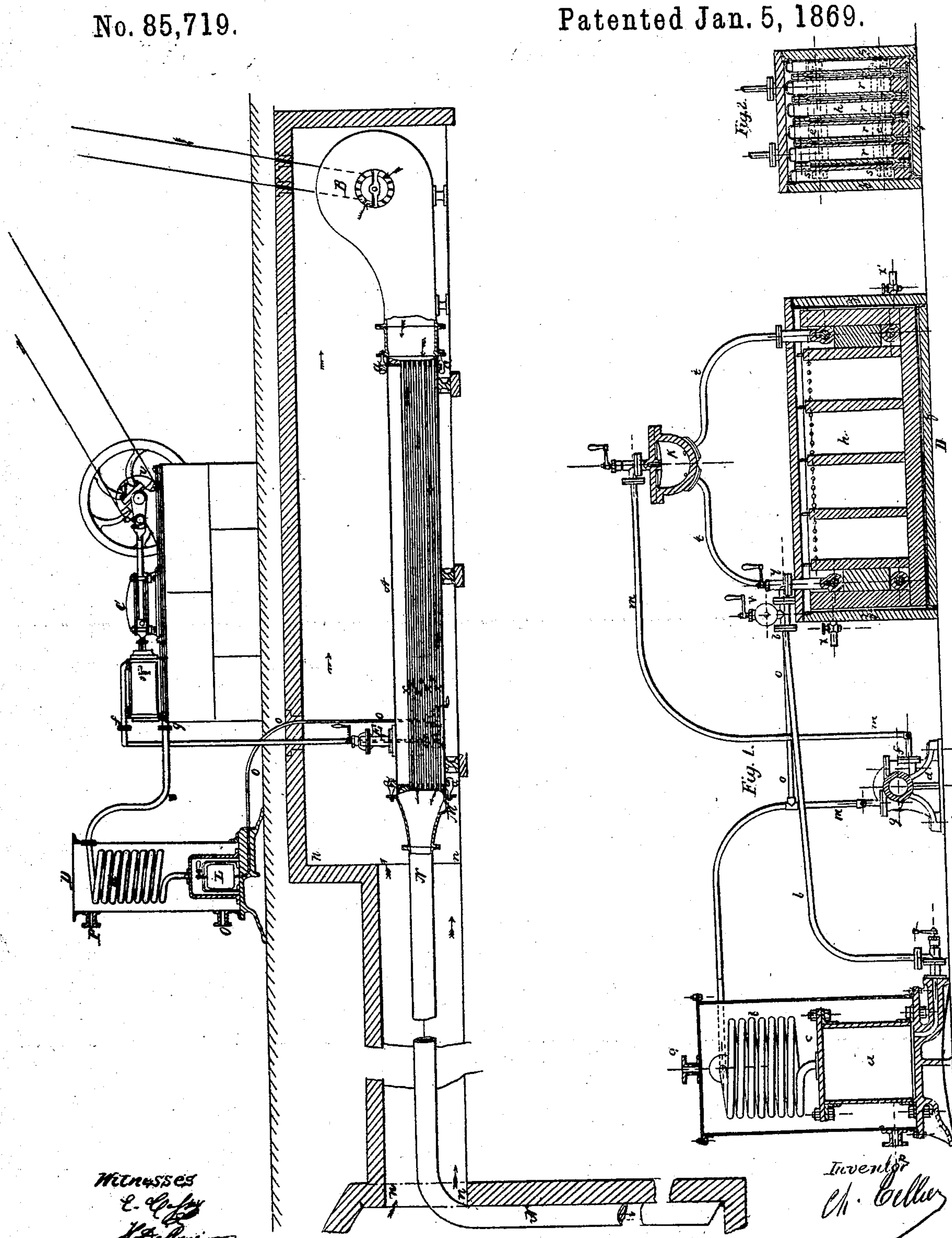
3 Sheets—Sheet 1.

