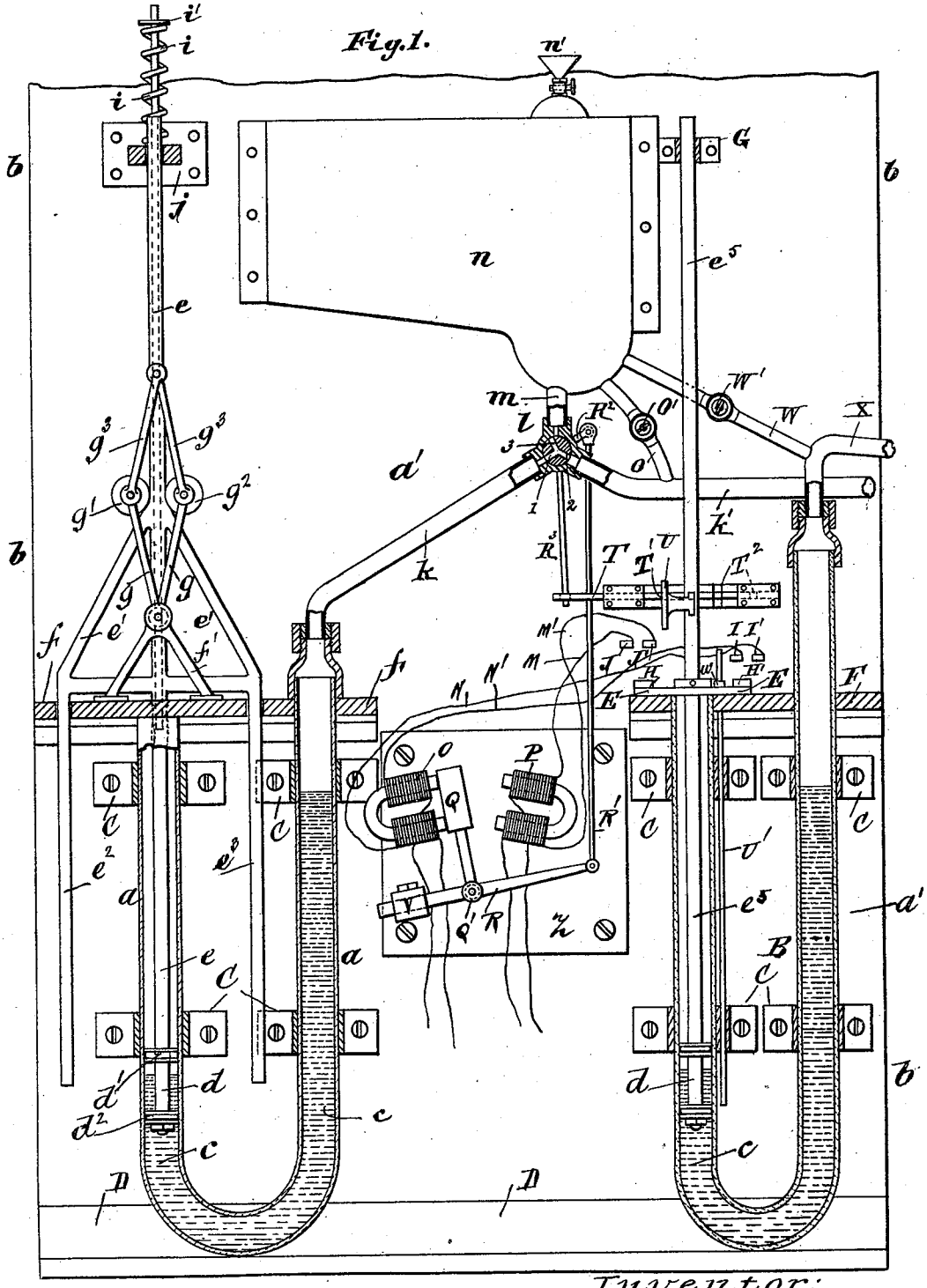
(No Model.) 6 Sheets—Sheet 1.

A. SHIELS.

APPARATUS FOR AUTOMATICALLY REGULATING TEMPERATURE.

No. 478,373. Patented July 5, 1892.

Fig. 1.



Witnesses:
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A. B. Summers

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(No Model.) 6 Sheets—Sheet 2.

