was reduced to $\frac{1}{324}$ of its volume by pressure, and by press ure and cold to $\frac{1}{664}$; hydrogen by cold and pressure to $\frac{1}{3}\frac{1}{78}$; carbonic oxide by same to $\frac{1}{278}$; and nitric oxide to $\frac{1}{650}$. Yet it is stated that none of these gases exhibited any appearance of liquefaction. Berthelot also made experiments in the same direction in 1850, and, by means of the expansion of mercury, subjected oxygen, nitric oxide, and carbonic oxide to immense pressures. He concludes "that pressure alone is not capable of effecting the liquefaction of gases under certain conditions of temperature," but suggests that better results may possibly be obtained by the aid of powerful refrigeration. Natterer of Vienna has also made valuable experiments in the same line.

Within the last few weeks the problem which for more than half a century has defied all experimenters has been solved. Almost simultaneously, yet by different methods, the liquefaction of the supposed permanent gases has been accomplished by Raoul Pictet, of German Switzerland, and M. Cailletet, in Paris. M. Cailletet's apparatus consists of a massive steel cylinder with two openings, through one of which hydraulic pressure is communicated. A very strong small tube passes through the other and is inclosed in a freezing mixture. It opens within the cylinder into a second smaller cylinder serving as a reservoir for the gas to be compressed. The remaining space in the large cylinder is occupied by mercury. The gas is compressed into the small tube and then suddenly placed in communication with the atmosphere, when its expansion causes its intense refrigeration.

The original announcement of M. Pictet's discovery is given in another column. The following details are given in *Nature:*

M. Pictet uses four vacuum and force pumps, similar to those used for making ice in his ice machine (which we recently illustrated), driven by an engine of 15 horse power. Two of these are employed in procuring a reduction of temperature in a tube about four feet long containing sulphurous acid. With the pumps at full work there is a nearly perfect vacuum over the liquid and the temperature falls to —85° or —94° Fah. M. Pictet uses this sulphurous acid to cool the carbonic acid after compression, as water is used to cool the sulphurous acid after compression. This is managed as follows: In the tube thus filled with liquid sulphurous acid at a temperature of —76° Fah. there is another central one of the same length but naturally of smaller diameter. This central tube M. Pictet fills with liquid carbonic acid at a pressure of four or six atmospheres. This is then let into another tube 12·8 feet long and 1·2 inch in diameter. When thus filled the liquid is next reduced to the solid form and a temperature of —220° Fah., the extraction of heat being effected as before by the pump.

Now it is the turn of the oxygen. Just as the tube containing carbonic acid was placed in the tube containing sulphurous acid, so is a tube containing oxygen inserted in the long glass tube containing the now solidified carbonic acid. One end of this tube is connected with a strong shell containing chlorate of potash; the other end is furnished with a stop-cock.

When the tube was as cold as its surroundings, heat was applied to the chlorate, and a pressure of 500 atmospheres was registered; this descended to 320. The stop-cock was then opened, and a liquid shot out with violence. Pieces of lighted wood held in this stream spontaneously inflamed with tremendous violence.

M. Cailletet first introduced pure nitrogen gas into the apparatus. Under a pressure of 200 atmospheres the tube was opened, and a number of drops of liquid nitrogen were formed. Hydrogen was next experimented with, and this, the lightest and most difficult of all gases, was reduced to the form of a mist at 280 atmospheres. The degree of cold attained by the sudden release of these compressed gases is scarcely conceivable. The physicists present at the experiment estimated it at —508° Fah.

Although oxygen and nitrogen had both been liquefied, it was deemed of interest to carry out the process with air, and the apparatus was filled with the latter, carefnlly dried and freed from carbonic acid. The experiment yielded the same result. On opening the tube a stream of *liquid air* issued from it resembling the fine jets forced from our modern perfume bottles.

M. Cailletet reports the liquefaction of nitric oxide at 146 atmospheres, and at +12° Fah.; the details relative to the other gases are not yet at hand.

The discoveries of MM. Pictet and Cailletet are of the highest importance, both as adding still further confirmation to the dynamic theory of heat, and as opening the way to new studies into the nature of our atmosphere. They will also tend to induce further examination into Professor Graham's inference of the existence of hydrogen in solid form—a substance which he named hydrogenium—believed to exist in an alloy with palladium, and the density of which he calculates to be 0·733. As it appears clearly from the records of the experiments now at hand that refrigeration—as Berthelot predicted—has more to do with liquefaction than compression, it would seem possible to find a limit for our atmosphere, which could not exist in gaseous form if suddenly dispersed in planetary space. The idea is suggested that a boundary may exist at which, through the intense cold, air is always liquefying, falling, revaporizing, and thus a circulation is constantly taking place.

