that pressure may be and may keep below that necessary for the action of the safety-valve. Things being in this condition, let any cause whatever disturb the equilibrium of the molecules, and all the heat stored up in the liquid mass is instantly employed in producing an enormous volume of steam, while the mass of water not evaporated falls to the temperature corresponding to its pressure.

Figures will easily account for the violence of the explosion which takes place. Let us suppose, in fact, that the pressure in the boiler, before the explosion, was 4 atmospheres, and that the temperature, in the quiescent state of the water, was only 170° Cent. (338° Fah.) As at 4 atmospheres the temperature of the water and steam is 145° Cent. (293° Fah.), each kilogramme of water in the boiler contains 25 units of heat above its normal quantity. Therefore, the moment this heat was liberated, it must have converted into steam $\frac{25}{606{\cdot}5+0{\cdot}305\times145-145}$ or nearly $\frac{1}{20}$th of a kilogramme of water; that is, about one-twentieth of the mass of water in the boiler was suddenly converted into steam.

Now, if we suppose that the volume of water in the boiler was double that of the steam, a quantity of water equal to one-tenth of the volume of the steam is suddenly vaporized; and as, at a pressure of 4 atmospheres, 1 volume of water produces 477 volumes of steam, the volume of the steam will be increased 47 times, and the pressure will be 188 atmospheres. It will be conceived that against such generations of steam, the safety-valves are of no effect, and that the explosions are really fulminating.

This manner of looking at the phenomenon leads to the suggestion of the following precautions. To prevent the *torpor* of the water, let the boiler be so arranged that there shall be a constant circulation kept up by the difference of temperatures of different parts. A second precaution easily taken is never to close a boiler when at rest, hermetically, but to keep the safety-valve slightly raised, or a steam-cock a little open, so that a small quantity of steam may always be forming.

On the Solidification of Carbonic Acid. By MM. A. Loir and Ch. Drion.

From the London Chemical News, No. 84.

In a paper read before the Academy, June 2, 1860, we stated that atmospheric pressure liquefies carbonic acid when its temperature is reduced to the point at which liquid ammonia evaporates *in vacuo.* By slightly modifying the conditions of the experiment, we have succeeded in solidifying carbonic acid with the aid of an apparatus as simple as those daily employed in chemical laboratories. This hitherto dangerous and costly operation may in future be easily repeated to a chemical class.

If liquid ammonia is introduced into a glass globe, and the interior of this put in communication with a good air-pump, by the intervention of a vessel containing coke impregnated with sulphuric acid, the temperature of the liquid is rapidly reduced from the first strokes of the piston. The liquid begins to solidify towards — 81°; it soon becomes a mass, and if the air-pump allows the reducing of the pressure to about a millimetre of mercury, the temperature of the solid ammonia becomes lowered some degrees more and reaches — 89·5°. This suffices to determine the liquefaction of carbonic acid under atmospheric pressure. We have, in fact, proved that carbonic gas liquefies by passing a current of the dry carbonic acid gas into a small U-shaped tube, immersed in ammonia; but as the temperature obtained is only a few degrees below that of saturation, we get only a small quantity liquefied. If, on the contrary, a slight elevation of pressure is employed, the experiment becomes easy, and yields in a short time notable quantities of solid carbonic acid. The following is the manner of operating:—Introduce about 150 cubic centimetres of liquid ammonia into a reversed glass receiver, the sides of which are cemented to a plate with two holes. In the central opening fit a glass tube, closed internally, and reaching the bottom of the receiver, the other opening serving to place the interior of the receiver in communication with the pneumatic machine. Carbonic acid is produced by heating previously dried bicarbonate of soda in a copper retort, the neck containing fragments of chloride of calcium. One part of this retort communicates by a leaden tube on one hand with the tube which is immersed in liquid ammonia, on the other hand with a small manometer of compressed air. The air being previously expelled from the apparatus, and the temperature of the ammonia lowered to about the point of solidification, the retort is heated, noting meanwhile carefully the pressure. The pressure is thus maintained between three and four atmospheres. Rapidly augmenting transparent crystals soon appear on the sides of the interior tube, so that in about half an hour all that portion of the tube which is plunged in ammonia becomes covered with a thick stratum of crystals (about 25 grammes). The experiment may then be concluded and the apparatus dismounted.

