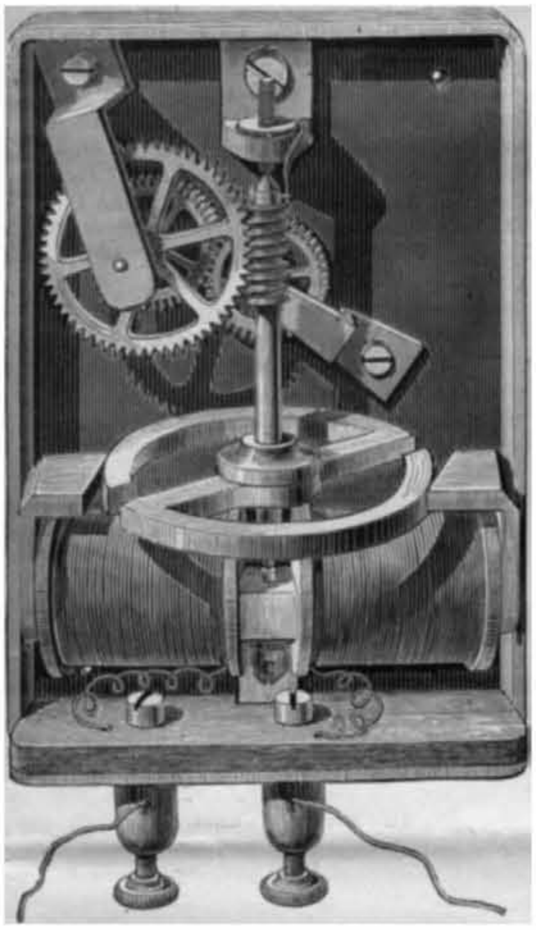
T. Walker, the present contractor. The accuracy with which the lines were taken and the engineering work carried through thus far is, of course, due to the engineering staff—Mr. Charles Richardson, assisted by Mr. A. W. Gooch and Mr. John J. Geach. The land portions of the work remain to be completed, and will, no doubt, occupy a considerable time. The tunnel will also have to be widened to a width of thirty feet, with a proportional height. The completion of the headings is, says the *Engineer*, a fact of great interest from an engineering and geological point of view, and gives every hope that the tunnel will now be completed by Mr. Walker, at a speed which will satisfy even the railway company.

ELECTRIC CLOCK-DIAL MECHANISM.

The construction of a perfect electric clock involves several difficult problems, and it is this which explains in part the existence of a large number of electric clocks varying in



ELECTRIC CLOCK-DIAL MECHANISM.

efficiency according to the attention paid to the fundamental principles which should control their construction.

Electricity actually plays three very distinct characters in the electrical clock, and the Paris Electrical Exposition presents numerous examples of this:

1. Electricity is made use of as a motive power, to swing a pendulum and replace the springs or weights of an ordinary clock.

2. Electricity is employed for transmission. A central clock sends an electric current every second, half minute, or minute, to one or more dials placed at a distance, which causes the hands to advance respectively a second, a half minute, or a minute.

3. Electricity is employed to regulate clocks and dials propelled by ordinary weights and springs, and adjusts the hands every hour, every six hours, or every twenty-four hours. It is this system of synchronism which has been adopted by the city of Paris for the public clocks.

We do not wish to discuss here the respective advantages of the two systems of distribution of time in a city by electric transmission or by electric adjustment effected at fixed intervals. The electric distribution of time has some special advantages which are not possessed by the system of electrical adjustment, and the disadvantages disappear in proportion as the apparatus is perfected and simplified. The pneumatic clock established in Paris two years ago has a transmitter operated by compressed air.

The engraving represents a simple electrical dial mechanism which exactly fulfills the requirements, working surely each minute under the action of the current sent by the central distributing clock.

All of the earlier forms of electrical dial apparatus are operated by an oscillating armature, moved by an electro-magnet and retracted by an antagonistic spring, or two electro-magnets acting upon a polarized armature. The movement of the armature is transmitted to the gearing by the levers and pawls, which must be very perfectly adjusted, as they cease to act if there is a little play, wear, or oxidation. In order to give a slight movement to the armature it is necessary to lengthen the lever immoderately.