C. TELLIER.

ICE MACHINE.

No. 85,719. Patented Jan. 5, 1869.



Witnesses

Inventor
Ch. Tellier

3 Sheets—Sheet 2.

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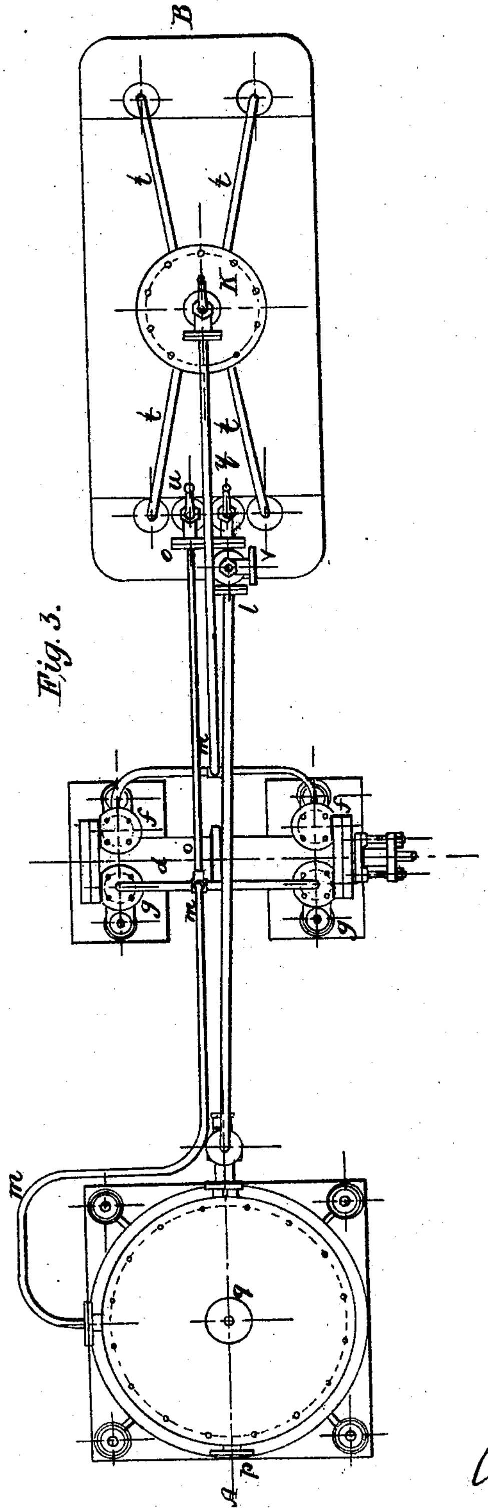

Fig. 3.

Witnesses:

E. Coffey [illegible]

[illegible]

Inventor;

Ch. Tellier

THE NATIONAL LITHOGRAPHING COMPANY, WASHINGTON, D. C.

