated air from the locomotive to the several passenger cars of a train is illustrated herewith, and has been patented by Mr. Marshal Wood, of Alderson, West Va. Air tubes, having funnel-shaped front ends, open into boxes or reservoirs in the fire box, these boxes being connected to rear ones by a series of small pipes designed to serve as grate bars. From the rear boxes the hot air pipes connect with a triangular-shaped heating drum, shown in the small figure, suspended beneath the cab and connected with a coupling. Each car is preferably provided with two registers. To aid in carrying the heated air to the several cars, the hot air drum is connected by means of a tube with the steam dome, and sufficient steam used to drive the air through the train and afford all the heat desired.



WOOD'S APPARATUS FOR HEATING RAILWAY CARS.

The St. Louis Bridge.

The beautiful bridge built by Captain Eads over the Mississippi River at St. Louis, bold in its design and excellent in its execution, is an object of admiration to all who visit it, but the impression of its importance would be greatly magnified if the part below the surface of the water, which bears the massive towers, and which extends to a depth twice as great as the height of the pier above the water, could be visible. There are three steel arches, the center one having a span of 520 feet, and each side arch a span of 502 feet. Each span has four parallel arches or ribs, and each arch is composed of two cylindrical steel tubes, 18 inches in exterior diameter, one acting as the upper and the other as the lower chord of the arch. The tubes are in sections, each 12 feet long, and connected by screw joints. The thickness of the steel forming the tubes runs from 1 3-16 to 2¼ inches. These upper and lower tubes are parallel and 12 feet apart, connected by a single system of diagonal bracing.

The double tracks of the railroad run through the bridge adjacent to the side arches at the elevation of the highest point of the lower tube. The carriage road and footpaths extend the full width of the bridge, and are carried, by braced vertical posts, at an elevation of 23 feet above the railroad. The clear headway is 55 feet above ordinary high water. The approaches on each side are masonry viaducts, and the railway connects with the city station by a tunnel nearly a mile in length. The great tubular ribs were built out from each side of a pier, the weight on one side acting as a counterpoise for the construction on the other side of the pier. They were thus gradually and systematically projected over the river, without support from below, till they met at the middle of the span, when the last central connecting tube was put in place by an ingenious mechanical arrangement, and the arch became self-supporting.—*Scribner's Magazine.*

Labor in State Prisons.

The Committee on Political Reform, of the State of New York, have recently issued a report on the above subject. For a number of years the prisoners in the prisons of this State were kept at work during the period of their incarceration. They were employed on the contract system. The labor of the prisoners was farmed out to manufacturers of shoes, stoves, and other goods, who made large quantities of manufactured material in the prisons. Much of the work was done by machinery, so that so far as the convicts were concerned, they were only taught a trade in the most limited sense of the term. Many articles were only partly completed in the prisons. The reformatory or educational aspects of labor were really subordinated to considerations of profit to the contractors.

The labor interest of the State, rightly or wrongly, looking upon prison labor as an injurious form of competition, succeeding in bringing about legislation practically abolishing prison labor, and reducing nearly all the prisoners to idleness. The results are described by the wardens of the different prisons as horrible. The body of criminals are left the greater part of their time in idleness, if a walk for exercise cannot also be described as such. The mind and body alike become unhealthy. Restlessness and ennui, leading to death, disease, and insanity, ensue, and the ultimate consequences may be very grave. Already the consignments to the insane asylum have begun to increase. The workers of this great State need protection at no such cost as this.

A prison should be a reformatory. At the best, but little reformation can be effected, but even a neutrality of operation is better than inflicting bodily and mental injury upon criminals. The plea of the committee is for employment for these wards of the State, which shall be so regulated as to have little or no effect upon general industrial occupations.

Assuming all the prisoners to be employed, their proportion to the total labor list of the State is put at fifty-two one-hundredths of one per cent. The committee hold that such competition, properly distributed, can do no harm. It is true that, under the old system, where the occupations covered a very restricted field, it might be felt. Admitting this, anything seems better than to maintain prisons as hot-beds for the fostering of evil habits, indolence, and some of the lowest forms of vice, and it seems perfectly clear that so small a proportion of laborers can be kept busy without perceptible effect upon the true interests of workmen. As compared with outside labor, prisoners are reckoned as having an efficiency of only sixty per cent. This reduces their competition to about three-tenths of one per cent—an infinitesimal amount.