A. SHIELS.

APPARATUS FOR AUTOMATICALLY REGULATING TEMPERATURE.

No. 478,373. Patented July 5, 1892.

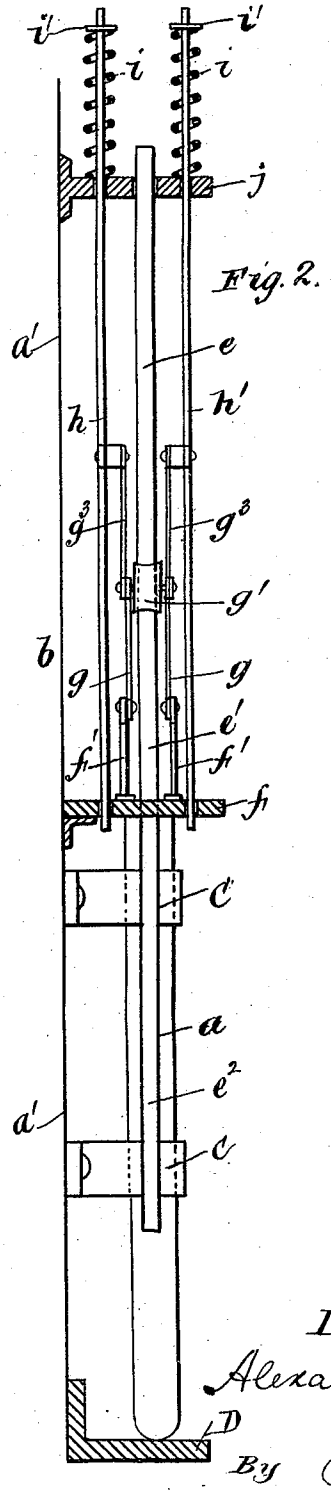

Fig. 2.

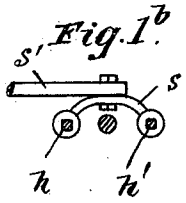

Fig. 1ᵇ.

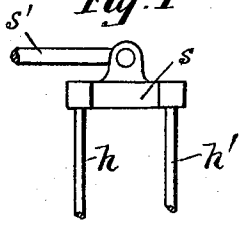

Fig. 1ᵃ.

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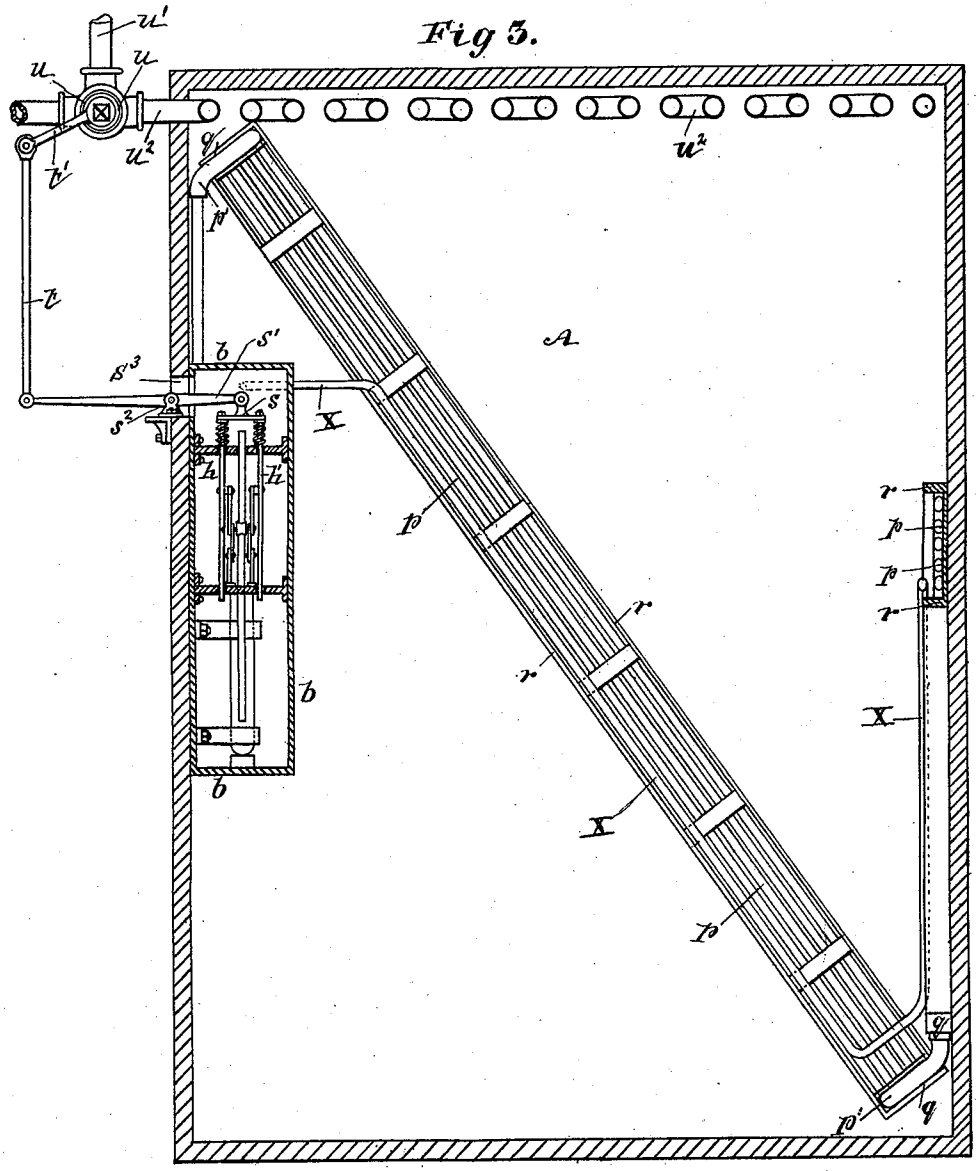
(No Model.) 6 Sheets—Sheet 3.