All of these inconveniences are avoided in the very simple apparatus of M. Thomas, the mechanism of which is represented in the engraving. It is composed of a horizontal electro-magnet, the poles carrying two armatures, between which is placed a polarized armature in the form of an S, fixed upon a vertical axis. This axis carries an endless screw, which operates the minute hand and gearing. The transmitting clock sends into the electro-magnet alternate positive and negative currents at every half minute. The current sent is such that it develops in the poles of the electro-magnet alternate positive and negative polarity, so that the polarized S-shaped armature is first attracted and then repelled, causing a half revolution of the S-shaped armature for every electrical impulse. The current should continue from two to three seconds, in order that the polarized armature may be maintained in position. The endless screw carries along the gearing and causes the hands to advance each time.

In consequence of its inertia the polarized S shaped armature tends to pass beyond its half revolution, and the speed acquired toward the end of the half revolution is checked by means of a spring against which a pin carried by the vertical spindle strikes at each half revolution.

This simple and ingenious apparatus requires no regulation. The rotation will be produced, whatever may be the distance from the extremities of the polarized armature to the electro magnet, and this distance may vary from one to two millimeters.

The power of the apparatus is determined by the dimensions of the S shaped polarized armature of the electro-magnet, and by the size and length of the wire which surrounds them.

By using a high tension current of electricity a large number of these electrical dial movements may be placed upon the same circuit and made to operate dials of two meters in diameter.

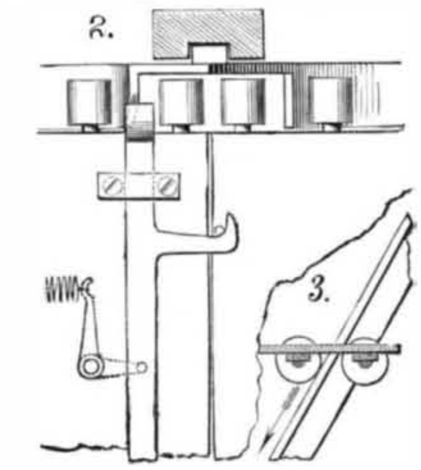
At the Exposition of Brussels, in 1880, where the electric dial mechanism of M. Thomas was in operation for the first time, he had in the same circuit a large dial of 1·80 meters in diameter and eighteen other smaller dials of 0·50 meter and 0·40 meter. They worked perfectly, excepting the five or six interruptions proceeding from the stopping of the transmitting clock caused by the moving of the platform on which the clock was placed.—*La Nature.*

Fire Risks and Tall Buildings.

We have frequently called attention to the fact that modern architecture was the greatest peril with which our large cities is threatened. During the present year, thousands of new buildings are being erected in this city, and of these a large number are tall buildings, seven, eight, and nine stories high, insecurely built from the foundation to the mansard roof, having granite foundations to support cast iron columns, which in turn support iron girders, upon which the floors are laid. Such a building is dangerous for a fireman to enter when a fire is raging within, as the granite foundation is liable to melt away under intense heat, and the iron columns and girders to twist and break, precipitating the floors above, with all their contents, into the basement. Put on top of such a building a mansard roof made of pine, and introduce an elevator shaft to carry the flames almost instantly from one floor to another, and you have a modern death trap that could scarcely be improved upon as a fire hazard, threatening the surrounding buildings and the lives of whoever may venture near it. In the lower part of the city there is one building whose roof is 185 feet above the sidewalk—away out of the city limits—and near by are many others nearly as tall. A fire in that roof would be wholly inaccessible to the firemen, while a high wind would scatter the blazing brands upon the roofs of lower buildings for many blocks.—*Fireman's Journal.*

IMPROVED HATCHWAY DOORS.

The accidents and dangers chargeable to open hatchways are too familiar to our readers to need recital, and it must be acknowledged that the various trap doors, gates, and other appliances in common use for rendering hatchways safe, are deficient in one way or another



