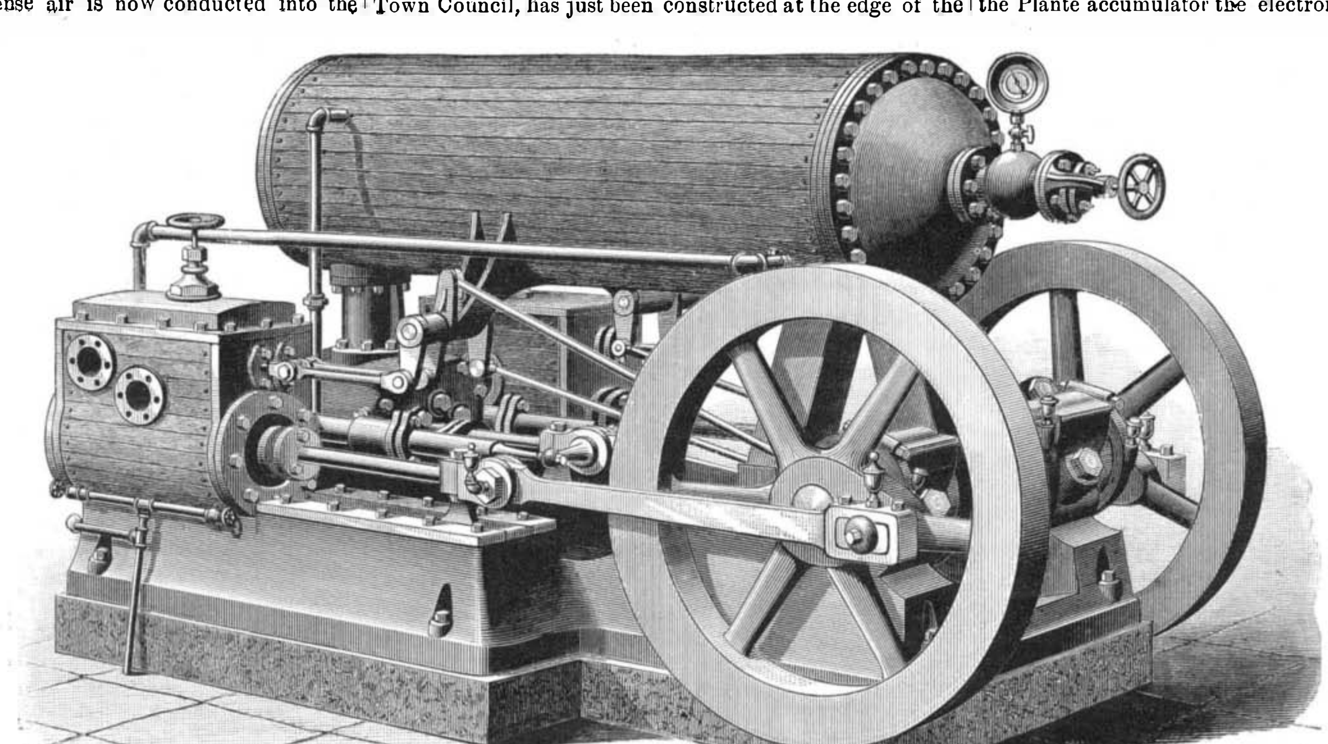
THE ALLEN DENSE AIR ICE MACHINE.

The many advantages which the use of air presents in the working of ice machines have for a long time led inventors to seek a means of applying it without incurring the large losses which have heretofore accompanied its use. These losses were due primarily to the low specific heat of air compared with other cooling gases or vapors, and in consequence thereof the machinery required was large and wasteful of fuel, on account of the large volumes of air required to produce a given cooling effect. In the old form of machines the air was taken at ordinary pressure, compressed, cooled, and re-expanded to ordinary pressure, at which it circulated in the cooling pipes. It will be readily seen, however, that the greater the heat-absorbing power *per volume* of the cooling medium, the smaller will be the volume required to produce a certain amount of cooling effect, and consequently the smaller will be the machinery required to compress and circulate that volume. Since, however, the weight and consequent heat-absorbing capacity of a cubic foot of air at a tension of four atmospheres is four times that of a cubic foot at one atmosphere pressure, it follows that by circulating air at the former tension only one-fourth the volume will be required to do the same amount of cooling.