Solid carbonic acid, obtained under the above mentioned conditions, appears a colorless mass as transparent as ice. It is easily detached from the sides of the condensing-tube by means of a glass rod; it then divides into large cubic crystals, each side about three to four millimetres. Exposed to the air, these crystals slowly return to their gaseous state; they evaporate, leaving no residue. Placed on the hand, they communicate no immediate sensation of heat or cold; they are with difficulty held in the fingers, and with a slight pressure escape as if covered with an unctuous matter. If one of these crystals is kept between the thumb and forefinger, it soon produces an intolerable burning.

An experiment was performed by placing a certain quantity of solid carbonic acid in a small glass tube communicating with a receiver filled with mercury. After some time the crystals disappeared, leaving no residue, while the receiver was filled with perfectly pure carbonic gas, capable of being completely absorbed by potash. Mixed with ether, in a small porcelain crucible, these carbonic acid crystals yield a freezing mixture of a temperature of — 81°.

As a conclusion to these summary indications we will add that the liquid ammonia used in our experiments was prepared by M. Bussy's process,—that is to say, by acting on ammoniacal gas in a globe surrounded with liquid sulphurous acid, the evaporation of which is expedited by an air-pump. By this method nearly two decilitres of liquid ammonia can be easily obtained in less than two hours.

We determined the temperatures here indicated by means of an alcoholic thermometer, on which we marked two fixed points,—that is to say, 0° at melting ice, and —40° at the temperature of melting mercury.—*Comptes Rendus.*

On the Boiling-points of Liquids. By M. L. Dufour, of Lausanne.

From the Lond. Chemical News, No. 84.

It is an established fact that the temperature of boiling water, instead of being always the same, or varying only with the atmospheric pressure, differs according to the vessel in which the liquid is heated. For instance, water boils sooner in a metal than in a glass vessel, and M. F. Marcet's numerous experiments (*Bibliothèque Universelle*, vol. xxxviii. p. 381) have shown, amongst other things, that the treatment a glass vessel has undergone (as washing in sulphuric acid, &c.) causes several degrees of variation in the boiling point. Water deprived of the air dissolved in it can be re-heated considerably above 100° C. before becoming gaseous, but then it boils violently. Donny, in his interesting experiments (*Annales de Chimie, et de Physique*, third series, vol. xvi. p. 167), carefully heated water completely freed from air, to 135° before a change of condition took place. This retardation of ebullition is manifested also by other liquids, and the production of vapors by starts is a frequent sign of it in glass vessels.

In the actual state of things, boiling produced at a higher temperature than that at which the elastic force of the vapor of the liquid is equal to the external pressure is generally considered as an anomaly due to two causes,—first, the adhesion of the liquid to the substance of the vessel; secondly, the absence of air in solution. There are, however, some curious facts, which show that the adhesion of a solid and the absence of air in solution are inadequate to explain the retardation in boiling; but on the contrary, contact with a solid produces an immediate and decided formation of vapors. If a few drops of water are dropped into linseed oil, heated to 105° or 110° in a porcelain capsule, they fall slowly to the bottom of the vessel. The instant they reach it, vapor is formed suddenly; the slightly diminished drop of water rebounds several millimetres from the bottom, then falls again, causing another disengagement of vapor; again it rises, and so on. Now, it must be remarked that the drops of water, while floating in the oil, before touching the bottom of the vessel, undergo no perceptible evaporation, and that it is only on their contact with a solid that there is a sudden production of a bubble of vapor.

It will, then, be asked, What would happen were the water, while being heated, kept away from the sides of the vessel, floating freely in a medium of a density equal to its own? The proper medium to be employed in these experiments ought to be able to bear temperatures above 100° without boiling, to be about the same density as water, and not to mix with water. Oils will not do, but certain essences sufficiently fulfil these conditions.