3 Sheets—Sheet 3.

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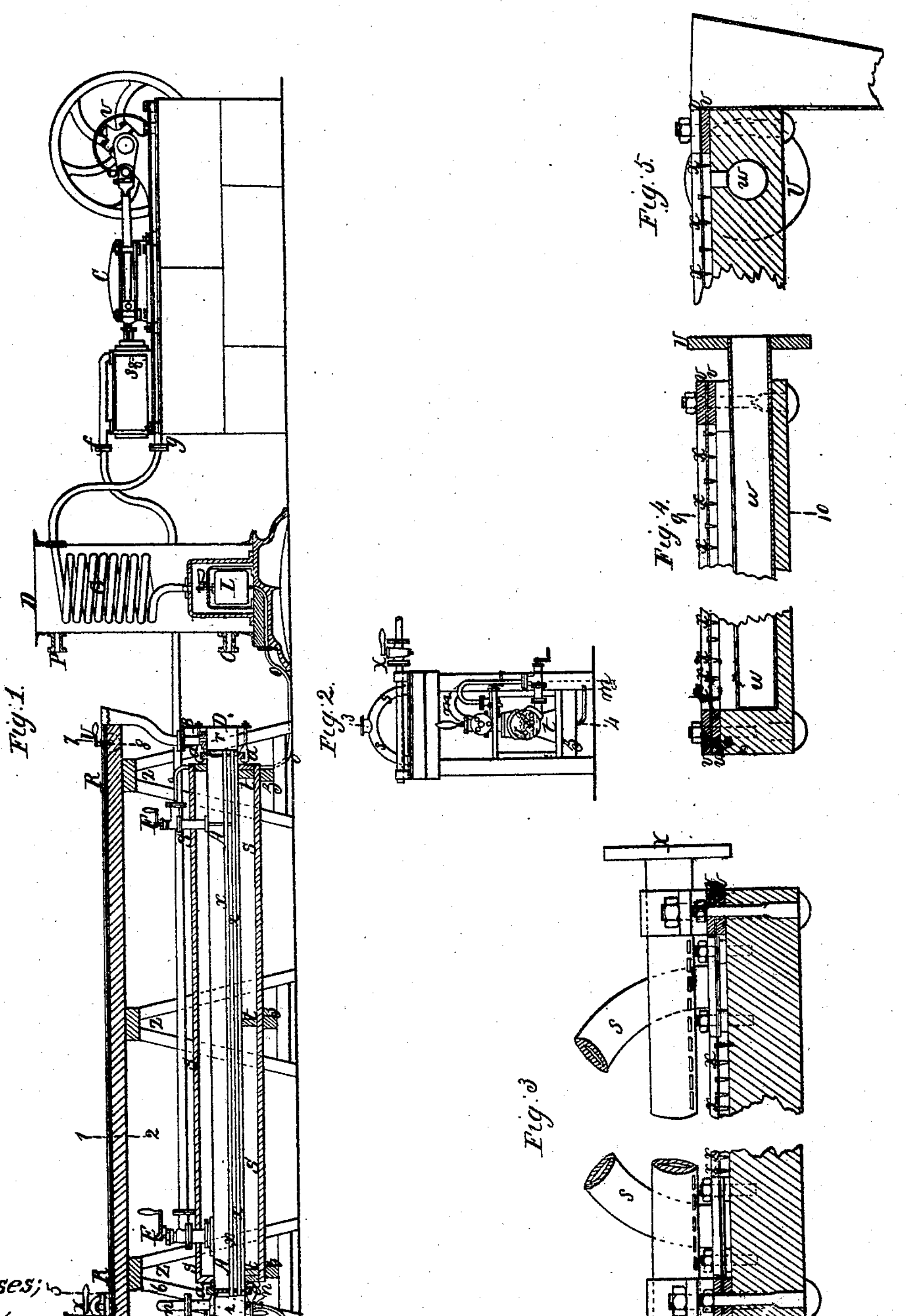

Witnesses;

Inventor;

Ch. Tellier

UNITED STATES PATENT OFFICE.

CHARLES TELLIER, OF PASSY, NEAR PARIS, FRANCE, ASSIGNOR TO LEOPOLD BOUVIER, OF ST. LOUIS, MISSOURI.

IMPROVEMENT IN THE MANUFACTURE OF ICE AND THE REFRIGERATING OF AIR, LIQUIDS, &c.

Specification forming part of Letters Patent No. **85,719**, dated January 5, 1869.

To all whom it may concern:

Be it known that I, CHARLES TELLIER, of Passy, near Paris, in the Empire of France, chemist, have invented Improvements in the Manufacture of Ice and the Refrigerating of Air, Liquids, &c.; and that the following is a full, clear, and exact description of the principle or character which distinguishes it from all other things before known, and of the usual manner of making, modifying, and using the same.

