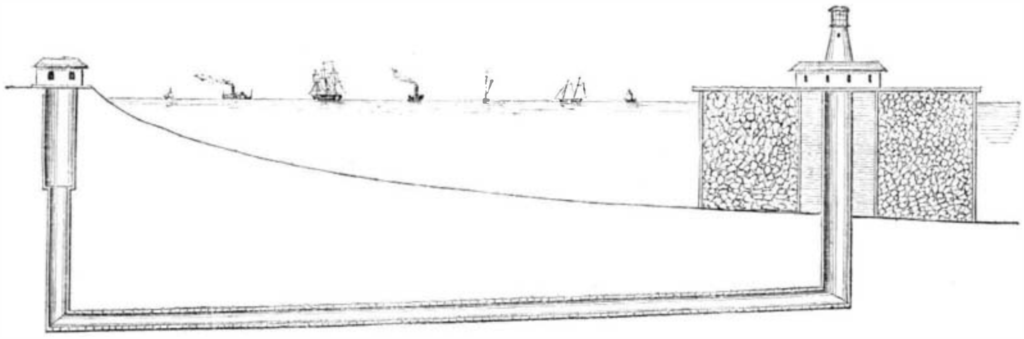
THE GREAT WATER TUNNEL UNDER LAKE MICHIGAN.

Our exchanges bring us, this week, accounts of the virtual completion of a work of American engineering, which, for boldness of conception, unerring skill, and uninterrupted success, deserves to be classed with the proudest achievements of the old world, or of any age.

The greatest produce market in the world, and the most energetic and enterprising city on even the American continent, Chicago has grown up in thirty-six years from a lair of wild beasts to a great metropolis, under some of the grossest natural disadvantages that ever taxed the resolution of any similar community. Its water supply—always miserable, since the drainage of a city begun to be mingled with the lake from which it was drawn —has been all this time growing execrable, until hardly fit to be tasted by man or beast. There the crystal waters of Lake Michigan, among the purest in the world, spread out before the tantalized citizen in all their beauty, beyond his reach, poisoned far along the shore by a ceaseless drench of abominations from the sewers of the city. It was impossible to conduct water from any point remote enough to be assured against this contamination; and in fact, the shore water from whatever point must always continue subject to every variation of impurity from attrition with the banks and from the deposits washed down by streams and rains. The pure and undisturbed depths of the mid-lake were the only source from which a supply of clean water could be obtained. It was resolved to reach those depths by a tunnel under the bed of the lake, tapping its bottom at a distance of two miles from the shore. Surveys of the lake-bed, by means of an auger inclosed in a tube, revealed the favorable circumstance of a continuous underlying stratum of hard blue clay. The contract for the bold undertaking was awarded in October, 1863, to James Gowan and James J. Dall, of Harrisburgh, Pa., at the sum of $315,139. They have already expended more than double this amount, mainly in consequence of the enhanced prices of labor and materials; and it is expected that, with all changes, improvements and finishing touches, the waterworks will not be completed for less than $1,000,000. The contractors have as yet received no relief; but their splendid success warrants the expectation that the city of Chicago will not suffer them to go either unrepaid or unrewarded.



CHICAGO WATER-WORKS TUNNEL.

Work was begun at both extremities—the shore end and the lake end—of the tunnel. At the latter point the great engineering difficulty and triumph occurred. The violent storms on the lake, it was thought by eminent engineers, would make it impossible to fix a permanent structure in the waters. A huge wooden crib, or coffer dam, was built, like a ship, on the shore, launched, and towed to its location. It was 40 feet deep, five-sided, 290 feet in circumference, and over 90 feet in diameter. Its angles were armored with iron two and a half inches thick. It had three distinct walls or shells, one within another, each constructed of twelve-inch square timber, caulked water-tight like a ship, and all three braced and girded together in every direction, with irons and timbers, to the utmost possible pitch of mechanical strength. The central area, or well, inclosed by the inner wall, was only twenty-five feet in diameter; leaving spaces about fifteen feet wide between the shells. Within these spaces were constructed fifteen caulked and water-tight compartments, which were filled with clean rubble stone, after the crib was placed in position. By this means the crib was sunk to the bottom, where it was firmly moored by cables reaching in every direction to huge screws forced ten feet into the bed of the lake. The water in which it was sunk was 35 feet deep, leaving five feet of the structure above the surface. This was in June, 1865. The crib had cost $100,000; consuming 618,625 feet of timber, 65 tuns of iron, and 400 bales of oakum.

