EXTRAORDINARY EXPERIMENTS ON STEAM BOILERS.

Perhaps the most interesting and important experiments, relating to the explosion of steam boilers, that were ever attempted were commenced on Wednesday, November 22, 1871, by Mr. Francis B. Stevens, under the authority of the United Railroad Companies of New Jersey. We give, herewith, an engraving of the scene of the experiments.

At the suggestion and by the advice of Mr. Stevens, that corporation generously and philanthropically appropriated the sum of ten thousand dollars to be expended by him in experimental investigation of the causes and of the subject generally of steam boiler explosions.

Mr. Stevens collected nine boilers; and, after testing, by hydrostatic pressure, several times to the point of rupture, each time repairing them, he finally set them all up on the United States reservation at Sandy Hook—by permission of the Secretary of War—with the object of actually exploding them by steam, and thus observing, if possible, the conditions of explosion and with the intention of obtaining as much valuable information as possible.

These latter experiments were commenced on November 22, in presence of Joseph G. Belknap, Inspector-General of Steamers for the United States, Coleman Sellers, President of the Franklin Institute of Philadelphia, Professor R. H. Thurston of the Stevens Institute of Technology at Hoboken, N. J., B. F. Isherwood, U. S. Navy, Captain Woolsey of the Jersey city ferry, Mr. A. Smith of the North Shore Ferry Company, Messrs. Callan and Dripps of the Pennsylvania Central Railroad Company, Mr. Brown of the Camden and Amboy Railroad Company, and Messrs. Erastus Smith, Charles Haswell, Norman Ward, William and Andrew Fletcher, and other engineers and manufacturers, making a party of about fifty of our best known experts in engineering.

The first boiler tried was a steamboat boiler which had been in use thirteen years—a return flue boiler, 6 feet 6 inches diameter of shell, 28 feet long. It had been subjected, November 4, to a hydrostatic pressure of 82 lbs. per square inch.

At 2 P. M. a large fire of wood burning violently in its furnaces, the gauges, which were placed at a distance of about 250 or 300 feet from the boiler, indicated 58 pounds pressure per square inch. The pressure rose steadily and regularly at a rate of about 2 pounds a minute until, at 2.18 by Professor Thurston's time, a pressure of 90 pounds was reached, and the horizontal seams of the shell began to leak very generally, while a rent started in the flange of the steam chimney at its junction with the shell. At 2.23 P. M. the pressure had reached a maximum of 93 pounds, and the leaks allowed steam to escape as rapidly as it was generated. The pressure then gradually subsided to 90 pounds at 2.50 P. M., when the fires were extinguished and the experiments were ended.

The next experiment was made upon a new construction namely: a copy of the back end of the *Westfield's* boiler, in the spacing of its screw stay bolts and in its dimensions generally. The fires having been lighted, the steam rose in pressure very rapidly, reaching 165 pounds to the inch in 29 minutes; and, while the Professor was entering the figure in his note book, the explosion took place, at 3.51 P. M., with a loud report and producing remarkably interesting effects. One side of the "leg,"—for the construction was that of the "water leg" of a boiler—was thrown a long way out into the adjoining field, tearing down the fence in its way; the other side went in the opposite direction, cutting a large hole in the next boiler, letting out its steam and water, and putting an effectual estoppel upon the proposed explosion of that, at least until repaired. The brickwork of the furnace was thrown in all directions with tremendous violence, some portions falling unpleasantly near the party at the gauges. Both parts of the exploded boiler were deeply "dished." The staybolts had drawn out of the sheets; and, around the holes, were noticed curious markings, resembling the magnetic spectra in their outlines, and possibly indicating the distribution of strains in the metal while yielding under pressure.

The next day, November 23, another boiler was experimented upon, the gauges being now placed 450 feet from the enclosure. This boiler was built by T. F. Secor in 1845, and was removed from the steamer after being in use 25 years; and, when removed, it had a certificate for 30 pounds. It was a return tubular boiler, 12 feet wide and 15 feet 5 inches long. It had been twice subjected to the hydrostatic test, the last time to a pressure of 59 pounds without fracture.