These improvements relate to the manufacture of ice, the cooling or refrigerating of air, liquids, &c., by the vaporization and subsequent liquefaction by mechanical pressure of methylic ether, which I am the first to have manufactured commercially and applied to this branch of trade.

The accompanying drawing represents, Figure 1, a longitudinal section of the apparatus, according to A B; Fig. 2, a transverse section of the same, according to C D; Fig. 3, a plan.

The apparatus may be divided in three principal parts—the congealer *h*, the compressing-pump *d*, the condenser *a b*.

I will first describe the congealer *h*. It is filled with methylic ether, by what means I will indicate hereafter. This congealer is composed of five receivers, in the form of hollow slabs, as seen in longitudinal section, Fig. 1, and in transverse section, Fig. 2. Each of these receivers is made of two pieces of stout sheet-iron, slightly bent in above and below, and strongly riveted together. Cross-slats *r r r r* give to this arrangement the required solidity. Four strong nuts, two of which may be seen, *s s*, Fig. 2, unite strongly these five receivers, which are, nevertheless, kept regularly apart from each other by the tubulures *e e e e*, which may be drawn tight by tightening the nuts *s s*. Thus is obtained a strong water-tight chamber, divided in compartments, and presenting very large surfaces. It is in this chamber that the methylic ether is brought. The apparatus thus formed is lodged in a wooden tank, properly isolated by the usual means, and if, then, water is introduced into this tank, it is quite evident that this water will fill all the spaces left free by this chamber and its compartments, and that it will come in immediate contact with the exterior faces of these compartments or hollow slabs. Further, if the ether is now made to evaporate, congelation will take place, the more rapid that nothing will intervene between the congealing-surfaces and the water. This point deserves special attention. In other ice-machines it is usual to take an uncongealable liquid—such as glycerine, alcohol, a solution of chloride of calcium, &c.—to refrigerate this liquid, and to plunge therein vessels or molds filled with water. This proces offers many inconveniences, and at sea would be utterly impracticable, as the motions of the ship would soon scatter about the non-congealing liquid during the handling of the ice-molds. Moreover, a certain quantity of this liquid adheres to the molds as they are being removed, and are apt to drop into the adjoining ones, thus injuring the purity of the ice. Finally, they must be wiped, washed in fresh water to detach the blocks of ice—all of which is tedious at all times, useless, and impracticable at sea. The congealer above described obviates all these inconveniences. Being closed during the freezing process by the lid N N, nothing, of course, can be projected outwardly. Sufficient time having been allowed for the congelation to take place, the cock *x'* is opened, and any water remaining liquid will at once escape, leaving in the congealer nothing but solid ice, which can be easily removed.

Another application, hitherto vainly attempted, and which may be realized by this congealer, is the preparation of fresh water at sea by means of congelation. It is a well-known fact that the water of the sea, when congealed, casts off the salts which it holds in solution, and that water is thus obtained quite as fresh as that produced by distillation, with this difference, however, in favor of the congealing process, that while a glass of distilled water can hardly be swallowed, there is no pleasanter drink than melted ice. The practical accomplishment of this object has remained hitherto a problem, the solution of which is now found in the above-described congealer, as I will now show.

Let the congealer be filled with sea-water, allow sufficient time for congelation to take place, and then open the cock x'. At once the mother waters, (or liquor,) laden with salts, will escape, while, on the contrary, the fresh water, in the shape of ice, will remain in the apparatus. This ice, being allowed to melt, will furnish, either alone or mixed with distilled or other water, excellent drinking-water, fit for any purpose.