The next business was to sink a water-tight shaft within the well of the crib, and into the bottom of the lake to a depth of some thirty feet further; making 66 feet in all below the surface of the water. Seven great iron cylinders were cast, each about 9 feet long, nine feet in diameter, 2½ inches thick, and weighing 30,000 pounds. One of these cylinders having been suspended in the well, another was placed upon it, the two were firmly bolted together with a water-tight joint, lowered, a third cylinder bolted to the second in the same manner, and so on until the shaft, a solid iron tube 64 feet deep, rested on the bottom, and forced its way by its own weight through the softer deposits into the hard blue clay beneath. The water was now pumped out, the top of the shaft was closed as nearly as possible air tight, and a powerful air-pump, driven by steam, commenced to exhaust the air also. As fast as a vacuum could be created, the atmospheric pressure, added to its own weight of over one hundred tuns, forced the huge shaft downward into the bed of the lake with inconceivable force. Thus a depth was reached and secured, at which it became perfectly safe to carry forward the excavation, and complete the shaft to the level at which the tunnel was to begin. The loose rubble stone is finally to be taken out of the water-tight compartments, one at a time, and they will be re-filled with piers of solid masonry, laid in hydraulic cement, and united above the surface in some manner, so as to present an immovable front on all sides against the force of storms. A light-house is to surmount the whole.

The process of constructing the rest of the tunnel was simple, though interesting. Three sections of great cast-iron tubing, like that used in the lake shaft, were let into the earth by simply excavating beneath them, and letting them sink as the earth was removed. Having thus worked through the sands, and into the blue clay, the shaft was now narrowed to eight feet, and completed and walled in the ordinary maner to a total depth of 77 feet. This shaft was sunk four feet further below the surface of the lake than the lake shaft; causing a descent of two feet to the mile in the tunnel, to facilitate emptying it when required.

Both shafts having been completed, the excavation of the tunnel was commenced from both ends. On the 16th ult. the opposite gangs of workmen were within two feet of each other; and on the following day, the Board of Public Works formally broke through this last natural obstruction to the passage of the pure waters of the mid-lake into the city of Chicago. The accuracy with which the two lines of excavation met was an admirable engineering success. The center lines coincided within nine and a-half inches, and the floors joined with a difference of only one inch. The tunnel is nearly a true cylinder, of five feet diameter in the clear, but worked two inches higher, vertically, on account of the keystone of the arch. It is lined with the best of brick and cement, 8 inches thick, laid lengthwise, in two shells, with toothing joints. The lining of the shore shaft consists of twelve inches of the same masonry, in three shells. About 4,000,000 of bricks were used.

Ground was first broken on the 17th of March, 1864; and the work has been continued with but slight interruption, night and day, and at all seasons. A narrow railway was laid from the foot of each shaft, as the work progressed, with turn-out chambers for the passage of meeting trains; and small cars, drawn by mules, conveyed the excavated earth to the hoisting apparatus, and brought back at every trip a load of brick and cement. The men worked in gangs of five, at the excavation; the foremost running a drift in the center of the tunnel, about two and a half feet wide, the second breaking down the sides of the drift, the third trimming up the work to proper shape and size, and the last two loading the earth into the cars. The bricklayers followed closely, only a few feet behind the miners. About a hundred and twenty-five men were employed in this work, in three relays, working eight hours each; the only cessation being from 12 o'clock Saturday night, to 12 o'clock Sunday night. A current of fresh air was constantly forced through the tunnel by machinery. It is remarkable that no accident from earth, gas, or water, occurred in the whole course of the work, sufficient to interrupt its progress.