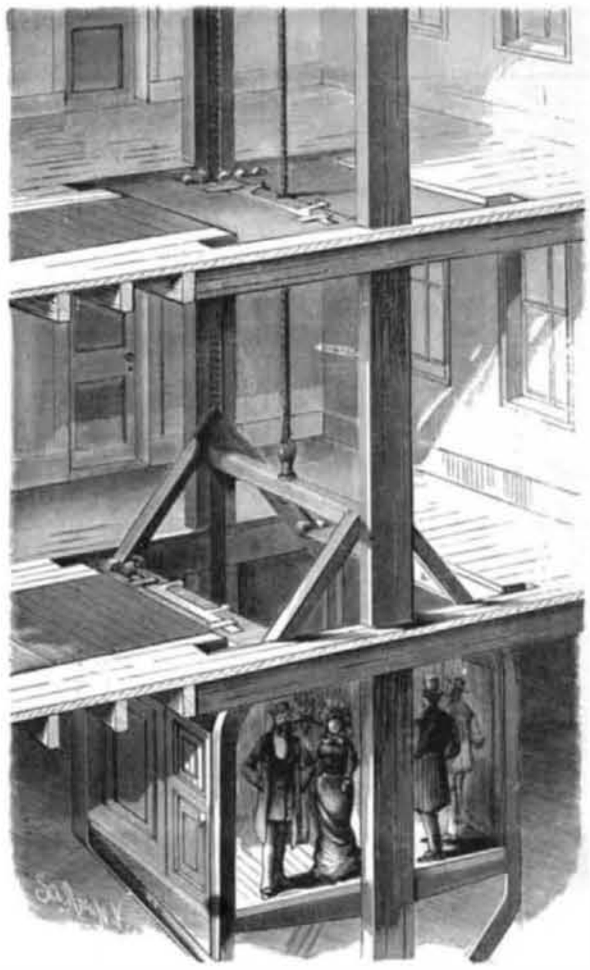
CHAMBERS' AUTOMATIC HATCHWAY DOOR.

Section showing angle irons, rollers, and fastener.

Our engravings represent improved automatic hatchway doors, which are opened and closed by the elevator car as it passes through the floor on which the doors are placed.

The doors are made of heavy boiler iron or of wood, and are placed either under or on the floor, or under the ceiling, as choice or convenience may require, and are so constructed as to easily move or slide horizontally upon rollers or tram-rails. Their operation is positive and automatic. The apparatus is simple, and can readily be applied to any platform elevator already in use. It consists in the attachment of angular irons about the cab or platform so as to form cam braces above and below it, as is indicated in the engraving; and as the platform passes up and down these angular irons run between two wheels or rollers attached to the doors, causing the doors to open as the platform approaches them and close as the platform passes through, making a complete covering for the hatchway—preventing any one from falling through—cutting off draught in case of fire, and when opening conveying safely off any one who may inadvertently stand in the way. Open hatchways become flues, conveying fire and smoke from floor to floor, with uncontrollable rapidity. The improvement shown in the engraving will confine to the floor where the fire originated.

In storerooms requiring heating these doors are found very efficient in preventing the escape of heat from one floor to another. The improvement also prevents the floods of dust and dirt which are constantly pouring through open hatchways.



CHAMBERS' AUTOMATIC HATCHWAY DOOR.

For further information address the Chambers Elevator Company, 145 Central avenue, Cincinnati, Ohio.

Electrical Measures.

At the late Electrical Congress in Paris a committee on electrical units made the following recommendations, which were unanimously adopted: 1. The fundamental units be the centimeter, gramme, and second (C., G., S.). 2. The practical units, ohm and volt, to retain their present definitions. 3. The unit of resistance, or ohm, to be represented by a column of mercury of a square millimeter section at the temperature zero Centigrade. 4. An international commission, to be charged with the duty of determining by new experiments, for practical purposes, the length of the column of mercury, of a square millimeter section at zero Centigrade, which represents the value of the ohm. 5. The name ampère to be given to the current produced by a volt in an ohm. 6. The name coulomb to be the name given to the quantity of electricity defined by the condition that an ampère gives one coulomb per second. 7. The name farad to be given to the capacity defined by the condition that a coulomb in a farad gives a volt. Until something better is discovered than the English candle, the French *Carcel bec*, and the German standard for the measurement of the electric light, preference will be given to the Carcel lamp.

A Can Soldering Machine.

Mr. Henry R. Robbins, of Baltimore, Md., has patented an improved machine for soldering the heads of tin cans to the bodies thereof. In this machine the cylindrical body of the can, having its heads applied, is held in horizontal position, and rotated by vertically moving supports and rotary holders or clamps, while the molten solder is discharged upon the joints of the can heads from an upper receptacle by hollow pistons or chargers which are controlled by the operator. A liquid flux is automatically supplied to the joint and soldering irons brought in contact with the can by the same motion which brings the latter up against the discharge tubes of the molten solder receptacle containing the chargers. A single rotation of the can holders will suffice to secure a firm soldering of the heads to the body of the can, which may then be removed by sliding one of the rotary can holders away from its end of the can. The machine is very ingenious and complete in all its details.

Manufacture of Paper Pulp from Wood.