To restore industrial occupation to prisoners, legislation is needed. It is proposed that a law shall be passed directing that prisoners be made to work. To prevent injurious competition, the number of prisoners employed in manufacturing any one kind of goods, according to the terms of the proposed law, shall not exceed ten per cent of the number of free workmen employed in manufacturing the same goods within the State. If this numerical ratio be further reduced by the coefficient of efficiency of prisoners, it will diminish to six per cent effective labor. By proper distribution of employments it can be reduced still lower, so as to approximate to the labor ratio of one in two hundred. The passage of such a law will undoubtedly do the prisoners much good, increase their chances of reformation, and will not perceptibly affect the prospects of outside workmen.

Salt Water in the Gas Wells.

Salt water is beginning to be a great nuisance to the oil and gas resources of Northwestern Ohio. It is invading nearly all the wells and making an immense amount of trouble, some property having been altogether abandoned on account of its presence. Salt water is affecting the gas wells of Findlay to a large extent, more noticeably in the famous "Karg," which at times cannot be used for several days. After a period of rest, however, the disturbing element seemingly disappears, but under high pressure upon the well returns again.

The Danger of Gas.

Much has been written regarding the attempt to put electric wires in gas mains, but far more yet remains to be said about how to keep gas out of electric conduits. Deaths among electric workmen from asphyxia and from injuries due to explosions caused by the presence of illuminating gas in underground conduits are being recorded with an increasing and unpleasant frequency.

What to do to keep the gas out, and if it is present how to render the operation of laying underground conductors a safe one, are problems which confront the electrical engineer. Obviously, if all the conditions were under control of the electrical company, the remedy should be applied to the first cause, leaky gas mains; but as such a treatment of the subject is impracticable, and as accidental leaks may occur at any time even in properly constructed mains, the electrical subways should be made as far as possible gas tight. No matter how much care may have been exercised in the construction of subways, they may at any time be found to contain gas in dangerous quantities, and precautions should always be adopted to guard against accident by those entering the manholes.

A good plan, much used by cable splicers when compelled to work in a manhole which is found to contain gas, is to allow fifteen or twenty minutes for ventilation after taking off the cover before entering; then to proceed to close up with pipe clay all the openings into the ducts. Pipe clay is used in preference to cement because it does not harden and can easily be removed. In those ducts into which cables have been drawn there is between the cables and the walls of the ducts more or less space which should be carefully filled with this clay.

During all the time that the splicer remains in the vault his helper on the surface sends down a supply of air from a rotary blower which is operated by a crank. This keeps the manhole ventilated and renders the work of splicing comparatively safe. Without the sealing up of the ducts all attempts at ventilation may prove useless, because if communication with neighboring manholes is allowed, a sudden draught of air might suck into the working chamber a volume of gas sufficient to smother the workman while his helper was contentedly turning the crank of the air pump on the surface above.

It is well to bear in mind that the treatment for asphyxia is similar in many respects to that used in resuscitation from drowning. If a workman should be overcome by gas, his life may depend on the way he is handled before the arrival of a physician. He should be brought into the fresh air at once. Efforts should be directed toward keeping up the heart's action and restoring the circulation, and for this purpose stimulants may be given. The foul gases should be expelled from his lungs and artificial respiration practiced if necessary.

Unless a general system of subway ventilation is carried out, this plan of sealing up the ducts should be extended to all the manholes whether there are men at work in them or not, otherwise a leak at one point might flood the entire system with gas. Under the latter condition an explosion at one place may be transmitted through the connecting ducts to a number of manholes, causing great destruction.

To detect the presence of gas is not an easy matter, especially in view of the fact that certain kinds of illuminating gas are inodorous. It has often been suggested that some chemically prepared paper, to be used after the manner of litmus paper, which is turned red by acids and blue by alkalies, might be devised for this purpose, but it hardly seems possible that anything of this kind will be produced, as it is necessary to know not only that gas is present, but also in what quantities. It is too much to expect that there ever could be devised an apparatus for the quantitative and qualitative analysis of gases simple enough to be operated by a subway laborer.

All ordinary underground cable-laying operations can be conducted without the use of a torch in the manholes, but there are cases where its use becomes necessary, and in those instances unusual precaution should be taken to make certain that an explosive mixture of gases is not present. The introduction of underground wires has brought with it new troubles, and it would seem for the interest of all that something should be done by the various companies toward securing uniformity of practice in dealing with this dangerous element, which threatens not only the lives of the cables, but also the lives of our workmen.—*Elec. Review.*

Why Fires Burn Brightly in Winter.