This latter fact is the basis of Mr. Leicester Allen's machine, for while heretofore air machines have circulated air at or near one atmosphere pressure, the former circulates air at a density of four atmospheres. This obviously gives the machine a great advantage over the older forms, and for the same work enables a machine to be used of only one-fourth the size of those in general use.

The accompanying illustration shows a perspective view of a four-ton machine. It will be seen to be mounted entirely on a single bed plate, thus greatly economizing space. On either side, at the rear, are situated cylinders, one being the steam cylinder, the other the expanding cylinder. Between these two the air compressor is placed, on both sides of which will be seen two small cylinders, the air and water pump, respectively. Above all these stands the large horizontal cylinder, through which water is circulated to cool the compressed air which passes through it in coils. The pistons of the compressor, pumps, and expander are directly connected with the crank shaft driven by the steam engine, as shown, thus giving them a positive motion.

The operation of the machine is as follows: We will assume that the pressure throughout the machine and cooling system is at ordinary atmospheric tension, and the steam engine started; immediately the small air pump at the side of the large compressor begins to force air into the system until a pressure of four atmospheres is reached, when a valve closes automatically and maintains the air in the system at that pressure. This dense air is now conducted into the compressor and compressed to 0·45 of its volume, or to a tension of twelve atmospheres. This heats it, and in order to lower its temperature it is led through coils into the large surface cooler, where the circulating water abstracts its heat and reduces the volume to one-third the initial volume. When cooled, the compressed air is led into the expanding cylinder, re-expanded to four atmospheres pressure, which lowers its temperature, and is then forced out into the circulating coils to cool surrounding objects. This process is a continuous one, and takes place in a closed cycle, no new air being admitted except to replace that lost by leakage, which amounts to an exceedingly small quantity. When it does occur, the valve of the air pump opens a trifle and admits just enough air to keep the pressure up to four atmospheres, when it again closes. By employing a closed cycle in operating the machine, several inconveniences and losses incident to air machines are avoided.



THE ALLEN DENSE AIR ICE MACHINE.

It is evident that while the power required to work a given weight of air between the limits of one and three atmospheres, as in the older systems, is the same as that required to work the same amount between four and twelve atmospheres in the new machine, the *losses* avoided by using the latter are several. In the first place it allows of a reduction of the compressor and expander to one-fourth of their ordinary size. As a result, the surface losses within the cylinders, radiation, etc., are proportionally reduced; while the passive resistances, such as friction, are reduced very nearly in the same ratio. The machine, which we saw in operation requires no more care or attention than an ordinary etsam engine, and when once adjusted will run indefinitely without the necessity of watching.

During one hour of working the temperature of the air delivered at the exit pipe fell from 84° Fah. to —30° Fah., after passing through three-fourths of a mile of piping contained in an ice maker and cool room. It is claimed for the machine that it produces a cooling effect of somewhat over five pounds of ice melted per pound of coal consumed, which efficiency is more than double that of any other machine using air as a refrigerating medium, and the claim, though high, is well within the bounds of possibility.

One of these machines has been in practical use for over six months, and has required no repairs whatever, while two others will shortly be placed in the yachts of Mr. Wm. Astor and Mr. Elbridge T. Gerry. Further information can be obtained of the Allen Dense Air Ice Machine Co., Delamater Iron Works, West 13th Street, N. Y.

An Electric Railway at Brighton, England.