A. SHIELS.

APPARATUS FOR AUTOMATICALLY REGULATING TEMPERATURE.

No. 478,373. Patented July 5, 1892.

Fig 3.



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(No Model.) 6 Sheets—Sheet 4.

A. SHIELS.

APPARATUS FOR AUTOMATICALLY REGULATING TEMPERATURE.

No. 478,373. Patented July 5, 1892.

Fig. 5a.

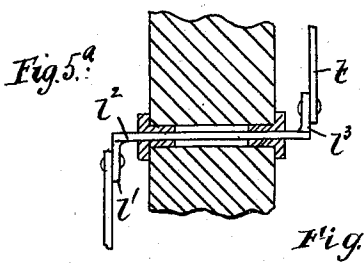


Fig. 4.

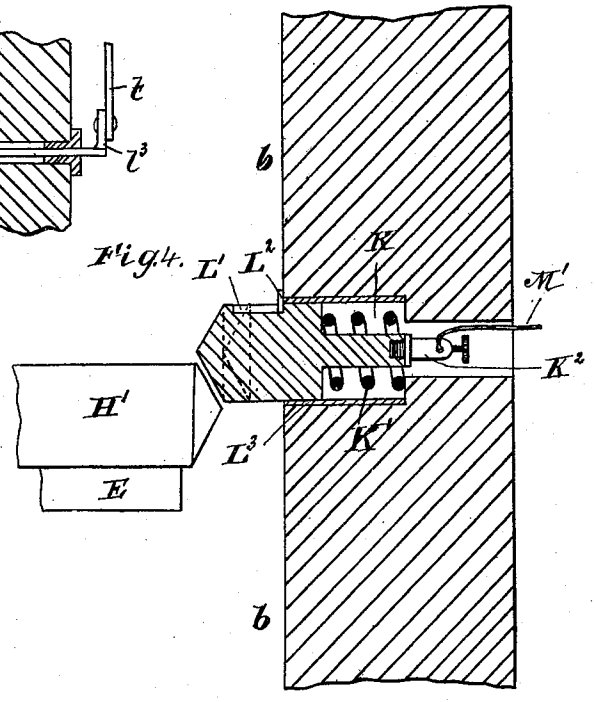
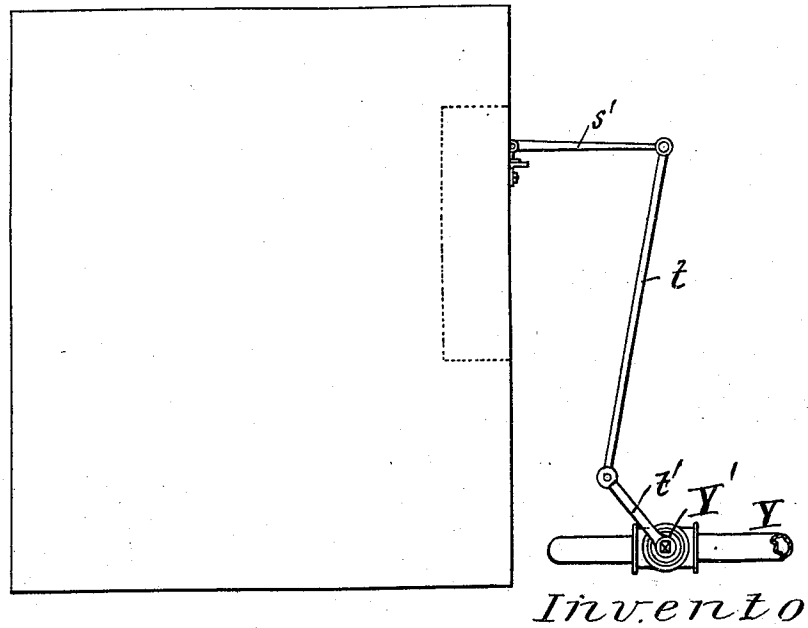


