CAILLETET'S APPARATUS FOR THE LIQUEFACTION OF GASES.

On the occasion of the Easter sessions of the Physical Society of Paris, Mr. Cailletet exhibited in the halls of the Observatory the apparatus that he used for demonstrating the fact that all gases (even oxygen, nitrogen, and hydrogen, that were formerly regarded as permanent) obey the general law, and may, like all other bodies, exist in three states—solid, liquid, and gaseous. As we have already described this apparatus, we shall not dwell upon it now, but shall merely say that it is at present in use in all laboratories, and that it has recently been applied in some interesting biological researches. Mr. Regnard, at the Sorbonne, and Mr. Certes, in conjunction with Mr. Pasteur, are studying life under high pressures, and are readily obtaining in the receiver of the apparatus such phenomena connected with pressure as were observed by Mr. Milne Edwards during the submarine explorations of the Travailleur and the Talisman.

With Mr. Cailletet's apparatus it is possible to obtain pressures of more than one thousand atmospheres and to maintain these for weeks at a time. Herein is a new and fertile field of research which promises results of great interest to science.

Mr. Cailletet likewise exhibited the mercurial piston pump that he employed for liquefying large quantities of carbonic acid and protoxide of nitrogen for use in laboratories in the production of low temperatures, and for condensing in strong steel receivers the ethylene and formene that permitted him to lower the temperature of substances to much below the point that had ever before been reached. Ethylene, or bicarbonated hydrogen, requires for its liquefaction a much greater pressure than that which is necessary for the condensation of carbonic acid, but the operation is easily effected with Mr. Cailletet's pump, this, when actuated by manual power, being capable of furnishing more than 500 grammes of ethylene per hour. As well known, all solids or liquids, upon entering the gaseous state, absorb a large amount of heat. Alcohol, or better still ether, when poured into one's hand, produces a sensation of cold, and, in surgical operations, this may be carried so far as to deaden all pain through the paralysis of the organs that are to be operated upon. The depression of temperature that ethylene effects upon evaporating is —104°; and, when its ebullition is hastened by means of an air pump (as Faraday pointed out with regard to protoxide of nitrogen), we obtain —142°. Upon cooling a glass vessel containing hydrogen in ethylene boiling at the pressure of the atmosphere, Mr. Cailletet perceived, at the moment the pressure began to diminish, that the liquefied oxygen was assuming the gaseous state and foaming just as champagne wine does upon coming from the bottle. Subsequently Mr. Wroblewski and one of his compatriots, in operating with the Cailletet apparatus, and with the use of a vacuum for hastening the evaporation of the ethylene, succeeded in obtaining quite large quantities of liquefied oxygen.

Under such effect of cold, nitrogen, oxygen, and atmospheric air resolve themselves into colorless, transparent liquids, of extreme mobility, which, upon passing over to the gaseous state, become the source of a cold that descends to —200°. Prof. Olszewski, of Cracow, announced last week at the Academy of Sciences that hydrogen, the most intractable of gases, when submitted to this excessive degree of cold, condenses in the form of a transparent liquid, which, at the moment of expansion, flows over the sides of the glass vessel. Hydrogen is not, then, a solid metallic body, as has been believed, but seems to be, as far as its appearance is concerned, in all respects like liquefied oxygen and nitrogen.

Formene, or marsh gas, can be obtained in a liquid state only at a low temperature and under a high pressure. The experiments that Mr. Cailletet has performed upon this gas have shown him that it produces, upon boiling, a much intenser cold than that obtained through the ebullition of ethylene.

The apparatus that have hitherto been employed for liquefying gases through compression have presented serious drawbacks—the dead space that always exists between the compressing cylinder and the bottom of the pump chamber limiting the pressure that is obtainable. Mr. Cailletet has completely surmounted this serious trouble by substituting a mercurial piston for the use that has generally been employed. A cylindrical rod, A (Fig. 2), covered with mercury, has an alternating motion in a cylinder, B B, and the compressed gas raises an ebonite valve, S, and flows through a tube, T, into the steel receptacle that is to hold it.

The dead space is thus avoided, since the mercury, upon touching the valve, S, at every revolution of the pump, permits not a trace of gas to remain in the cylinder. Pieces of leather, *a* and *b*, placed at the base of the cylinder, prevent a re-entrance of the air during suction and an exit of the gas during compression.

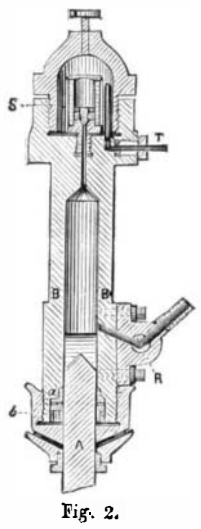


Fig. 2.