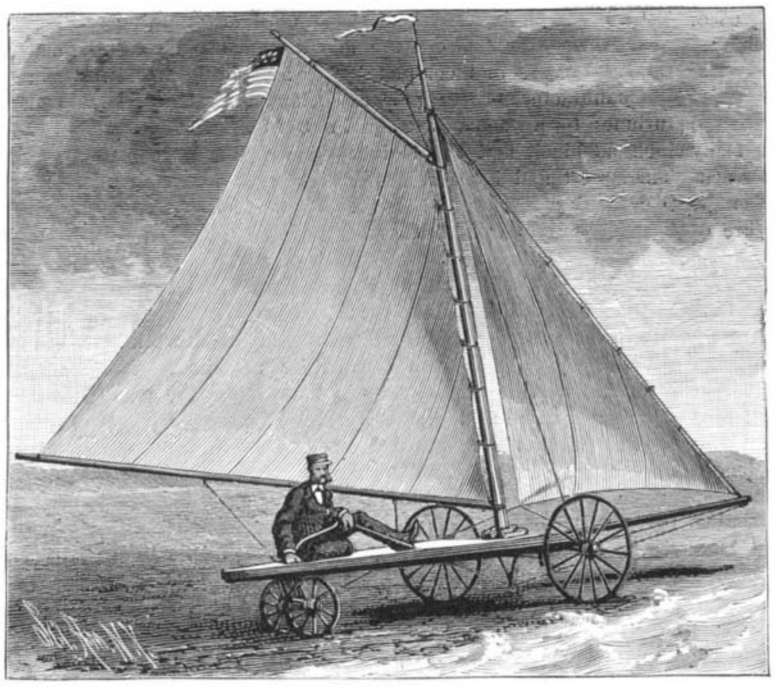
The first journeys were made April 7, on an electric railway about a mile long, which, with the sanction of the Town Council, has just been constructed at the edge of the beach, starting opposite the entrance to the Brighton Aquarium and running eastward. There is a single ornamental car, which will hold about a dozen persons, and the speed is limited to six or eight miles an hour, though a much higher rate can be attained. The scheme has met with a small but vigorous opposition, on the ground that it cuts off access to the beach and will not improve the residential character of the east end of the town. On the other hand, some of the most influential residents at that part have declared that it will be one of the greatest boons ever conferred on the district, as by means of a lift it will make access from the sea to the cliffs easy, and give pleasant communication with the center of the town. Approach to the beach is not stopped, as the line can be stepped across at any point. The car runs almost noiselessly, and is worked by a stationary engine, which sends a current along the metals.

SAIL WAGON.

Across the wide forward end of the triangular frame extends an axle to which wheels are journaled. The short axle of the rear wheels is pivoted by a kingbolt to the narrow end of the frame. To the short axle is attached a gear wheel into which meshes a smaller wheel secured to the lower end of a vertical shaft journaled in bearings fastened to the frame. Upon the upper end of this shaft is a hand wheel or tiller, by means of which the wagon may be guided. The speed of the wagon is regulated by brakes upon the front wheels, connected with an upright lever pivoted in the middle part of the frame and provided at its upper end with a crosshead, so that it can be operated either with the hands or feet. A mast fastened to the middle forward part of the frame is provided with a sail and appliances for raising, lowering, and controlling the sail in the same manner as an ordinary sail boat.

With this construction the wagon can be driven at great speed by the wind, and can be driven with, on, or against the wind, where the beach or road is hard, with as much effect as can a sail boat on the water.

This invention has been patented by Mr. J. A. Aspinwall, of Bay Ridge, N. Y.



ASPINWALL'S SAIL WAGON.

Accumulators.

M. Reynier, the well known electrician, has made experiments on three systems of secondary battery: (1) The Plante accumulator of reduced lead, peroxide of lead, and sulphuric acidulated water; (2) the copper accumulator of lead, copper, lead peroxide, acidulated solution of sulphate of copper; (3) the amalgamated zinc accumulator of zincked lead, lead peroxide, acidulated solution. His object was to test the electromotive forces of the combinations, and find their variations of sulphate of zinc. The accumulators were not completely formed. The electromotive forces were measured during charge and discharge by the method of equal deflection. His results confirm those formerly obtained by M. Gaston Plante, and are as follows:

(1) In the three systems of accumulators studied, the secondary electromotive force is notably more elevated during charge than during discharge. The ratio of the smallest of these values to the greatest may be called the *coefficient of fall*. It is a factor of loss which affects the efficiency of accumulators. (2) The fugitive superelevation of the electromotive force increases with the intensity of the charging current and the electromotive force of the source. (3) In the Plante accumulator the electromotive force is at least 1·95 volts during the charging, and at most 1·85 volts during the discharge. The coefficient of fall is therefore 0·95 under the most favorable conditions. (4) In the copper accumulator the electromotive force is at least 1·43 volts during charging, and at most 1·25 volts during discharge. The coefficient of fall is therefore 0·87 under the most favorable conditions. The copper accumulator is that which loses most. (5) In the amalgamated zinc accumulator the electromotive force is at least 2·4 volts during charging, and at most 2·36 volts during discharge. The coefficient of fall is 0 983 in the most favorable conditions. The amalgamated zinc accumulator is that which loses least. (6) In practice the losses due to variations of electromotive force will be greater than are indicated above, because the times of charging and discharging are generally more rapid than correspond to these experiments.

A FOREIGN contemporary says that a luminous waterproof paper, which may be of use in places not well adapted for the application of the so-called luminous paint, may be made from a mixture of 40 parts pulp, 10 parts phosphorescent powder, 1 part of gelatine, 1 part of potassium bichromate, and 10 parts of water.