I will now proceed with the description of the apparatus. Under the influence of the absorption of the caloric an active vaporization of the methylic ether takes place. These vapors, under ordinary circumstances, would carry with them but an insignificant proportion of liquid particles. At sea, however, the motions of the vessel would soon project the liquid itself through the pipes, and thus the congealer would be emptied of its contents, while the required frigorific action would not be attained. To obviate these difficulties, and the better to adapt my congealer for use at sea, I take two precautions: First, I provide four different outlets for the vapors, one at each angle of the congealer, as seen, *t t*, Fig. 1, *t t t t*, Fig. 3, one of which, at least, must necessarily remain always unobstructed, and allow the passage of the vapors without any of the liquid; but should any of the liquid find its way into the pipes notwithstanding this precaution I provide for its return by bringing the four tubulures *t t t t* into the draining-trap K, whence such liquid finds its way easily back to the congealer through one or more of the apertures. This contrivance is, of course, unnecessary on land. The congelation will then take place easily and regularly.

In order to attain proper conditions of economy it is indispensable that the vapors formed in the congealer should not be lost. To accomplish this object I make use of the pump *d*, which may be moved by any machinery, and, if on shipboard, by the ship's engine. This pump, by means of valves working in ordinary conditions, exhausts constantly the vapors which are formed in the congealer, and drives them into the condensing-coil *b*. This coil is immersed in a current of cold water, which enters the lower part of the tank *c*, and rises through it, completing and constantly enveloping this coil. Under the combined influence of the relatively cold temperature produced by this current, and of the pressure which the pump *d* gives to the vapors, the methylic ether becomes liquid again, and flows into the lower part of the coil. If it were only necessary now to produce constant frigorific action without any ice to remove, (as is the case in the apparatus described hereafter for the refrigeration of air or liquids,) I would cause the ether thus condensed to return at once from the condenser to the congealer; but the necessity of removing the ice formed in the congealer compels us to allow the ether produced by condensation to remain stationary during a given time in the receiver *a*, and for the following reason: We have seen that the ice formed directly upon the ten faces of the congealer. The blocks thus formed are subdivided in cakes by the cross-slats *r r r r*, Fig. 1. These cakes, however divided, adhere to the sides of the congealer, and it is indispensable to detach them in order that they be removed. At this instant the congealer is empty, the receiver *a* having received all the ether produced by the condensation. The congealer being empty, if I bring into it vapors at a higher pressure than that corresponding to 32° Fahrenheit, condensation must necessarily take place, and, as a natural consequence, production of caloric, the action of which will at once loosen the blocks of ice—a result which I obtain by opening the cock *u*, Fig. 3. This cock, through the pipe *o*, connects with the tube *m m*, which leads to the condenser. The latter contains vapors at a temperature of 70° to 75° Fahrenheit, and possesses a tension corresponding to this temperature. The cock *u* being opened, these vapors rush toward the congealer, where a temperature of 5° to 10° Fahrenheit prevails. There they condense, and this condensation, raising the temperature of the sides to 33° Fahrenheit, loosens the cakes at once. This operation requires but a moment, the amount of ice which it is necessary to melt being scarcely appreciable, the only inconvenience being that the temperature of the congealer rises 25° to 30° Fahrenheit—an inconvenience which is partly mitigated by the fact that the latter is made of iron, the specific caloric of which is to that of water as 0.1137 is to 1.

To further facilitate the removing of the ice from the congealer, I use iron clamps, which fit in between the ether-chambers at the points where the two sides of said chambers are drawn together by rivets, as shown in Fig. 2. The water, when admitted into the congealer, covers these clamps, and when the congelation has taken place they are thus perfectly fast into the ice, offering a convenient and easy mode of removing the cakes.

This operation concluded, the cock *x* is opened and the water-compartments of the congealer again filled with water. The cock *y* is then opened and the ether held in the receiver *a* allowed to return through the pipes *l l* to the congealer. The cock *y* is then closed, and the apparatus ready for a second operation.