There are several reasons why a fire burns so brightly in frosty weather. First, the air being cold is denser, and the heated air and gases from the fire are comparatively more buoyant. Consequently there is a greater draught. Then the air, being denser, contains more oxygen in an equal volume, and that gas being quickly supplied, the combustion is fiercer and more perfect. In frosty weather, too, the atmosphere is comparatively free from moisture, which of course has a tendency to damp a fire.

SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

In some experiments described in a former article it was shown that hydrostatic pressure is equally distributed on all sides of the containing vessel. Fig. 1 illustrates an experiment in which are shown the effects of removing pressure from a portion of one side of the vessel, thus allowing the pressure to act upon the opposite side of the vessel in such a manner as to cause it to move. This experiment is arranged to show this action in two ways, one so as to propel the vessel forward, the other so as to cause it to turn.

The apparatus consists of a tall tin can—such as is used by fancy bakers for wafers or fine crackers—

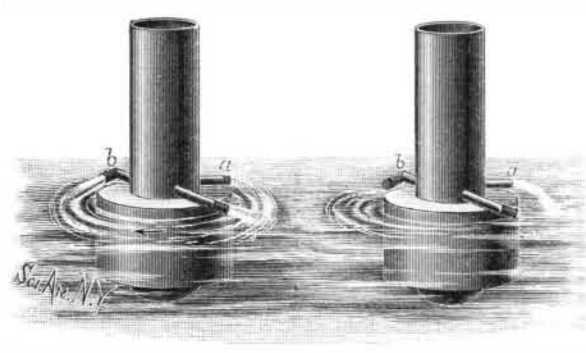


Fig. 1.—REACTIONARY APPARATUS.

mounted upon a wooden float provided with a lead ballast to keep it in an upright position. In one side of the can at the bottom is inserted a short tube, *a*, and in diametrically opposite sides of the can, also at the bottom, are inserted longer tubes, *b*, which reach over the wooden block and have their ends turned in opposite directions. All of the tubes are stopped, and the float is placed in a large vessel of water, when the can is filled with water and the stopper of the tube, *a*, is withdrawn, thereby allowing water to escape from the can, thus relieving the pressure over so much of the area of the can as is represented by the bore of the tube. This disturbs the equilibrium of the lateral pressure in the can, and allows the pressure on the side opposite the opening to preponderate and press the can forward, as shown in the right hand figure.

When the straight tube, *a*, remains closed, and the bent tubes, *b*, are opened, the relief of the pressure results in the rotary movement of the apparatus. In this case the bent tubes are virtually extensions of the containing vessel, and the relief of pressure at one side of one tube causes that tube to move forward, while the relief of pressure at the corresponding side of the other tube causes that tube to move rearward, the resultant of the two motions being a rotation of the two bent tubes, and the parts to which they are attached, around a vertical axis. The apparatus arranged in this way illustrates the principle of Barker's mill.

The hydraulic ram, a simple form of which is illustrated in Fig. 2, depends for its action on the momen-

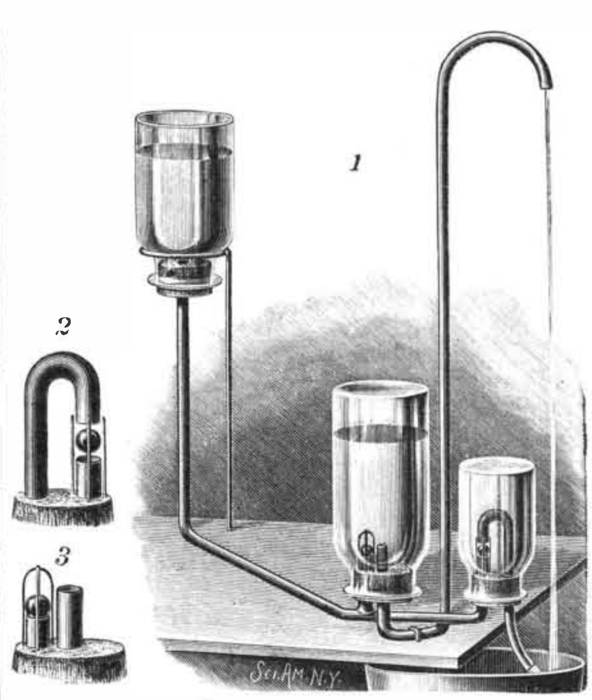


Fig. 2.—HYDRAULIC RAM.

tum of the water column and upon the elasticity of air. The reservoir in the present case consists of an inverted glass bottle having no bottom, and provided with a perforated stopper in which is inserted one end of a tube, preferably lead, on account of the facility with which it may be cut and bent. The other end of the tube is branched, one branch extending through a stopper inserted in an inverted bottle which serves as an air chamber. The other branch of the tube extends to the overflow valve. In the stopper of the air chamber is inserted a second tube, which is bent upward and curved over, forming the riser.