AMERICAN INDUSTRIES.—No. 91.

[SEE FIRST PAGE.]

THE MANUFACTURE OF FINE PRINTING PAPERS.

In no other department of industry have there been more marked advances in recent years than in the manufacture of paper. Modern printing presses, and a society of which nearly all are large readers, as well of tastily printed books and periodicals as of the daily papers, have increased the demand many fold within the present generation. It would have been impossible to meet this greatly enlarged call for paper if it were all manufactured of rags, as was the case a few years ago, and to use the cotton, flax, etc., in their raw state would have made the product very expensive; therefore, in this country, wood has been largely used, either in connection with rags or alone for the cheaper grades, and in England the Spanish esparto grass has, since 1856, furnished a very large proportion of all the paper stock. Materials of which paper can be made are found in nearly all vegetable life, but the cellulose is in many cases so intimately associated with coloring and other matters as to require the use of expensive chemicals, while rags, having been originally purified during the manufacture of the cotton and flax, yield a large percentage of fiber with comparatively little cost for chemicals. They give a very pure white with exceedingly strong fiber, and are used alone for only the finest qualities of paper, although pulp from inferior fibers is often mixed therewith in making medium grades of paper. Of the wood used in paper making poplar is most esteemed, as it gives a very white fiber; pine gives a long and strong fiber, but the wood has so much resinous matter that it requires stronger chemicals and more work to fit it for the paper machine. The manufacture of paper pulp from wood is principally confined to the United States and Sweden, though wood pulp is somewhat used by English and European paper manufacturers.

In practical paper making the assorting and dusting of the rags is the first step. They come in great variety, differing according to the locality where gathered, and are divided into many classes and grades, this market receiving many from the Baltic and Mediterranean ports. When stored in large quantities great care should be taken that they are perfectly dry, many fires having occurred from the heat developed by the slow decomposition of rags stored in a damp condition. The sorting of the rags is necessarily done by hand, but cutting them up into pieces about two by five inches or less is now done principally by machine. Both before and after the sorting they are passed through thrashers or dusters, which beat the rags and drive the dust through wire gauze partitions.

The boiling, which comes next, may be done in various kinds of vessels, but a horizontal cylindrical boiler, which revolves, gives a more perfect circulation of the liquor, and is generally preferred. The chemical used is lime, carbonate of soda, caustic soda, or a mixture of the two former, which is equivalent to the latter. The quantities used, as well as the pressure and time of boiling, vary with the quality of rags, and afterward the rags must be thoroughly washed, which is effected by running on water, and with more or less pressure of steam. The breaking and washing usually require from two to four hours, and the machinery therefor is represented at the right in two of our first page views.

The bleaching may be effected with a liquor made by dissolving bleaching powder in water, although bleaching with gas and sour bleaching are sometimes followed, but, whatever the method adopted, any excess of bleaching agent must be got rid of.

The sizing is effected by the precipitation and intimate mixture with the pulp of a substance which will, when dry, to some extent fill up the interstices between the fibers of the paper, and which will not readily take up water. Common resin and alumina, with carbonate of soda, through the medium of a resin soap, make a mixture which may be thoroughly incorporated with the fiber, and it is here that a small quantity of china clay is added, for some qualities of paper, to close up the pores and enable it to take a good surface, such addition, to the amount of five per cent, not being considered detrimental, while more than that would weaken the fiber.

The Fourdrinier paper machine, of which several may be seen in the large view near the middle of the page, forms in itself one of the best representations of the high attainment reached by modern mechanical skill. Improvements have been steadily made in it through many years, for the better working of different kinds of pulp, and the making of a greater variety of product, but the original features of its construction have been maintained. The pulp is fed to it over sand tables and strainers, to remove lumps and imperfections and separate the fibers, then to an endless cloth of very fine wire carried by a large number of small rolls, the wire cloth also having a shaking motion from side to side to weave and intertwine the fibers; thence it passes to an endless felt, traveling over rolls, and between press rolls, till the water is so taken out and the fiber knit together that it can be passed over drying cylinders and between heated and polished rolls for surfacing and calendering. There are, of course, many different modifications of machines, the details being variously contrived for the best results in different kinds of work, but these are the essential features in all of them.

The calendering machines, a view of which is given at the bottom of the page, are for the purpose of giving a hard finish, the paper being here passed around steam heated cylinders and rolls, where powerful pressure can be applied.