The capacity of the receiver is so calculated as to hold exactly the quantity of ether required to fill the congealer, and to give a stated result; consequently neither gages, levels, tubes, &c., have to be consulted, all that is required being the simple opening and shutting of a cock. It is important that the apparatus should be thoroughly purged of atmospheric air, as the presence of this body interferes notably with the condensation of vapors. To that effect a purge-cock, *v*, is placed in front of the cock *y*, which admits the ether into the congealer. By opening slightly this cock *v*, all the air in the apparatus may be swept out.

The quantity of ether required, say, for a machine making fifty kilograms, or one hundred and ten pounds per hour, is about five gallons. The possible loss of ether in the working of this apparatus is not appreciable. It could only occur through the stuffing-box of the pump *d*. Its smell would then at once betray its presence, so that it is easy to watch this stuffing-box, the screws of which should be tightened from time to time.

The apparatus is charged by connecting the purge-cock *v* with a vessel containing the required quantity of ether, and then permitting it to flow into the congealer.

The ice produced by this machine is perfectly hard and compact, being formed at a temperature of about 10° Fahrenheit above 0; whereas the greater part of the ice gathered from ponds and rivers is formed at 25° to 31° Fahrenheit. Regarding the question of economy, there are few localities where natural ice could compete with the cost-price of ice made by this machine, which may be fixed at the maximum figure ot two dollars per ton throughout the United States. The machines may be constructed of any capacity up to one and two tons per hour.

It is not necessary that the respective parts of the apparatus be disposed precisely as shown in the drawing; but they may be placed nearer to or farther from each other, above or below, as the requirements of space, power, &c., may demand.

When, instead of producing ice, it is only required to cool or refrigerate air or liquids to temperatures no lower than 32° Fahrenheit, I substitute for the congealer hereinbefore described the apparatus shown on Sheet No. 2. The refrigerating-tube A is made of an iron cylinder, forming a strong outer jacket, within which are lodged a number of smaller tubes, one-half to three-eighths ($\frac{1}{2}$ to $\frac{3}{8}$) of an inch in diameter, part of which may be seen at *x x x x*. All open freely into the atmosphere at the two extremities of the cylinder A. The latter is closed at each end with a metallic disk, through which pass the tubes *x x x x*, so that while the interior of the latter is left perfectly free the space circumscribed by the tube A and these disks forms, nevertheless, a chamber strong and perfectly tight. That this result may be the more perfectly obtained, a strong iron band is welded over each extremity of the cylinder, and gives it additional strength.

The whole arrangement, being then carefully tinned and soldered, is heated, and covered with a coating of solder one-fourth to one-half inch thick, so that the whole forms one solid mass, without the possibility of any leak, as there are neither rivets, joints, nor nuts, save the two tubes of the cocks E and F, which are themselves set so as to form integral part of the tube A. This tube or cylinder is filled with a sufficient quantity of methylic ether to bathe all the small tubes *x x x x*. The air, which is made to pass through these tubes by means of the ventilator B, causes the liquid to vaporize, while the pump C removes the vapors thus formed.

It is necessary not to allow the temperature of the air to descend below freezing-point, as, in this case, the abundant condensation which takes place in the tubes would soon freeze and clog the apparatus. By keeping close to, and just above, freezing-point, the only result will be an abundant condensation, the product of which is allowed to escape through the tube M. The refrigerated air escapes through the conduit N N, and may be distributed wherever it is needed.

As in this application there is no necessity of suspending the working of the machine to remove ice, instead of gathering the condensed ether in a receiver, it is allowed to flow directly back into the cylinder A, the float L regulating such flow, and the glass level, connecting the tubes E and F, permits the ascertainment at all times of the quantity of ether in the cylinder, which quantity must always be sufficient to bathe all the tubes *x x x x*.

When it is more especially desired to cool or refrigerate liquids, such as beer, &c., I recommend the use of the same cylinder, in connection with a cooling-table, as shown in Sheet No. 3.