Water is to be let into the lake shaft by three gates, on different sides, and at different hights. The lowest is five feet from the bottom of the lake; the next ten feet, and the highest fifteen feet. Flumes through the surrounding masonry, also closed by gates and gratings at their outward ends, will conduct the water to the shaft gates. All the gates can, of course, be opened and closed at pleasure. Chicago will boast—with how much reason unprejudiced water-drinkers must judge—of all other cities on the continent, the best supply of the best water, at a trifling cost for both construction and maintenance—if the work holds as good as it promises to—in comparison with some of her eastern sisters.

Galileo's Instruments.

About a year since, M. Boquillon, formerly librarian of the *Conservatoire des Arts et Metiers*, of Paris, and who enjoyed a high reputation as expert in connection with scientific questions before the French law courts, went to Italy commissioned to search the public libraries, museums, and private collections of that country, for all the documents throwing any light upon the labors of the great astronomer and natural philosopher, Galileo. It is said that the many works and dissertations published respecting the life and experiments of the illustrious Tuscan abound in grave errors, and that M. Boquillon has been fortunate to find authentic materials for correcting these errors. With the assistance of M. Mateucci, formerly Minister of Instruction in Italy, and M. Donati, the astronomer, M. Boquillon has had access to all the manuscripts of Galileo, and has been enabled to read, study, and compare them at his ease, and is now in a position to publish a complete work upon the subject. Some of the documents which will be embodied in this work are said never to have been made known to the scientific world. The museum called *La Specola*, in Florence, possesses a most precious and interesting collection of scientific relics, namely, the instruments which served for the experiments of Galileo and for those of the *Academy del Cimento*; they are preserved in that portion of the museum which is known as the Tribune of Galileo. The greater portion of these instruments are composed of extremely thin transparent glass, and they are said to be perfect marvels of the glass-blower's art. The whole of these have been carefully photographed, under the direction of M. Boquillon, by two of the ablest photographers of Italy, and it is said that these interesting reproductions of the instruments, which served for the famous experiments of Pisa, will be shown at the Exhibition in Paris next year. It is hardly possible to imagine a more attractive series of pictures than these will present to the scientific world.

A NOVEL and commendable feature of a recent fair in Canada consisted of two essays by young ladies on the qualifications of a farmer's wife.

English Hop Culture.

The culture of hops is becoming profitable and extensive in this country, in consequence of the great influx of beer-drinkers from abroad, and the growing fashion of beer-drinking among Americans. A few notes on the English hop plantations may therefore be of interest and use; conceding the disputed point, that beer is an addition to the sources of human welfare.

The hop culture in England is so extensive, particularly in the counties of Kent and Sussex, that the picking season draws throngs of laborers by railway and otherwise, from the great cities and all parts of the country, and keeps them profitably employed from three to six weeks. "Hop gathering," as most of our readers interested in the fine arts will remember, has been made the subject of a very pleasing picture by a modern English artist. The motley multitude of men, women and children, employed in hop gathering—encamped together as they are for weeks in the open fields, by night and day, in wild but crowded liberty—must open a yawning door for missionary work. Whether the long, promiscuous encampment be on the whole more demoralizing than the pure influences of nature are salutary, to these poor creatures, may be matter of doubt.

The heavily laden poles are first hauled out of their earthen sockets and placed in piles, by a class of hands employed for that purpose, and using a lifter with iron teeth, acting as a lever. The pickers throw the hops into canvas sheets, loosely hung within frames like a light bedstead. The measurers pass around and empty these receptacles as often as they are filled, leaving each picker checks indicating the number of bushels, according to which they are paid.