Essence of cloves, with a little oil added, forms a liquid in which water maintains its equilibrium in perfectly rounded drops, and moving about freely in the interior. Carefully heated, the mixture always passes 100° C., and sometimes goes much higher, before the water boils. It is easily and constantly raised to 120°, 130°, and even higher. I have many times raised the temperature of aqueous globules of ten millimetres in diameter, to 140° and 150°. Minute globules, from one to two millimetres in diameter, have several times reached 170°, and even 175°,—that is to say, to temperatures at which the elastic force of aqueous vapor is more than eight atmospheres. I am speaking here of water which has undergone no preparation, which has been neither distilled nor freed from air. At these high temperatures the globules do not undergo, as might be imagined, slow and continuous ebullition; they are as quiet and limpid at 150° as at 10°; it is rather the liquid state continued much beyond the limits corresponding to the pressure under which the operation is performed.

Ebullition is produced when the globules come in contact with a solid. If, drawn by the currents which heating inevitably occasions, they strike against the sides of the vessel or the bulb of the thermometer, there is suddenly formed a bubble of vapor; the globule, become rather smaller, is projected violently from the point at which it produced this kind of explosion, and then continues floating in the medium. The result is the same if, when the temperature is above 115° or 120°, a globule is touched with a glass or metal rod; an explosion is produced at the point of contact, a bubble of vapor is disengaged and passes through the essence, and the globule touched rebounds as though the solid point exercised a sudden repulsion over it. However, all solids are not equally efficacious in producing this change of state; glass or metal rods sometimes fail, but a slender wooden or charcoal stick always incites an immediate and tumultuous ebullition in the middle of the overheated globules. Contact with saline crystals is generally very efficacious.

It is difficult to preserve large globules from contact with the sides; hence they are the seat of the formation of vapor on one point of their surface, which has the effect generally of breaking them up into smaller globules. In my experiments, the vessels employed were small glass globes, and I have already easily obtained a globule of eighteen millimetres, at 130° C., and others of six to ten millimetres at 150° C., &c. The smallest globules most readily escape contact with the sides, and can be submitted to a higher temperature.

It may well be supposed that the preceding facts may be realized with other liquids if heated under proper conditions. This supposition is confirmed by the experiments I am now making. For instance, chloroform, heated in a concentrated solution of chloride of zinc, easily reaches 90° and 100°. The chloroform globules float lightly in this liquid, like water globules in essence of cloves. Beyond 70° contact with a solid rod produces decided and violent evaporation.

It is difficult not to connect these facts with those in which contact with a solid causes the crystallization of super saturated saline solutions, and also the sudden solidification of water, sulphur, &c., when brought below their ordinary temperature for solidifying. It is equally difficult to disconnect them from the facts which I have lately had the honor to bring before the Academy,—facts which showed that liquids resist solidification when immersed in a fluid medium. It appears that contact with a solid determines a change of state in liquids, and it may be that the limits of temperature assigned to the various conditions of bodies are not so absolute as they seem. Our experiments on liquids, always made in vessels in contact with solid bodies, may perhaps have led us wrongly to consider, as inherent properties of the liquids themselves, the phenomena resulting, at least in part, from the presence of solids. Thus, when water floats freely in a fluid it rarely freezes at 0°, and it is only changed into vapor at a point of the thermometric scale always exceeding 100°.—*Comptes-Rendus.*

Preservation of Meats.

At the last meeting of the Society for the Encouragement of National Industry, M. Peligot read the following note of M. Martin de Lignac on his new patented process for the preservation of meats:—

In the usual way of salting, the meat is placed first in salt and afterwards in the pickle. The salt absorbs the liquids in proportion as they separate from the flesh, then the pickle penetrates by endosmose, and preserves them from any subsequent alteration by its antiseptic properties. But in this case, the salt acts on the surface a long time before it penetrates to the centre, whence results an excess of salt at the surface, whilst the centre is not sufficiently salted and still contains the principles of fermentation. To avoid this, the habit is to cut up the meat, but this, while it increases the chances of its preservation, greatly alters its quality. In fact, the salt in contact with large surfaces absorbs too largely the liquids contained in the flesh, and extracts from them the aroma and a portion of their nutritive juices. Pork, the tissue of which is dense and protected by fat, bears this preparation better than beef, the flesh of which after long standing in the salt, presents only a fibrous tissue without flavor and with but a low nutritive power.