I will now briefly describe my process for preparing methylic ether. The usual means consist in forming a mixture in equal parts of sulphuric acid and wood alcohol. The mixture is introduced in a retort, and slightly heated. The ether disengages itself, carrying with it carbonic acid, sulphurous acid, and divers empyreumatic vapors, which are produced, specially, at the beginning of the operation, and proceed from the nature of the alcohol used. To get rid of these vapors, the first parts of ether must be thrown away. As to carbonic acid, sulphurous acid, they must be absorbed by potash, which dries the ether at the same time, and thus permits of its being collected properly purified. Some precautions are required to conduct successfully the operation without danger. The mixture of acid and alcohol must be made in a vessel having a large aperture. The acid is poured first; then the alcohol is added in small quantities, stirring all the while, so that the combination may be made gradually, and as fast as the alcohol is being introduced; otherwise, however great is the affinity of the two bodies, the sulphuric acid, by reason of its greater weight, might reach the lower part of the vessel, and cause an explosion, when the ebullition of the mass produces the combination. The fire must be well controlled. The reaction at a certain moment becoming very lively, it would become difficult to check the operation, and a portion of the mixture would pass through the neck of the retort. The temperature must not exceed 255° to 260° Fahrenheit. Over 265° there is decomposition of the alcohol, formation of carbon, consequently abundant production of sulphurous acid, carbonic acid, while, on the contrary, the formation of ether would almost entirely cease.

This process is only applicable to the production of ether in small quantities. To manufacture on a large scale, I have contrived the following special dispositions: First of all, I discovered that the mixture formed of equal parts of acid and methylic alcohol is not the most favorable to an abundant yield of ether. It is necessary to increase the proportion of alcohol.

The introduction of the latter in the mixture must cease, however, when the areometer plunged in this mixture indicates 34° Baumé. Methylic alcohol must be employed as pure as possible. The ordinary article of commerce contains a considerable proportion of essential oils. It may be roughly tested by mixing with an equal volume of water. The oils separate and collect on the surface of the liquid, while the alcohol remains in solution in the water. Any alcohol indicating the presence of such oils should be rejected. I use it at as high a degree as possible, ninety per cent. at least.

When the mixture of alcohol and acid has been made, at a certain moment of the combination, much ether is produced. It is important, therefore, to so combine the apparatus that while the mixture may be going on this ether may be saved. In using an excess of alcohol, a certain quantity of it vaporizes at the beginning of the operation. These vapors should be condensed through a coil and the alcohol thus saved. As to the vapors which are not condensed, they pass through a solution of potash, then over chloride of calcium to dry them, and finally into sulphuric ether, which collects them by dissolution.

The vapors of ether might be liquefied directly in the apparatus; but with a body of so irregular a nature as the methylic alcohol of commerce, abundant deposits of bitumen sometimes take place, and it is more convenient to proceed as I have just indicated. The mode of absorption permits not only the storing of the ether, but also its easy extraction when it is necessary to make use of it.

The operation, limited to these features alone, would come to a stand-still whenever the temperature would reach 255° to 260° Fahrenheit. It would be necessary to draw off the exhausted mixture and replace it by a fresh quantity of new mixture, which would cause at once a loss of time and a considerable production of residuum. In order to obviate these inconveniences, I had at first rendered constant the supply of alcohol; but after a certain lapse of time the operation ceased to work, the reaction seemed paralyzed, the apparatus had to be taken apart, and the mixture completely renewed. I had to abandon this process. I now proceed differently. When the operation has reached 260°, I leave it for a few moments between 260° and 265° Fahrenheit, in order to allow all the ether which might still disengage itself to escape. In order not to exceed this point, I use, by preference, heating by steam. I now shut off the heat. I introduce anew, and as rapidly as possible, by means of a pump, a sufficient quantity of alcohol to bring back the mixture to 34° Baumé. I apply the heat anew, and so on, the same solution being thus used a number of times without inconvenience. In these conditions it may be reckoned that four volumes of alcohol will give one volume of ether, a quantity of residuum being left.