The invention of wood pulp has revolutionized paper making and paper prices. It has brought good books, good newspapers, and writing paper within the means of thousands of the common people who could never have afforded such luxuries had rags remained the only available material for papers of good quality. Pulp is made from several varieties of wood, and by both mechanical and chemical processes. A chemical pulp from sound poplar wood has no superior.

In the busy manufacturing town of Manayunk, Pa., a few miles up the Schuylkill Valley from Philadelphia, the operations of wood pulp making may be seen on a large scale, in the extensive works of the American Wood Paper Company, where twelve thousand cords of poplar from the forests of Virginia are annually converted into paper fiber. A description of the manufacture as here carried on will afford a fairly representative idea of the methods of this industry at its best development; while certain accessory details will furnish some indication of its commercial importance.

The mills, which are substantially but plainly built—some of the buildings one and some two stories high—spread over a large area in the outskirts of the village. In the ample yards and along the bank of the canal are always piled several thousand cords of wood. This is cut to ordinary cord wood length, along the York and James and Rappahannock rivers, and having been cleanly barked is cheaply floated up the coast and then up the Delaware River to its destination. Yet so great has been the drain, within a few years, that the supply of first class poplar is already approaching exhaustion in the localities named, and before long the army of choppers will have to shoulder their axes and move farther down in Dixie.

The wood once at the mills the operations of pulp making group themselves into three classes. There is first the mechanical process of cutting the sticks into small chips. The conversion of these into pulp constitutes a second distinct set of operations, while a third, also entirely distinct from the others, includes the preparation of the alkali used in reducing the chips—and the reclamation, for further use, of soda from the liquor that drains off from the pulp. We will look at each in turn.

The chipping is a simple operation, soon done with. A stick is placed in a sloping slide or trough, and its own weight holds its lower end firmly against a set of powerful revolving knives, which rapidly cut it at an angle of 45 degrees, across the grain, into chips five-eighths of an inch thick. These fall into the basement, where boys shovel them into cars similar to those seen for wheeling ore in blast furnaces, and they are taken up by elevator to the second story, to be thrown into the digesters. At this point the chemical processes begin. The digesters are upright boilers, the tops being on a level with the second floor Underneath, level with the ground, are furnaces, while above and behind the boilers, on the second floor, are large iron tanks containing the alkali liquor—strong caustic soda—in which the chips are to be boiled. Each tank has an outlet pipe and stop-cock for discharging its contents into the boiler beneath. At the works we are now describing there are thirteen of these digesters, with their corresponding furnaces and tanks. When a digester is to be filled the cover closing the top is removed and the stop-cock opened, allowing alkali to run and mix thoroughly with the chips which are shoveled in at the same time. When full to the top the packing cover is replaced and secured by a strong bar held firmly in place by a heavy nut screwed down tight. The liquor is soon in vigorous ebullition, and the steam pressure is allowed to reach 100 pounds. In this manner the chips are cooked until reduced to a pulp as soft as the most delicate jelly, every trace of resemblance to its original condition having disappeared.

The contents of the boilers are now blown off into strong iron tanks capable of withstanding the steam pressure in the boilers. From the tanks the pulp and liquor are drawn into what are known as pulp cars. These are simply large vats, with perforated bottoms, and mounted on small wheels, each vat having a capacity equal to that of its adjoining tank. The liquor drains off into tanks prepared to receive it, and clear water is then run through the mass of pulp until all traces of soda are washed out, for every particle of that costly chemical is worth reclaiming for further use. The pulp cars are then run out upon turn-tables, from which they are run down a track to the mixer to be thoroughly mixed with clear water, after which it is pumped into the large pulp chest. From the latter it runs into the two pulp dressers, where any bits of undigested wood are intercepted by screen plates. Leaving the dressers in the form of large sheets, it is immediately torn up and thrown into the bleaching engines, where, through the action of chloride of lime, it is freed from all coloring impurities and left creamy white.

The operations are now nearly complete. From the bleaching engines the pulp is run into the drainers—large vats in the basement—where the chloride of lime is thoroughly washed out. Thrown out from these, the pulp is once more mixed up with clear water, and after passing through a second set of pulp dressers, is run through the 84-inch cylinder machine and over the nineteen driers, which convert it into a strong thick sheet, much resembling blotting-paper, except that the surface is harder and smoother. From the driers it is wound on a long reel, and from the latter it passes between knives that divide it longitudinally into three strips, each of which is wound on a cylinder into a roll of about 118 pounds weight. Nothing remains but to wrap the rolls suitably in packing paper and they are ready for shipment.