It results from these facts; first, that meat preserved by the usual process contains necessarily too much salt, and that its prolonged use is injurious to health; secondly, that it loses a part, sometimes a notable part of its nutritive value.

The method of avoiding these inconveniences is to salt uniformly and not subdivide too far the meat, thus preserving its aroma and its juices; I think that I have found the solution of this problem, and the following are the means which I employ:

If it is a ham which I wish to salt, I introduce, by means of a trocar, between the bone and the muscle at the small end, a sound which I attach to a stop-cock which communicates by a tube with a reservoir of water saturated with salt, to which are added various aromatics and condiments. The reservoir is from 25 to 35 feet high. When the stop-cock is opened, the liquid by its pressure rapidly separates the muscle, and the two or three ounces of pickle which are necessary for the preparation of one pound of meat, are easily lodged in the cellular tissue which surrounds the bone. Thence it forms a kind of reservoir, the liquid spreads penetrating all the fibres by infiltration, distributing regularly and homogeneously the conservative agent, and producing its first effect upon the parts most susceptible of alteration, that which surrounds the bone. The ham thus prepared is put for some days in a pickle-bath. The object of this bath is to prevent by its pressure, the issue of the liquid injected; besides which it completes the preparation by saturating the surface. When they leave the bath, the meat has lost nothing of the weight which it had at its entrance. I then expose it to a current of air at a moderate temperature. When by evaporation, they have lost the infiltrated liquid and 5 per cent. of their normal weight, I expose them to the action of smoke for a time which varies with their weight. This latter operation is not necessary for their preservation, but it gives them a taste which is generally sought for, and effects a reduction of weight. On leaving the smoke-house they have lost from 12 to 15 per cent. of their weight; before entering they had already lost about 5 per cent., so that their whole loss is from 18 to 20 per cent.—*Cosmos.*

For the Journal of the Franklin Institute.

Decision of the U. S. Patent Office on the Application of W. J. Cantelo for a Patent for Manufacturing Cordage, Paper, &c. April 15, 1862. Reported by H. Howson, Esq., Philadelphia.

On Appeal to the Examiners in Chief.

The applicant claims to have discovered that cordage, paper, &c., may be manufactured to advantage out of the hibiscus moscheutos, or hibiscus palustris, and he describes the process, in which there is no especial novelty, and claims a patent. The objections raised against his petition are threefold.

In the first place, it is said that a patent has been already granted to one Jean Blanc, 24th June, 1851, for the manufacture of cordage, &c., out of the okra plant, or hibiscus esculentus. This is of the same botanical genus as the hibiscus moscheutos, and it is asserted that in plants of the same genus, the resemblance between their properties is so uniform and so great, that those that are found in any one may be presumed to exist in every other of the same genus. This can hardly be said to hold true in all cases, nor in so large a proportion as to furnish any rule. The genera of plants are arranged according to certain distinguishing features in them, which by no means indicate their peculiar characteristics.

It is true, that in some cases those of a particular genus are, many of them, found to possess common qualities. But this is by no means universally true. The vegetables of many of the genera are widely different in their virtues and powers. The broomcorn, for instance, would never lead any one to suspect the peculiar merits of the Chinese sugar cane, the sorghum saccharatum, although both are of the same genus. Many other examples of this might be named. And the number of species under each head is so great, that it would be entirely unsafe to infer the character of one from that of another, and unjust to deny invention to him who discovers in one, the properties which had before been known to exist in another. The application of J. B. Read, rejected 14th February, 1859, for making paper out of the okra plant, which was mentioned, must be disposed of upon the same considerations.