On this occasion, the steam rose regularly, and at 50 pounds some of the traces gave way with a loud report, and at 53½ pounds, the water standing 15 inches above the flues, it exploded with terribly destructive effects. The steam chimney, with a part of the boiler top, weighing altogether several tuns, rose to a great hight in the air, falling over four hundred feet from its original position, and the boiler itself was torn into hundreds of pieces, the flying fragments tearing down the high fence and injuring others of the boilers remaining to be tested.

Mr. Stevens concluded to leave the other proposed experiments until some days later, in order that all interested persons might have an opportunity to witness the effect of this last explosion, and to satisfy themselves that steam boilers are not necessarily safe because there is "plenty of water."

The public owe a debt of gratitude to Mr. Stevens and to the United Railroad Companies of New Jersey for the professional zeal and enthusiasm that has proposed and urged the prosecution of these experiments, and for the liberality which has enabled them to be carried out. We doubt not that thousands of dollars and hundreds of lives will be saved by this signal disproof of the prevalent belief among engineers that a boiler is safe from explosion so long as it has a good supply of water, even though old and worn out.

Other wealthy railroad and steamboat companies owe it to themselves and to the public that the New Jersey companies are not compelled to pay all of the expenses of these experiments, and that Mr. Stevens is not compelled to stop in this good work for lack of funds.

The experiments having now ceased for lack of means to continue them, Congress has been petitioned to provide funds to prosecute them to final results. We trust this petition will be granted as not only engineers, but the general public, are greatly interested in obtaining more light upon the subject. We know of no scientific work more worthy assistance from the General Government, and none from which more practical benefits are to be anticipated.

Williams' Car and Tender Loading Apparatus.

Mr. James Williams, of Bell's Depot, Tenn., has just patented an invention which consists in a box holding a sufficient quantity to load the tender with fuel or the car with freight. The box is pivoted on a frame higher than the tender and car, so as to tilt toward the tender and car, and the side of the box which swings down is hinged so as to be let fall upon the top of the tender or car and form a chute for conducting the contents into the vehicle to be loaded. The ends of the hinged side have pieces similar to the end boards of the box, which assume a vertical position when the side falls down, and form sides to the chute, preventing the escape of the contents of the box over the ends.

For loading tenders, the box is much smaller than is required for discharging a car load at once into a car, and is arranged in vertical ways. A hoisting drum and other necessary apparatus for lifting the box from the ground to the proper elevation for discharging is employed; but for loading cars the freight should be as high as the box to be put into it, or it may be carried up by elevators. The frame supporting this loading apparatus is mounted on car wheels to to be run along a temporary track, to facilitate the taking of the wood or coal from different positions, and conveying the load to the proper place for discharging.

THE refusal of Mechanics' Unions to reconsider their unreasonable restriction, whereby their own sons are denied the privilege of learning the trades of their fathers, is one of the mysteries of the age. We have before alluded to this, for we feel that the prosperity of the country, the interest of humanity, and the welfare of coming generations, all demand that the shutting out of boys from learning the trades ought to cease, so that they may be trained up to become good workmen, and be able to learn an honorable mode of living.

BOILER EXPERIMENTS AT SANDY HOOK.

Chromium and its Compounds in the Arts and in Medicine.

The following is a brief abstract of an interesting lecture on chromium, delivered by Dr. Louis Feuchtwanger, before the Polytechnic Club of New York. It was fully illustrated by specimens.

Chromium is a very remarkable metal, which is very sparingly distributed in the earth's crust. Chromic iron is the only mineral which is found in sufficient quantities to be useful as a source of this element. It is found in serpentine rocks, in veins and disseminated grains. It is quite abundant in Siberia, Styria, Asia Minor, the Shetland Islands, Cuba, and the United States. (The lecturer described the deposits of Pennsylvania, Maryland, North Carolina, and California, which he had carefully studied.)

The constitution of chromic iron is exhibited by the formula FeO, Cr_2O_3 or (FeO,MgO), (Al_2O_3,Cr_2O_3).

The following analyses exhibit the percentage composition:

Locality.	FeO.	MgO.	Cr_2O_3.	Al_2O_3.	SiO_2.	
Baltimore, *cryst.*	20·13	7·45	60·04	11·85		Abich.
" *massive.*	18·97	9·96	44·91	13·85	0·83	Abich.
Bolton, Canada.	35·68	15·03	45·90	3·20		Hunt.
L. Memphremagog.	21·28	18·13	49·75	11·80		Hunt.
Beresof.	18·42	6·68	64·17	10·83	0·91	Moberg

The following minerals also contain chromium:

Crocoisite, PbO,CrO_3, containing 31·3 per cent of chromic acid.