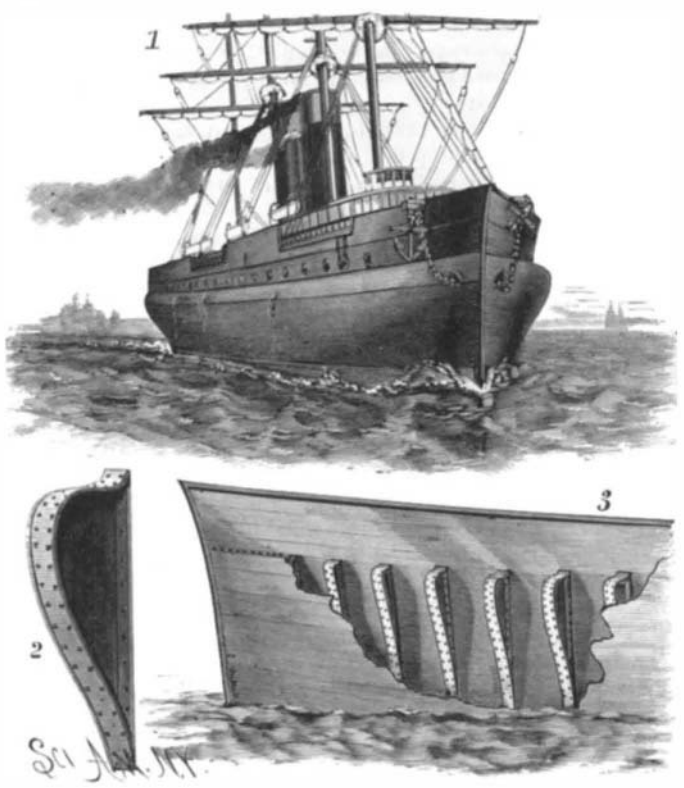
Mr. Cailletet has also substituted a sort of cock, R, for the suction valve of the former apparatus, and this is opened and closed by cams arranged upon the shaft of the fly-wheel.

In Fig. 1 we show the arrangement employed for the production of liquid carbonic acid. The gas, which is prepared by the action of hydrochloric acid upon white marble, is washed in a bottle having two tubulures, dried over calcium chloride, and then sucked up by the pump and forced into a steel flask which is kept cool in a mixture of ice and salt, thus singularly facilitating the liquefaction. One man, by turning the winch affixed to the flywheel, can manufacture from 400 to 500 grammes of liquefied carbonic acid per hour.

The protoxide of nitrogen, as well as the other condensed gases that are employed for obtaining very low temperatures, must be prepared beforehand and stored up in gasometers. Their liquefaction presents no peculiarity, and the pressure that they are undergoing is made known at every instant by the metallic pressure gauge affixed to the apparatus.

In short, Mr. Cailletet's pump is simple in construction and very compact. It is very easily maneuvered, and the use of it has permitted of the liquefaction of not only carbonic acid and protoxide of nitrogen, but also of the ethylene that is used for preparing liquid oxygen.—*La Nature.*

NOTE.—In the SCIENTIFIC AMERICAN of June 21, are illustrations of the industrial applications of the Cailletet process.



LAMBART'S WATER-TIGHT COMPARTMENTS FOR STEAMSHIPS.

NOVEL ARRANGEMENT OF WATER-TIGHT COMPARTMENTS.

The accompanying engraving shows the arrangement of water-tight compartments for steamships, designed by Mr. O. H. Lambart, of Vinelynne, New Edinburgh, Ontario, Canada. The upper figure shows a vessel built in accordance with these plans; Fig. 2 shows the air-tight partition, and Fig. 3 the hull, part of the plates being broken away to show the construction and arrangement of the compartments. The water-tight compartments completely surround the ship, thereby very much reducing the danger of foundering at sea. The designer claims that in case of a collision not many of the compartments could be destroyed at once; that the hull would have an outside protection; and that in case an aperture were made below the water line and the ship were to fill with water, the rim of compartments surrounding the ship would keep her afloat.

It will be observed that this method of building does not interfere with the buoyancy of the ship, since the space occupied by the chambers is above the water line. Neither does this method impair her sailing qualities nor destroy the elegance of her lines.

Serious if True.

The *Insurance Critic* asserts that there are more than 10,000 steam boilers in New York city, attended by 7,000 men, of whom not one-seventh are believed to be trustworthy and qualified for their responsible work; and yet dynamite cartridges are a terror to many people.

Gelatine Dynamite.