The smaller bottle, which serves as a valve chamber, is provided with a stopper which receives the branch of the supply tube and an overflow tube. The arrangement of these tubes is shown in detail at 2, the curved tube being the overflow, the straight one the inlet. To the inlet and overflow tubes is fitted a valve consisting of a metal ball or a marble. The fitting is accomplished by simply driving the ball against the end of each tube, so as to form valve seats. Four wires are inserted in the stopper around the inlet tube to prevent the escape of the valve. The distance which should separate these tubes as well as the weight of the ball valve is determined by experiment.

In the air chamber above the branch of the supply tube is confined a ball valve by a cage formed of wires inserted in the stopper as shown at 3. This valve is fitted in the manner already described.

The discharge tube extends above the level of the reservoir. The reservoir and the tubes are supported by wire loops and standards inserted in a base board.

Water flows from the reservoir through the valve chamber and out at the overflow. When the velocity of the flow is sufficient to carry the valve in the valve chamber up against the end of the curved overflow tube, the overflow is immediately checked and the momentum acquired by the water causes it to continue to flow for an instant into the air chamber, compressing the air in the chamber, and causing the water to rise in the discharge tube. As soon as equilibrium is established, the valve in the air chamber closes and the valve in the valve chamber falls away from its seat on the overflow tube, allowing the water to discharge again, and so on, this intermittent action continuing so long as there is water in the reservoir. The water discharged by the riser is only a fraction of that flowing out of the reservoir.

Emmensite.

The new explosive emmensite, which is now attracting considerable attention, is prepared, says *Engineering*, by dissolving at a moderate temperature an excess of picric acid in nitric acid of a density of from 50° to 60° Baume; an operation which can be performed without danger if the temperature is kept low. On evaporating the liquid afterward, fine rhombic crystals of a bright yellow color are first deposited, which are followed by others of a lighter hue, and finally by a precipitate of a light gray color, the whole of these three being probably isomers, though their composition has not as yet been determined with accuracy. It has, however, been recognized that they contain more hydrogen than picric acid, and a quantity of oxygen insufficient for complete combustion.

To provide this missing quantity, Dr. Emmens, the inventor of the explosive, employs ammonium nitrate, the mixture being effected by melting together five parts, by weight, of the above crystals with five parts of ammonium nitrate over a paraffine bath. When completely fused, six parts of picric acid are added and thoroughly incorporated, after which the whole is poured out into suitable moulds. These operations involve no danger if the temperature is kept below 200° Cent. Thus prepared, emmensite is an amorphous solid of a bright yellow color, completely odorless, but having a bitter taste. It has a spongy texture, and its specific gravity is 1·7. Microscopic examination tends to confirm the opinion that it is a chemical compound, and not a mere mixture. The explosive is made in several degrees of strength, some of the qualities resembling dynamite, while others can be used for firearms. It is but slightly sensitive to shock, and No. 1 emmensite can be heated without exploding, but Nos. 3 and 4 detonate slightly when raised to a high temperature.

The Fashionable Wood of the Season.

Oak finished antique will be as much used as ever in the manufacture of furniture next year. It is the most popular of all the woods, and the demand for it is steady, and no signs of a change in popular favor are apparent. Walnut is nowhere in the race with oak for popularity, and furniture of that richest of all materials, especially for the bedroom, boudoir, and dining room, remains in the warerooms uncalled for and in no demand. Mahogany is used now, as it always was and will be, for the finest goods, and cherry takes a high rank, but oak stands first in favor and will continue in the front rank for another year at least, and probably much longer, as there is nothing to take its place. For the cheaper grades of furniture, ash, maple, birch, and these woods, with various stains and finishes, continue, as they always will, in favor.

A Remarkable Meteor.

At Oswego, N. Y., on the night of January 26, a large and brilliant meteor was seen. It appeared in the southern sky about ten minutes past 9, 25 degrees above the horizon. It seemed about twice the brilliancy of Venus. It moved horizontally from west to east with the apparent speed of a rocket. It grew in size as it moved, and in the southwest broke into three balls, each larger than the whole when first seen. Just before breaking it showed a red tinge, and after separation each part showed vivid green like the characteristic flame of copper.