Melanochroite, 3PbO,2CrO_3, containing 23·3 per cent of chromic acid.

Vauquelinite, 3CuO,2CrO_3+2(3PbO,2CrO_3), containing 27·9 per cent chromic acid.

Pyrope, Bohemian garnet, a silicate of alumina, iron, and magnesia, containing from two to six per cent of chromic acid.

Ouvarovite, lime chrome garnet. Silicate of lime and chromium, containing 22 per cent of Chromic oxide.

Emerald, a silicate of glucina and alumina, colored by three-tenths of one per cent of chromic oxide, according to Klaproth.

The following are the more important applications of chromium compounds in the arts:

1. The yellow or neutral chromate of potassa is the basis of all the other preparations, being made directly from the chromic iron.

2. The red or bichromate of potassa is obtained from the foregoing salt, and is extensively employed in the arts. In photography it is the basis of most of the printing processes, on account of the property which it has of rendering gelatin insoluble by exposure to light. In dyeing, it is extensively used as a mordant. It is the material from which chromic oxide, chromic acid, and the metallic chromates are prepared.

3. Chromic oxide is the most insoluble green pigment known; it is extensively used in printing "greenbacks," and in staining glass and painting porcelain.

4. Chromic acid is a powerful oxidizing agent. It is extensively used on this account in chemical researches, is found very useful as an exciting fluid in galvanic batteries, was used for preparing the beautiful "mauve red" from aniline, is employed in bleaching palm oil, destroying the empyreumatic impurities of acetic acid, etc.

5. The chromates of lead, bismuth, baryta, strontia and zinc are extensively used as pigments, varying in tint from the vermillion red of the basic chromate of lead, to the pale straw yellow of the strontia salt. The common "chrome green" is a mixture of chromate of lead and Prussian blue.

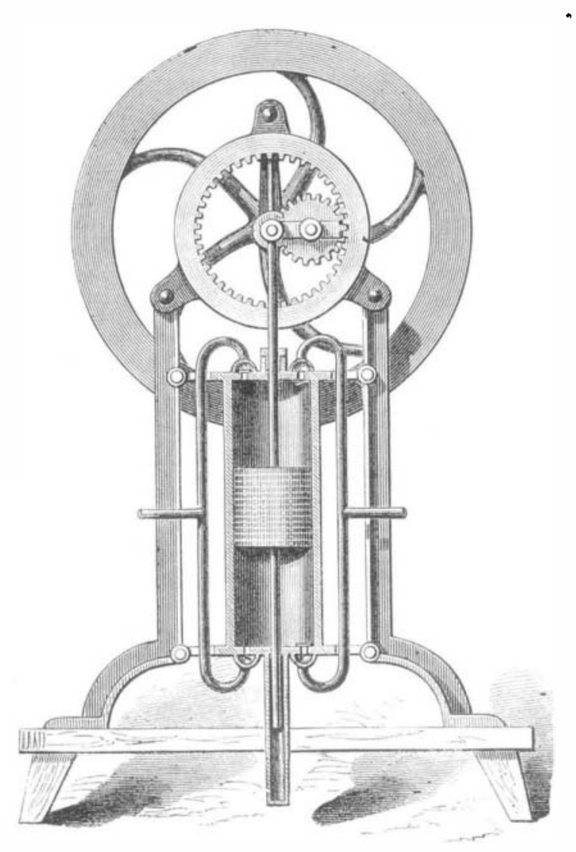
6. The beautiful violet chromic chloride has recently been introduced as a cancer remedy.

7. Chromium steel, made by combining about five per cent of chromium with cast iron, possesses most remarkable properties. On account of its excessive hardness, it is the best metal for the construction of safes, while its tensile strength, equal to a strain of 140,000 pounds to the square inch, especially adapts it to the construction of suspension bridges; it was employed in the St. Louis bridge, and will be used in the Brooklyn bridge.

FREE PISTON AIR PUMP.