Explosive gelatine, or gelatine dynamite, is the result of the solution of from 7 to 8 per cent of collodion cotton in nitro-glycerine. When, however, less than that quantity is taken, the substance becomes less firm, and if from 2 to 3 per cent only is used, the product is simply a thickened oil, or gelatinized nitro-glycerine. This gelatinized nitro-glycerine has the great advantage of being capable of being absorbed and retained completely by a much smaller quantity of other substances than nitro-glycerine, and it is possible, therefore, to prepare stable mixtures of an explosive base and gelatinized nitroglycerine. The Nobels now prepare three grades of these new extra dynamites: No. I. consisting of 64·5 per cent of gelatinized nitro glycerine, and 35·5 per cent of an absorbent containing 75 per cent of potash saltpeter, 24 per cent of wood shavings, and 1 per cent of soda; No. II. being composed of 45 per cent of gelatinized nitroglycerine and 55 per cent of above absorbent; and No. III. being a mixture of 14 per cent of ordinary nitro-glycerine and 86 per cent of an absorbent containing 70 per cent of soda saltpeter, 15 per cent. of sulphur, 14 per cent of charcoal, and 1 per cent of soda. With a charge of 20 grammes the volume of the cavity in the lead cylinders had expanded, using No. I., from 15 cubic centimeters to 1,229 cubic centimeters, No. II. to 886, and No. III to 466 c.c.

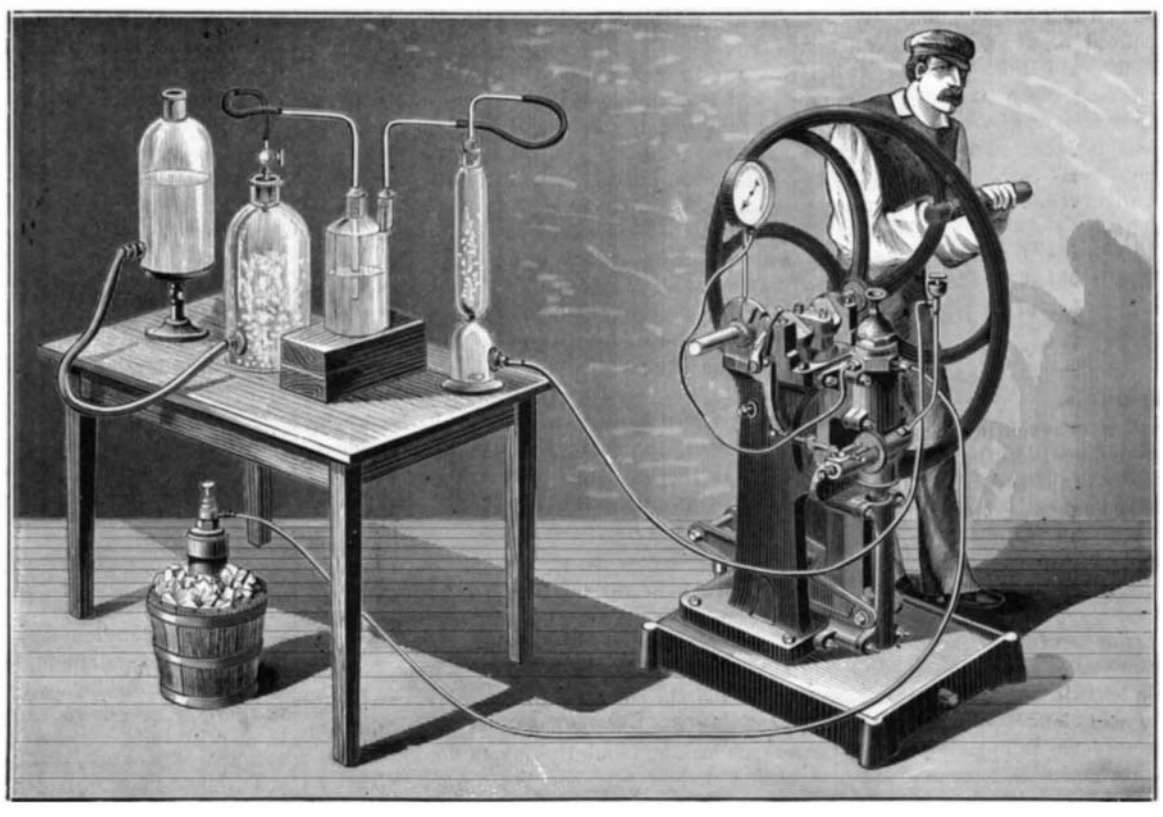


Fig. 1.—CAILLETET'S NEW MERCURIAL PUMP FOR LIQUEFYING GASES.