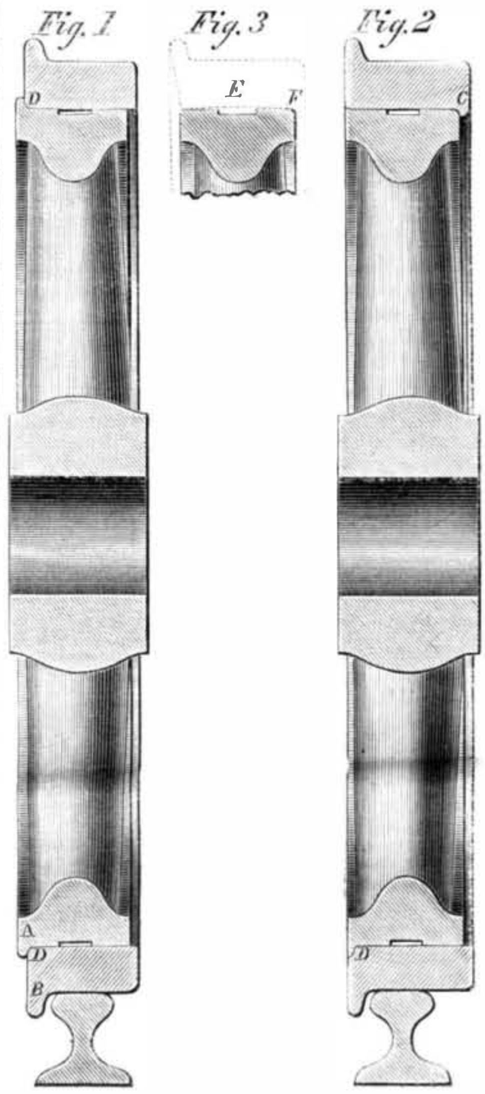
From the field, the hops go to the "oast house," or drying house. The word is of doubtful etymology: Webster only suggests a conjectural analogy to the latin *ustus*—burned. The oast house is a circular building from eight to eighteen feet in diameter, or very commonly a cluster of four such buildings, meeting in one at the center; each having a spiral roof, with an opening at the top covered with a revolving cowl, to secure a strong and uninterrupted outward draft. The first floor is occupied by fires, placed about the center, of charcoal and Welsh coal, causing little smoke. Roll sulphur is added at intervals, to give the hops the pale yellow tinge so much sought after. The second floor is made of horsehair to afford free and uniform passage to the heat and sulphurous fumes of the fires beneath, supported on a light framework of wood. Upon this horsehair floor the hops are emptied as they are brought from the plantation; spread, stirred and turned, from eight to eleven hours, until thoroughly dried by the heat; and afterward transferred to a cooling room. When cooled, they are compressed into bags, and branded for market.

MELLONS' IMPROVED LOCOMOTIVE TIRE.

The unavoidable working loose of the tires on locomotive driving wheels is a large annual bill of expense to all railroad companies. Usually dependence has been placed mainly on the adhesion of the tire to the wheel by shrinkage, with other mechanical devices. In time the tire becomes expanded by the continual pressure, combined with rolling, to which it is subjected, aided perhaps by the percussion incident to a defective permanent way, and the tire is loosened, endangering not only the locomotive, but the train with its passengers. Then comes the annoyance of removing and reheating the tire, "shimming up," and sometimes returning the surface. The inventor of the improvement under consideration attempts to remove these objections and obviate these difficulties. He does not hope to prevent the gradual stretching of the tire from use, but to prevent it when loose from moving from its seat, endangering life and property.

Figs. 1 and 2 in the engraving represent the improved method of forming and attaching the tire. Fig. 3 is a section of an ordinary tire worn and stretched by use. Fig. 1 shows a wheel and improved tire section, the wheel having on its inner edge a rim against which the edge of the tire sets firmly. It will be seen that the flange, A, on the periphery of the wheel prevents the tire, should it become loose, from slipping off at the inner side of the wheel, and the flange, B, of the tire prevents it from slipping off on the outer side.

The same result will be attained by having the inner surface of the tire at its outer edge provided with a flange, as at C, Fig. 2. It will be noticed that the inner edge of the tire, where it comes in contact with the wheel, is rounded, as at D, to prevent it from indenting or sinking into the substance of the wheel and rendering the removal of the tire difficult. In Fig. 3 is seen the result of the



spreading of the tires ordinarily used. The center of the tire is concave, as at E, while the edge, at F, has spread over the edge of the wheel. Frequently this overlapping compels the cutting of the tire in order to effect its removal. No bolts, rivets, nor keys are required to secure this improved tire. If it becomes loose while on the road, it will be safe until the terminus or shop is reached, as it cannot fly off, when it can be readily removed and replaced by another.