Probably the most remarkable pneumatic machine which appeared in the French Exposition, or which has been yet constructed, is the free piston air pump, of Mr. J. A. Deleuil, of Paris. The peculiarity of this machine is that the piston works out of contact with the barrel of the pump, and of course entirely without friction. This piston is a metallic cylinder, and the barrel within which it moves is of glass. But though there is no contact between the surfaces, the space between them is exceedingly minute, being stated at the fiftieth part of a millimeter. It is of course necessary that the workmanship should be very superior, and that the strength of the whole machine should be such as to remove all danger of change of figure, or of any even very slight deviation of movement, or disturbance of the truly concentric adjustment.

The efficacy of this machine depends upon the difficulty and slowness with which gases make their way through very narrow spaces. The film of air between the piston and the wall of the cylinder is practically confined there, and forms a kind of lubricating cushion. The only resistance, therefore, which the piston encounters in its movement, is that which arises from the unequal density of the air above and below it. The engraving shows this machine in elevation. The piston is driven by means of the epicycloidal combination of La Hire, operated by a crank and flywheel. It is guided by a rod extending entirely through the barrel at bottom as well as at top. There are two valves at each end of the cylinder, one opening inward and the other outward. The outward opening valves both communicate with the same tube, which is recurved and united with the cylinder at both extremities. At the middle point of this tube, a branch leading from it may be connected with a condensing apparatus; so that the pump may be used for compression as well as for rarefaction. When used for the ordinary purposes of an air pump, however, this branch is open to the atmosphere. On the other side, the two inward opening valves are similarly connected, and the branch tube on that side establishes communication with the receiver to be exhausted. But when the pump is employed to compress air, this branch is open in its turn to the atmosphere. The valves, as drawn in the figure, are operated by the elasticity of the air. But, in the construction now given to this part of the apparatus, they are opened and shut mechanically by the piston itself. For this purpose, there are introduced two cylindrical rods passing through the piston and reaching from end to end of the cylinder, but capable of a slight longitudinal movement as the piston changes its direction. This movement opens a valve at one end and simultaneously closes the corresponding one at the opposite end; but this change having been effected, the rod remains stationary, the piston sliding on it as it continues its movement. The particular contrivance here described is not peculiar to Mr. Deleuil's pumps, however, as it has been often employed before.



The interior bore of the barrel must, of course, be very truly cylindrical and well polished. The piston is, in length, more than equal to its diameter. When the pump is used for compression, a greater length of piston is employed than is necessary for exhaustion. In point of fact, in this case, the difference of pressure on opposite sides of the piston becomes several times greater than it can be when the machine is employed only to produce a vacuum. There is no difficulty in carrying the condensation, in the course of a very few minutes, as high as five or six atmospheres. On the other hand, exhaustion is effected with remarkable rapidity. With a machine having a cylinder of four and a half inches in diameter, a twenty gallon receiver may be exhausted down to a pressure of less than half an inch of mercury in five minutes. Exhaustion may be carried lower than to the tenth of an inch in mercury.

The figure shows that the piston has not a continuously cylindrical surface from top to bottom. It is cut by grooves of very slight depth, and about half an inch apart. These grooves fulfil, apparently, a very useful function. Suppose the difference of pressure below and above the piston to be very great—the excess being, for example, below: the velocity, with which the air tends to escape on the upper side, will be much less than that with which it tends to enter the narrow space between the piston and cylinder on the lower. But before this superior velocity can be transmitted beyond the first groove, this groove must be filled with air of density equal to that below the piston. And before the same velocity can be propagated beyond the second groove, this second groove must be filled in like manner. As the movement is slow even when the pressure is greatest, it will take a much longer time to transmit, through all the intermediate grooves to the upper limit of the piston, the tendency to movement which exists at the lower limit, than it would do if the piston were quite continuously cylindrical; and thus we have the paradoxical effect of a *packing*, produced not by *adding to* the substance of the piston, but by *taking from* it. It is found, in fact, that the working of the pump may be interrupted a sensible time without turning a stopcock, and yet without vitiation, by the infiltration of air between the piston and cylinder, of the vacuum already secured.

HOW greatly the world would be benefitted by unlimited facilities for transportation and exchange of goods is shown by the fact that, while the people of Persia are starving by tens of thousands, the inhabitants of some of our Western States are burning corn in their stoves in place of coal.

The Coast Survey.