WHILE this winter may yet be very cold, Professor Smyth's predictions to that effect thus far are hardly verified.

MYSTERIOUS EXPLOSIONS.

A singular explosion occurred in a candy manufactory in this city about a month ago. We adverted to this last week, giving a correspondent's theory, and pointing out that fire officials and other authorities had reached no definite conclusion as to its cause. Investigation as to the inflammable or explosive material in the manufactory has shown that there was chlorate of potash, a small amount of fulminate, used for the making of snap crackers, and a large quantity of starch, from which material moulds are made for candy. These moulds, it appears, after being charged with syrup, are put in a drying room, which is highly heated. And it is stated that in previous fires in candy manufactories, when the flames have reached this room, explosions have occurred. Starch also was probably present in several of the work rooms in the form of fine dust, owing to its being used in this condition in some of the manufacturing processes,

It seems to us that here are quite sufficient data to base a reasonable theory as to the cause of the catastrophe. It may be assumed that accidental conditions were such as to ignite the chlorate of potash or the fulminate, which last would explode with terrific violence, and that thereby the powdered starch in the rooms became fired and also exploded; or the circumstances may be reversed, as it is quite as reasonable to suppose that the starch, being highly explosive in its comminuted state, blew up first, constituting the major explosion, which subsequently involved the chemicals. The examination of the details of many other mysterious explosions fortifies us in the belief that the finely pulverized starch lies at the bottom of this one.

Two years ago just such a casualty occurred in the Pullman Car Works at Detroit. There all the sawdust and shavings from the wood-working machines were taken by exhaust blast into a pipe and forced to the furnaces, where they were consumed. When it was not desired to direct the material into the furnace, communication therewith was closed and a grating prevented the escape of the dust, etc. from the cupola in the roof, to which it was conducted. While cleaning this receptacle the workmen discovered its contents to be on fire, sparks having been drawn in from the furnace. A stream of water was thrown in, but the instant this was done a tremendous explosion ensued, killing 13 men and destroying the adjacent portions of the building. Two months prior to this casualty a similar one occurred at the works of the Milburn Wagon Company at Toledo, where the fine wood dust in a shaft exploded, causing extensive destruction.

Much further evidence can be adduced to show that just as ordinary illuminating gas is liable to explode when mixed with air in the right proportion, so will the dust of any inflammable material. A sawdust explosion occurred four years ago in the town hall of Friedele, Germany. At the Ofen-Pesth (Austria) steam mill a terrific explosion was caused by a cloud of dust of some very fine varieties of flour being ignited by a candle. In 1872, at Glasgow, a flour explosion was caused by sparks from the millstones. Professors Rankine and MacAdam investigated the subject, and found that the rapid combustion of the finely divided flour, as well as the ignition of a mixture of air with the gases furnished by the decomposition of flour and of wood, may produce explosions. Flour and bran mixed gave off at 450° Fah. a gas which, mingled with nine times its volume of air, ignites; and such a temperature may be obtained by friction in the grinding process, or, as might have been the case in the Barclay street disaster, by actual contact of the dust-laden air with a light.

Flour, bran, starch, sawdust, all belong to the same category in this respect. The correspondent whose letter we published last week states that finely pulverized cork in air is also explosive, and that it caused a similar disaster at the Linoleum Company's factory on Staten Island, where it is used in the manufacture of floor covering. In the Grahamite mines of West Virginia an explosion was caused by a dry, resinons, brittle material filling the mining shaft in the form of impalpable dust, which it was afterward found could not be entered with impunity without safety lamps.

We do not doubt but that conditions for explosions of this kind, as well as those tending toward slow spontaneous combustion, often exist over long periods of time in manufactories without the immediate cause of disaster happening to come into action. Probably the rooms in this factory had been filled with starch dust day after day for years, just as rooms in other candy factories now are; but the combining proportions might not have been exactly right, or the misopportune spark might not have been applied. So also in wood-working shops. Under the flooring of many we dare say there are abundant accumulations of sawdust and shavings—perhaps steam pipes are imbedded in this refuse. Inspection may reveal no immediate apprehension of danger, but a few drops of oil may trickle in upon the mass, rapid oxidation may be caused, and a disastrous fire or explosion may ensue. The ounce of prevention in such cases would be worth many pounds of cure.

NOTES OF PATENT LAW DECISIONS.