Reference was made also to William Johnson's English patent, No. 135, for 1855, for manufacturing paper, &c., out of plants of the order Malvaceæ, which embraces among several other genera that of the hibiscus. But if we cannot infer from the nature of one plant, that of another of the same genus, much less can we that of others of the same order. In fact, plants which possess hardly any useful properties in common, are frequently embraced under this division. It may well be questioned, therefore, whether a patent which supposes all the plants of an order to be capable of the same uses, can be valid. Certainly it cannot be, unless the supposition is true. Now there are many of the Malvaceæ which have no such supply of fibre, as to warrant any attempt to manufacture them into cordage or paper. Add to this the fact, established by affidavit, that the hibiscus moscheutos is not indigenous in England, and is known only as a rare exotic, if at all, and the supposition that it is embraced in the English patent, becomes manifestly preposterous. Another reason for disregarding the English patent is, the very large number of vegetables embraced in it. It cannot be well supposed, that any one person can have ascertained the nature of every species, included under the various divisions named, so as to ascertain how far each is available for the object in view. The conviction must force itself upon every one, that many of them are named merely from conjecture. To allow any one to monopolize the use of all that may come within the description, without distinguishing those that are of use from those that are not, is an abuse of the patent law, which ought not to be sanctioned.

It is further alleged, that the capacity of all vegetable fibre to be manufactured into paper has become so well established, that the selection of any particular plant for that purpose is no longer regarded as deserving of protection.

It has always been the practice of the Patent Office, notwithstanding, to reward any one who discovers that any particular plant possesses properties especially favorable for any manufacture. The patent of Jean Blanc shows this, and there are many others of the same kind.

It is considered that there is error in the decision of the Examiner, and it is reversed.

New Chronograph.

M. Lissajous presented to the Academy of Sciences of Paris, in his own name and that of Captain Schultz of the Artillery, a new instrument for measuring small intervals of time, by which he proposes to estimate accurately the five-hundred-thousandth part of a second. The instrument is to be composed (for it is not made yet) of, 1, A silvered drum about 40 ins. in circumference, which is to be coated with lampblack for the experiment: it makes three turns per second. 2, A tuning-fork giving five hundred vibrations per second, with the electric apparatus for preserving its vibrations according to the plan of M. Lissajous; a point fixed upon this, marks on the drum during the experiment. 3, An electrical apparatus to give a spark at the beginning and end of each phenomenon according to the plan of M. Martin de Brettes. That which characterizes the new apparatus is the length of the line on the drum, which corresponds to the very short duration of the phenomenon, and the facility of dividing it by the microscope.

Cosmos.

[This appears to be an improvement on the electric chronograph of Prof. Henry—described in the Proceedings of the American Philosophical Society, and which has been so extensively re-invented without acknowledgment in France, England, and elsewhere.

ED. JOUR. FR. INST.]

On the Manufacture of Strings for Musical Instruments, and other uses, of Gut and Sinew.

From the Lond. Mechanics' Magazine, December, 1861.

A manufacture of which comparatively little is known, is the preparation of the substance usually termed catgut, though for the most part made from the dried, twisted, peritoneal coverings of the intestines of sheep. Catgut cord is used for a variety of purposes where strength and tension are required, as for the strings of musical instruments, for suspending clock-weights, bow-strings for hatters use, and for archers bows.

The manufacture of musical strings requires a great amount of care and skill, both in the choice of materials and in the manufacturing processes, in order to obtain strings combining the two qualities of resistance to a given tension and sonority. Until the beginning of the last century, Italy had the entire monopoly of this trade, and they were imported under the names of harplings, catlings, lute-strings, &c.; but the trade is now carried out with more or less success in every part of Europe. However, in the opinion of musicians, Naples still maintains the reputation of making the best small violin strings, because the Italian sheep, from their leanness, afford the most suitable material; it being a well ascertained fact, that the membranes of lean animals are much tougher than those of high condition. The smallest violin strings are formed by the union of three guts of a lamb (not over one year old), spun together.

The chief difficulty in this manufacture is in finding guts having the qualities before mentioned—namely, to resist tension, and giving