Patented through the Scientific American Patent Agency, Oct. 2, 1866, by Edward Mellon, of Scranton, Pa., to whom those interested should apply for additional information.

THE Commissioner of the General Land Office, at Washington, has received rich specimens of argentiferous galena from newly discovered veins in Colorado, within five miles of one of the finest coal veins in the territory. The discovery (says the *Intelligencer*) is important, as it indicates a continuation of the precious metallic veins in a north-easterly direction nearly if not quite to the plains, and in close proximity to the coal.

"THEIR Academy of Natural Sciences (says the *Enquirer*) has been for fifty years a pride to Philadelphians. No other city on the continent possesses so fine a collection." The specimens collected are said to be worth half a million of dollars. The Building Fund Committee are now making a final appeal for subscriptions to secure a fire-proof building worthy of the institution.

Correspondence.

The Crank and Piston in Setting Valves.

MESSRS. EDITORS:—I trust you will excuse me if I respond to some editorial remarks appended to the letter of a correspondent in your issue of Nov. 24. In the communication referred to there is a diagram of the crank of a steam engine, giving the relative positions of crank and piston at various points of the stroke. Concerning the best method of finding this, much correspondence has been published in the SCIENTIFIC AMERICAN. In the remarks I criticise it is said, "the importance of a correct knowledge of the relative positions of the crank and piston will be conceded by those who have to set the valves of steam engines." I do not think this will be conceded, Messrs. Editors, for the following reasons:—

The crank has nothing whatever to do with setting the valves.

Any valve set with the crank as a guide is more apt to be wrong than right, for the reason that the relative distance moved over by the crank and piston vary with different points of the stroke, vary with different strokes, and with different lengths of connecting rod.

All valves that cut off steam at a given point of the stroke should have that given point measured from the end of the slide, not on the crank. The large number of badly-set valves you speak of is accounted for by guessing at the position of the crank and piston, or by measuring on the crank, which amount to the same thing.

Further, the expansion of bed plates and springing of valve and eccentric rods, always derange the lead, even when it is measured on the slide. It is much more liable to be deranged when measured on the crank, for the reason that the point of no motion on the slide, at or near which lead is given, cannot be found on the crank without much trouble, for when the piston is on the dead center the crank has freedom to move through a considerable arc, enough to disturb the lead very much.

It is not of any importance to know the relative position of the crank and piston in setting valves, but I do not see any harm in persons amusing themselves by making diagrams of it. The practice is akin to the problem of the celebrated ten-foot pole in the forty-acre lot, which casts a shadow at sunrise so many feet long; how long will it be at some other time?

It may be asserted, without fear of contradiction, that if we take care of the piston, the crank will take care of itself, for we measure divisions in the cylinder by the space occupied and traveled through by it, not by the movement of the crank.

EGBERT P. WATSON.

New York City, Dec. 21, 1866.

[We publish the above communication for the purpose of drawing attention to some erroneous opinions in it, which we believe are shared by a number of mechanics. The ordinary steam engine not only is a medium for transmitting the power of steam by the reciprocating movements of the piston, but is also a medium for converting those movements into a rotary motion by means of a crank with its connections. The movement of the piston is not often exactly coincident with that of the crank, varying, as our correspondent truly says, "with different points of the stroke, with different strokes, and with different lengths of connecting rod." It will be evident to any one who will sit down and analyze the diagram accompanying the article to our comments on which Mr. Watson takes exception, that the "crank *has* something to do with setting the valves," and that it *is* of some importance to "know the relative position of the crank and piston in setting valves." One of the uses of the indicator is to ascertain the difference between the action of the steam at either end of the cylinder and that at the other. We have seen diagrams taken by the indicator, from an engine built by a manufacturer whose name on an engine is a guarantee almost of perfection, which showed a difference amounting to one-eighth of the power exerted on the piston. Yet the valves were set, as our corre-