OF THE COURTS.

In Reissner *vs.* Auness, the suit was brought against the defendant for infringement of certain letters patent, No. 7,751, reissued to John A. Fray, June 19, 1877, for "improvements in coal oil stoves," to which the defendant put in a plea embracing three distinct defenses, namely: 1. That the reissue to Fray was unlawful, because he had previously obtained a patent in Canada for the same invention, granted May 15, 1873, for the term of five years, and the reissue in question was not limited to expire at the same time with the foreign patent. 2. That new matter was introduced into the reissue which was not shown and described in the original patent. 3. That for the purpose of deceiving the public the description in the reissued letters patent was made to contain less than the whole truth relative to the alleged invention. The plea or pleas were set down for argument, and the first question raised was whether the same were not bad for duplicity. The counsel for the defendant insisted that they were not, because, although three distinct matters were alleged against the right of the complainant to recover, they all related to a single defense—to wit, the invalidity of the complainant's patent. The court held that the plea was bad for duplicity, as the several matters, although relating in a general way to but a single defense, namely, the invalidity of the complainant's patent, were essentially independent of one another, and by their retention destroyed the very office of the plea, which was to secure singleness in the issue. The court therefore ordered that the pleas as filed might be set down as an answer at the option of the defendant, or that the defendant might elect within a specified time which of the several grounds of defense he would stand on, and that the other grounds be overruled.

The case of the Gould's Manufacturing Company *vs.* Cowing came up on exceptions taken by the defendant to the report of the master under the interlocutory decree directing an accounting upon the infringement of the plaintiff's patent.

The invention was one only of an improvement in a pump, and not of the entire pump. Numerous parts of the pump were in general use prior to the grant of the complainant's letters patent, and were not claimed therein, and were free to be used by the defendant. The patented invention claimed was a special construction of a side chamber, whereby the same was adapted to use with valve casings bolted on the outside. Held: That the damages could not exceed the profits upon such improvement, and that upon the failure of the complainant to show the profits or damages arising from the use of the improvement, the master should decide that nominal damages only could be recovered; and that it was not sufficient for the complainant to show that wherever the particular patented improvement was introduced other kindred devices could not be sold.

OF THE PATENT OFFICE.

The interlocutory appeal in the matter of the application of Henry Law for letters patent for "improved window blind actuator" has been decided adversely to the applicant.

The claim was for two independent results produced by two independent mechanisms, namely, a device for opening and closing window blinds and a device for locking and unlocking the blinds.

Rule 15 of Office Practice authorizes the claiming of two distinct devices in one application where they are "dependent upon each other and mutually contribute to produce the new result." The question to be determined in the case, therefore, was: Had the applicant combined the two devices so that the operation of each contributed, either simultaneously or successively, to a unitary result?

It appeared that not a single part of the mechanism for opening and closing the blinds was described as affecting the operation of any part of the locking mechanism, nor was the latter dependent on the former in any respect whatever. Both mechanisms performed precisely no other function, when used together on one window, than when used separately a thousand miles apart. The Commissioner held that there was not such an intercommunication of parts or mutual dependence of the distinct devices to entitle them to be incorporated in the same application.

In the interlocutory appeal of Howland, lately decided, the practice of the office in regard to the admissibility of several specific devices embodying the same general features of construction in a single application is laid down as follows: Whenever a generic claim can be predicated which is good in view of the state of the art, and which will include the modifications or specific devices described or exhibited in the drawings, then these may all be retained in a single application; for it is manifest, from the fact that the claim applies with equal aptitude to each, that there are generic features of identity which indicate the same basis of invention. On the other hand, where no claim of the character indicated can be maintained, it is equally true that there is such diversity as will require a division of the application, this restriction being pursued until the matter retained in a single case can be safely said to relate to but one invention, or, in other words, can be contained in the broadest patentable claim that is capable of being drawn to it.

A New and Easily Cleansed Filter.

Filters are liable to become choked with the material which they collect, especially where water is filtered before use in a steam boiler, and the result is that the supply through the stoppage of its conduit is materially diminished. Messrs. Ralph S. Jennings and Norman G. Kellogg have recently patented, both in this country and abroad, an ingenious device which they claim entirely obviates the above mentioned trouble. The filter is provided with a valve and a series of pipes by means of which hot water may at any time be conveyed through the filter. The water enters at the discharge end and passes through to the supply end, where it escapes to a pipe leading to the sewer. The hot water dissolves the various salts hitherto held in solution by the cold water, and mechanically removes all solid matter from the charcoal filling.