The Jessup & Moore Paper Company, whose establishments furnish the subjects of our illustrations, have four paper mills, the Augustine, the Rockland, the Delaware, and the Chester, the two former being on the Brandywine, near Wilmington, Delaware, the Delaware mill on the Christiana River, and the Chester mill near Coatesville, Pa. In selecting a site for a paper mill, it is absolutely requisite to obtain one which shall have an abundant supply of pure water, not only as a matter of economy in working, but fine paper cannot be made at all with the water found in many localities. In respect of this prime essential, these mills have exceptionally advantageous locations.

The Augustine mill was the first built and run by the firm, but it has been successively changed until now nothing remains of the original structure, and it stands to-day one of the most costly and complete paper mills in the world for the manufacture of fine grades of book paper. It has Jonval turbines for a water power equal to 300 horses, besides a 20 inch, a 30 inch, and two 15 inch cylinder Corliss engines. The largest and heaviest leather belt ever then sent from New York was furnished for this mill about five years ago. The engine room forms a striking feature of the establishment. The entire mill is of stone and iron, fireproof, and lighted by electricity, and all the machinery is of the latest and most improved description, the engines for the preparation of the stock being of iron, and there being at work here two 90 and one 76 inch Fourdrinier machines. Many of the most artistic publications in the country are printed upon paper made at this mill, and it has for years furnished the paper for the SCIENTIFIC AMERICAN. The capacity of the mill is 30,000 pounds a day.

The Rockland mill, built in 1860, was designed for the manufacture of newspaper, and was among the first to utilize the process of making printing paper from chemically prepared straw pulp. Reconstructed, after a fire in 1864, of stone and iron, its capacity was greatly enlarged, the straw process abandoned, modern machinery introduced, and good grades of paper for book work and weekly newspapers have since been made. Besides the water power furnished by Jonval turbines there are employed here two 20 inch and a 16 inch cylinder Corliss engine, and one 28 inch cylinder Babcock engine. Three Fourdrinier machines are used, one 74 inches and two 86 inches wide, and the product is 26,000 pounds of paper a day.

The Delaware mill has a production of 32,000 pounds a day, and the Chester mill 8,000 pounds daily, and both are completely equipped with the best modern appliances.

The firm of Jessup & Moore was organized in 1843, by Augustus E. Jessup, of Westfield, Mass., and Bloomfield H. Moore, of Philadelphia, and the corporation of the Jessup & Moore Paper Company was organized December 1, 1878, its officers consisting of C. B. Moore, President; D. W. Evans, of New York city, Vice-President; F. W. McDowell, Secretary; and J. R. Moore, of New York, Treasurer—under whose management the business is still conducted. The business offices of the house are in the Bennett Building, New York, and 28 South Sixth Street, Philadelphia.

The history of this house has been in a marked degree typical of the progress of paper making for the past half century. It has kept fully abreast of the times, and its exhibit of cellulose at the last Paris Exposition was a great surprise to the papermakers of Europe, showing, as it did, that American paper manufacturers were decidedly in advance of their European competitors in the utilization of new raw materials in the manufacture.

Death of a Pioneer in Machine Shoemaking.

Mr. Edwin C. Burt, the widely known New York shoe manufacturer, died at his home in Orange, N. J., May 23, 66 years of age. It is doubtful whether any other manufacturer in this business ever attained the wide reputation which he achieved, in a short space of time, from the success with which he employed the sewing machine in making the finest grades of ladies' shoes. Previous to 1862, when machinery began to be introduced generally in shoe factories, it was not thought possible to make fine goods in this way, but Mr. Burt bought the finest kids and the best sole leather, employed a high class of workmen, and then, himself superintending the work, used machinery to make a finer class of goods than had ever before been offered as ready made, and which was rarely equaled in the best handmade goods. The success which attended his efforts did much to hasten that industrial change from which it now appears that about nineteen-twentieths of all the boots and shoes worn in the country are factory made, and the "bespoke" shoemaker of the olden time has almost gone out of existence.

Annual Convention of Civil Engineers.

The American Society of Civil Engineers will hold its annual convention for 1884 at Buffalo, N. Y., June 10th to 13th. A special train over the New York, West Shore, and Buffalo line will convey members from this section. Reports are expected and discussions will be had on "Standard Time," a "Uniform System for Tests of Cement," the "Preservation of Timber," and other topics.