The fact must not be overlooked that the formation of ether is almost always accompanied with production of bitumen. This bitumen, in cooling, solidifies, and covers the surface of the acid-bath.

In constructing the apparatus, it is important to contrive an armhole, through which, every morning, the bitumen formed the day before may be extracted, and the apparatus kept in best working order.

I have stated that the residuum could be used. Sufficiently filtered on a close metallic wire-cloth, it forms a brown liquid, the density of which is 45° Baumé. This liquid, formed of sulphuric acid and sulpho-methylic ether, is eminently proper to absorb the methylic ether formed. Thus, it takes, with advantage, the place of sulphuric acid to collect the ether produced by the apparatus.

I say with advantage for this reason: When methylic ether has been dissolved in acid at 66° Baumé, the compound remains in the liquor, and the proportion which may be produced from it is so great that this mixture may fall to 36° or 38° Baumé; but when the operation is attempted a second time the decomposition of the sulpho-methylic ether commences at 90° Fahrenheit; but as the mixture becomes poorer the temperature increases, and when it reaches 260° or 265° Fahrenheit (which cannot be exceeded without producing carbon) the mixture still weighs only 45° Baumé. Thus only the ether has been saved, which reduces the density from 36° to 45°. The much greater proportion between 45° and 66° remains in the liquor at the risk of decomposition. This quantity is thus lost, and constitutes a notable loss in the production. Since I have thought of purifying the residuum, and of using it as an absorbent, this source of loss has disappeared.

The absorbent is taken at 45° Baumé. It reaches 36° to 38° by absorption; but, as it returns to 45° by decomposition, all that has been produced may thus be withdrawn from the mixture. The absorbent thus has no influence on the production. This result leads to the utilization, as complete as possible, of the methylic alcohol. Thus, except the water produced by the decomposition of the alcohol,

($C^2H^4O^2 = C^2H^3O + HO$,) there is only formation of bitumen, and of a few volatile products having no importance as to the final yield.

The combination formed by sulphuric acid and methylic alcohol has no action upon ordinary metals. It only affects them in contact with water. The experience of several years has enabled me to ascertain the perfect preservation of the apparatus containing this liquid.

Having now fully set forth and described my invention, I wish to state that I do not claim as new the pump and coil used for vaporizing and condensing the ether, the same being already in general use for the purposes aforesaid; but

What I do claim as new, and for which I desire to secure Letters Patent, is—

1. The congealer or refrigerator, formed of metallic plates, so as to freeze by immediate contact, substantially as described in the above specification.

2. The combination of refrigerator, pump, and condenser with pipes, cocks, and direct connections, so as to draw off the vapors when formed, and at the same time prevent the drawing off of any liquid from the refrigerator, substantially as described.

3. The condenser, formed of a coil or pipe, *b*, and a reservoir, *a*, so as to contain a specific charge of vaporizable fluid, substantially as described.

4. Arranging the connecting-pipes and cocks so that the vapor may be forced back into the refrigerator or congealer to loosen or detach the ice, substantially as described.

5. The use of methylic ether in machines for freezing, cooling, and refrigerating, substantially as described.

6. The process herein described for manufacturing, collecting, and applying methylic ether, substantially as described.

7. The refrigerating or cooling cylinder shown on Sheet 2, together with the tubes running through it, for the purpose of refrigerating or cooling air, liquids, &c., substantially as described.

8. The float L, or its equivalent, for the purpose of regulating the return of the liquid to the refrigerating-cylinder, substantially as described.

9. The application of the said refrigerating-cylinder to the cooling of liquids, as shown on Sheet 3.

10. The production of ice, the generation of cold for the purpose of cooling air, liquids, &c., in a simple, practical, and economical manner, by the means and apparatus substantially as described in the above specification.

CH. TELLIER. [L. S.]

Witnesses:
E. CASSÉ,
H. DUFRENÉ.