The interesting operations of reclaiming soda and making caustic soda remain to be looked at. We noticed that when the pulp, having been reduced in the digesters, was drawn off into the pulp cars, the liquor was drained off and clear water run through the pulp to wash out all traces of soda. This liquor is the original caustic soda, mixed with coloring matters and other chemicals in small proportions, boiled out of the chips. The successive washings, of course, contain the same ingredients, only more and more diluted. All these drainings pass into tanks from which they are pumped to the evaporating house, a large dingy structure across the yard from the pulp making buildings. Here are four furnaces, each fitted with a large evaporating pan so adjusted that the flames pass over the pan on their way to the chimney. The hot gases are still further utilized before being allowed to escape by being passed over another set of pans placed high up toward the roof. The liquor is pumped into these upper pans first, where some of the water is evaporated. It is then run down into the furnace pans, where the balance of the water is evaporated and all vegetable fiber burned out, leaving nothing but black soda ash, which is hauled out and thrown on the ground to cool. Care must be taken not to burn the soda.

A large storehouse stands near by, to which this black ash is taken, and where are also kept white soda ash and lime. Passing from this we enter the alkali house. On the upper floor are ten tanks, into which are put water, black ash, lime, and a small percentage of white ash. Steam is applied and the mixture thoroughly boiled until converted into caustic soda, which is simply the hydrate of soda, or soda held in solution in water. It is then run off into vats and left to stand over night to clarify. A sediment sinks to the bottom composed of lime and the coloring matters of the black ash. The clear liquor is drawn off and is ready for use in the digesters. The sediment is thrown into other vats and water run on it to take up any soda remaining, a process which may be repeated several times. The sediment or waste finally thrown out is of no value.

The capacity of these works is eighteen to twenty tons of fine pulp every twenty-four hours. The product is highly esteemed wherever it has found its way for its superior quality. Large quantities are lately being shipped to France. The works were originally run by water power, but the frequent recurrence of low water compelling a shut down of eleven or twelve hours out of every twenty-four, has led to the introduction of steam. The pulp department is now driven by two fire engines of 250 and 125 horse power respectively, and the water which still turns the machinery of the alkali department will soon give way to its more reliable rival. Twenty-five thousand tons of coal are already consumed every year in the furnaces, an amount which will, of course, be greatly increased now that it is also used for motive power.—*Paper World.*

Industrial Mortality.

An English statistician has lately brought out the following fact, which, it is claimed, is a discovery and a fit subject of legislation. It appears that 107,000 men, women, and children have lost their lives or been injured in English mines and factories, on railways, and by boiler accidents during the four years preceding 1877, and on this basis, it is estimated that half a million workmen will lose their lives in ten years—300,000 in mines, 70,000 on railways, and 130,000 in factories.

Another writer sets the figures at a full million, or 100,000 persons per annum in England alone, killed from causes in connection with the industrial occupations in which they are engaged. As much as six-tenths are ascribed to mining accidents. This aggregate is sufficiently appalling, and ought to be inquired into in this country as well as in England, but it is difficult to prescribe efficient legislative measures to meet the case.

It is probable that the diffusion of technical knowledge among all classes of laborers and artisans, and especially the foremen and managers of industrial establishments, would do more than laws, not only to decrease the number of violent deaths, but to ameliorate the sanitary condition of all establishments where tools or machines of any kind are used. The well lighted, well aired, and roomy work-shop or factory, moreover, promotes the production of more and better products than can be expected from dark, damp, and dingy cellars and crowded, ill-ventilated, dirty shops in densely packed neighborhoods. Even the dismal mine may be much improved by the electric light and more efficient ventilating appliances, and the natural result is more safety, better health, and a greater yield, so that once understood no thoughtful manager will need to be driven by law into the adoption of sanitary means.

Steel Breastplate.

Some interesting experiments have been lately carried out in Leipsic with a cuirass made of a newly invented preparation of steel. The metal of the cuirass is only about three-fiftieths of an inch thick, and is lined inside with a thin layer of wool. The cuirass itself is 14 inches wide and 10 inches high, being intended only to protect the heart and lungs, and weighs 2¼ pounds. Eleven rounds were fired at it at a distance of 175 yards from a Martini breech-loading rifle, and of eight bullets which struck the cuirass only two pierced the metal, while even these were completely flattened and remained in the woolen lining, so that a man wearing the cuirass would have been uninjured.

ENGINEERING INVENTIONS.