AN illustrated article on paper making machinery, as manufactured at the Pusey & Jones Works, at Wilmington, Del., will appear in the SCIENTIFIC AMERICAN in next issue.

Science and Manufactures.

There was never perhaps a time when the special industries of England were more depressed, or their outlook more gloomy. The fact that the steel rail makers of England have banded themselves with those of France and Belgium into an association for the maintenance of remunerative prices speaks volumes, not only as to the severity of competition, but as to the sources from which that competition comes. On the other side we see the ironmasters of America extending their output year by year, and her manufacturers entering into competition with us in neutral markets, while jealously excluding us from their own.

What is to be the remedy for this state of things? How is the demand for manufactured articles, and for the raw materials out of which those articles are made, to be once more equalized with the supply? Unless some vast market, such as China or Central Africa, can be opened up to European commerce, the only chance seems to lie in a new departure; in some great cheapening of production, or cheapening of transport, comparable to that which was effected by the development of railways. Now, what is the physical fact lying at the basis of railway locomotion? It is simply this, that iron laid in the form of a track offers a resistance to rolling which, as compared with an ordinary road, is insignificant, while at the same time it offers a resistance to sliding large enough to utilize to the full the vast tractive power of the modern locomotive. The first point had long been known; the second was seized by the practical genius of George Stephenson, and enabled him at once to solve the problem of high speed locomotion. In so doing he owed nothing to science; but science might have discovered the fact, and would have done so with small trouble, if the idea had been put into her head—if, in fact, there had been in England that union of theory with practice which it is our present aim to advocate.

What is wanted now is that science shall point out some other fact of nature, new or old, which practice may seize upon, turn to her own ends, and make the basis of some new industrial development. It is easy to indicate various directions which such a development might take. Thus there is great need of some system of light railways which can be laid down on ordinary roads, and so cheaply that the traffic available on such roads may be sufficient to pay a fair return on the capital. It is impossible to calculate the advantages which would spring from the wide extension of such "third class railways," as they are called in Germany. Again, the storage of power, such as that of the tidal wave, with cheap and ready means for giving it out when and where it is needed, offers a wide field for invention, and may lead to the most fruitful results. The transmission of power to long distances, whether by electricity, compressed air, or otherwise, is a somewhat similar problem, which at present occupies the attention of many engineers and men of science. Lastly, the more homely subject of house building offers at this moment special inducements to constructive genius. If houses could be built, by the use of iron or otherwise, at, say, half their present cost, the problem of sheltering our poor would be solved; unsafe and ruinous tenements would disappear, and a demand would set in for building materials and labor such as the world has never known.

Here, however, the question arises, Supposing that science and art should combine successfully for any such purpose, is it in England that the development will take shape?

At the time of the last industrial epoch, that of the introduction of railways, it would have been safe to prophesy that this would be the case. It is by no means so certain now. As regards cheap transport, for instance, the most promising recent invention in this field, viz., the caustic soda condenser previously described by us, was brought out in Germany. Other improvements in the same field, such as the portable railways of De Cauville, the rack railway of Riggenbach, the cable tramway of Hallidie, the fireless engine of Francq, the iron sleepers which are rapidly becoming universal in Germany, have all taken their rise either on the Continent or in America. The storage of power, in its only practical form, that of the secondary battery, owes its origin to Plante and Faure. The transmission of power is being worked out by Siemens in Berlin, and by Deprez and Tresca in Paris. Lastly, as to building, no one can travel abroad without seeing that as regards scientific architecture England stands far nearer the bottom than the top in the scale of civilized nations.

What is the reason of this? Why is England thus lagging behind in the race? The answer is not far to seek. In America, in France, above all in Germany, the union between science and art is far more close and cordial than with us. Every practical constructor or manufacturer is anxious to know all he can of science, every scientific professor desires to mix practice with his theory. Thus on the one hand we find ordinary engineers drawing on all the resources of mathematics for the solution of such problems as the proper sections of rails or the resistance of trains; on the other hand we see Clausius, perhaps the greatest of German physicists, devoting two long papers to investigate the working theory of the dynamo machine. But a concrete instance will make our meaning clearer. Within the last few days we have inspected a safety lamp, of which some thousands have already been sold for the German mines. It has many points of excellence, but we need only dwell upon one. It is well known to be most important that a miner's lamp should be locked in such a way that he cannot, if he will, open it; and it has been found very difficult to provide any simple kind of lock which it is beyond the resources of a