Professor Benjamin F. Pierce, the distinguished astronomer and mathematician, succeeded Professor Bache, and now superintends the operations of the coast survey. Some idea of the extreme accuracy with which the survey is carried on may be obtained from a description of the manner of measuring the base lines of the primary triangles. Four bars, each a little over two yards in length, are clamped together, end to end, making a combined length of over eight yards, or of exactly eight French meters. These bars are stiffened by being placed in a wooden box, allowing the ends to project beyond the box, the whole forming a measuring rod, which is used as follows: The compound bar is carefully placed in position in the line to be measured, and a powerful microscope placed over the forward end and adjusted so that its crosswise exactly coincides with the edge of the bar. The bars are then advanced until the rear edge comes into exactly the same position under the microscope that the forward edge has just left. A microscope is now adjusted over the forward edge again, the rod advanced as before and adjusted to its second position. This process is repeated until the base line of six miles, more or less, is measured. During the whole time, the temperature of the bars has to be carefully observed. The base line apparatus now in use was devised by Professor Bache, and has superseded the one here described on account of its greater accuracy. The measuring bar is so constructed that its length is not affected by changes of temperature, and greater nicety is obtained in making each successive length of the bar commence precisely where the previous one ended. Such accuracy has been obtained in the use of this apparatus that repeated measurements of the same mile do not differ from each other more than one twentieth of an inch. The necessity for such accuracy does not at first sight appear, but becomes evident when we remember that an error of a one-thousandth part in the base line is reproduced in such a way that all the lines measured will be in error a one-thousandth part. This, in a line of one hundred miles, would be about five hundred feet. An error of five feet in that distance would disgrace the survey. In order to verify the triangulation, a line is established by means of it at a considerable distance from the base, and then measured with the base line apparatus. The length of the line by the two methods should agree. It is a source of gratification to those who take pride in the successes of their own country that our coast survey, tried by these checks, is not surpassed by the most careful surveys of any other country. The accuracy which is indicated by this method of measuring the base lines is an example of the accuracy required in every part of the survey. In the triangulation, the form of the earth has to be rigorously taken into account, and the angles are obtained by repeated measurements with the most accurate instruments. The geographical positions of the various stations have also to be fixed by the most refined astronomical observations, reduced by the most elaborate and accurate methods. In this way, the assumed figure of the earth is constantly tested, and the effect, upon the plumb line, of its irregularities and want of homogeneity shown. Two methods of making astronomical observations, first introduced into work of the kind by the United States Coast Survey, have drawn very flattering commendation from the old astronomers and masters of survey in England and Europe generally. They are that of determining the latitude with the zenith telescope, and that of determining the longitude with the aid of the telegraph. The accuracy obtained by these methods is such that they have nearly superseded all others.

A California Tea Plantation.

A writer in the *Overland Monthly* for January says: At Colonel W. W. Hollister's, I saw something I had never seen before. The Colonel has a tea plantation, in an evidently flourishing condition; but, though the plants looked thriving, and the planter believes that, in time, he will reap an abundant harvest, this is a venture I should not advise many to embark in for the present. Fortunately, Colonel Hollister has both the means and the disposition to make these experiments, of which the farming community of all California will some day reap the benefit. Shall I expose my ignorance by confessing that I never before knew that there is really but one tea plant? The different varieties we buy are only the result of the different manipulations in preparing it for the market. The plants themselves look to me like little, young orange trees. I saw them from one to four inches in hight, and the seeds are about the size and shape of a small hazel nut. Together with the tea, the Colonel has imported a "live Japanese," to take charge of the plantation; so that if tea raising succeeds at all, it certainly will here. His almond orchard, too, is on a grander scale than that of his neighbors: fifty thousand trees have already been set out—some of them, in fact, are over two years old—and fifty thousand more are being planted. Speaking of his neighbors: they are not so very near. The Colonel has a hundred thousand acres, more or less on which to plant tea, cotton or Canada thistles, should he so choose.

JOSEPH GILLOTT, who died at Birmingham, England, January 5, at the age of seventy-two years, had a world-wide reputation as a manufacturer of steel pens. He was born at Sheffield, and removed to Birmingham when about thirty years old. In 1803 Mr. Wise, of Great Britain, began the manufacture of steel pens. Mr. Gillott became interested in the business, and by his wonderful mechanical talent made several improvements and built up a large trade. About thirty years ago he put up the extensive Victoria Works, on Graham street, Birmingham, which are to-day one of the sights of the town.

IT is an ancient proverb, "The feet of the avenging deities are shod with wool."