An improvement in railway air brakes has been patented by Mr. Clarence L. Lorraine, of Oronoco, Minn. The invention consists in a novel arrangement of hanging bars, connecting rods attached to brake beams, and an expansible and contractible air chamber.

Mr. Dyson D. Wass, of San Francisco, Cal., has patented an improved device for removing air and grease from feed water. The invention consists in a chamber into which the pipe from the feed pump conducts the feed water, this water being drawn from this chamber below the surface, so that the oil and grease which rise to the surface of the water cannot leave the chamber with the water. As the air forced into this closed chamber is compressed therein and forces the level of the water downward, a float valve is provided, which opens an air cock to allow the air to escape as soon as the water level drops to a certain extent.

An improved steam engine governor has been patented by Mr. John W. Peck, of Evansville, Ind. This invention relates to devices which are more particularly intended for use in connection with what is known as the "Corliss engine," the object being to provide means for quickly stopping the engine in case of accident. The improvement consists in the combination, with the cut-off valve gear, of one or more independent stop cams, located on the same moving part with the cut-off cams, and a detachable connection with the governor, which transmits the normal action of the governor to the cut-off cams, but which at will may be broken to allow the stop cam to throw the cut-off gear out of action and stop the induction of steam.

Cheap Antiseptic and Disinfectant.

Prof. Beilstein has made comparative experiments with disinfectants, to determine their relative value as such. He arrives at the conclusion that aluminum sulphate is an effective and at the same time the cheapest substance arresting putrefaction. If sufficient time is given for its action (two to three days), a four per cent solution will effect more than a fifteen per cent solution of ferrous sulphate, thereby counterbalancing any difference in price in favor of the latter. Besides, a very crude article might be manufactured from clay and sulphuric acid, which would be very cheap indeed. A four per cent solution of aluminum sulphate will kill all infusorial life, no matter how tenacious. However, this substance has no power of destroying putrid odors, and for this carbolic acid seems to be the only available article. The author inclines to the belief that this disinfectant does not merely supplant foul odors by its own, but that the phenol enters into actual combination with the skatol of the fæcal effluvia. He therefore recommends aluminum sulphate, combined with a little phenol, as the most effectual as well as economical for rendering decaying organic substances both odorless and innocuous.—*Pharm. Centralh. from Deu sche Viertelj.*

Braga Beer.

This is a kind of beer brewed in Russia. C. O. Cech, the editor of the *Russian Brewers' Record,* gives some interesting particulars of the primitive system of brewing adopted in preparing it. In order to obtain 25 wedros (about 2 barrels) of beer, 1 sack of corn, 40 lb. of malt, and 3 lb. of cultivated, or 5 lb. of wild hops, and 40 wedros (about 3 barrels) of water are taken. The whole of the corn and malt is placed in a wooden vat and treated with 30 wedros (about 2¼ barrels) of boiling water; in the meantime the hops are boiled in a copper. In a second vat a layer of straw is spread over the bottom, the latter being provided with a small opening into which a long rod is fixed, which is used as a stop valve. The steamed hops are then brought into this vat, and the sweet wort and boiling water added. The rod is then drawn up, and the hopped wort filters through the straw into a tub. It is again warmed, then brought in contact with the hops and filtered, and this operation is repeated till a clear liquid of aromatic smell has been obtained. One liter (about 1 quart) of yeast diluted with 4 wedros (about 10 gallons) of warm water is now added to the wort, and the whole allowed to ferment for two hours. The beer is then transferred to casks and left to ferment in a cool place, the yeast escaping through the vent hole. After two or three days the vent peg is fastened firmly into the cask, and the beer is ready for use shortly after this time, but it is considered preferable to bury the casks in hay for a short interval. By this treatment the quality and brightness of the beer are considerably improved.

A Prolific Ewe.

Mr. A. Chartraud, of Matanzas, Cuba, reports, in a communication to us dated September 27, the following remarkable behavior of one of his ewes. On the 3d of January last this ewe gave birth to a lamb, which appeared to be strong and healthy, but died in about a fortnight. The ewe appeared to be still with lamb. On the 8th of February she dropped another lamb, which lived and throve. On the 13th of March she dropped two lambs, both living. In September she was again with lamb, and on the 10th she dropped a strong and healthy one. On the 26th she dropped another; and when our correspondent wrote, the next day, she was apparently still "full."

Mr. Chartraud adds: "I have visited numbers of sheep owners, but no one has ever witnessed such a departure from the natural order of things. This makes the sixth lamb since the beginning of the year. I have heard of a foal of four lambs, but all in the same day or period of birth."