Fig. 5.



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(No Model.) 6 Sheets—Sheet 5.

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APPARATUS FOR AUTOMATICALLY REGULATING TEMPERATURE.

No. 478,373. Patented July 5, 1892.

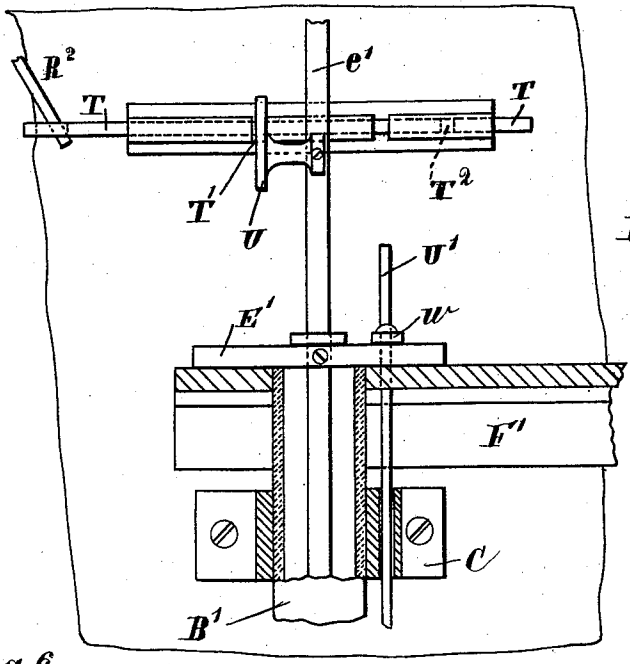
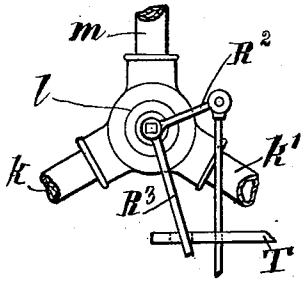


Fig. 7.

Fig. 6.



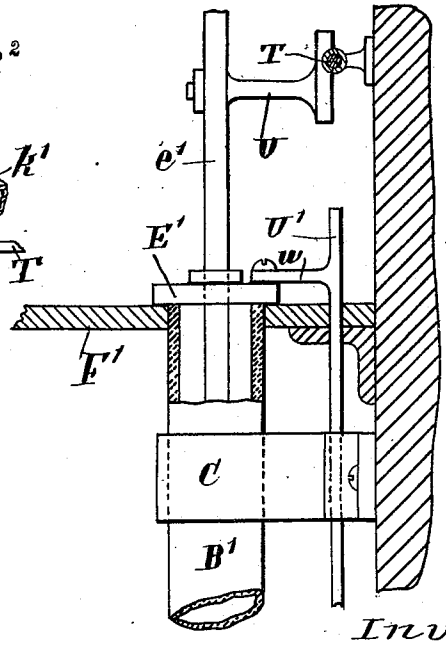


Fig. 8.

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(No Model.) 6 Sheets—Sheet 6.

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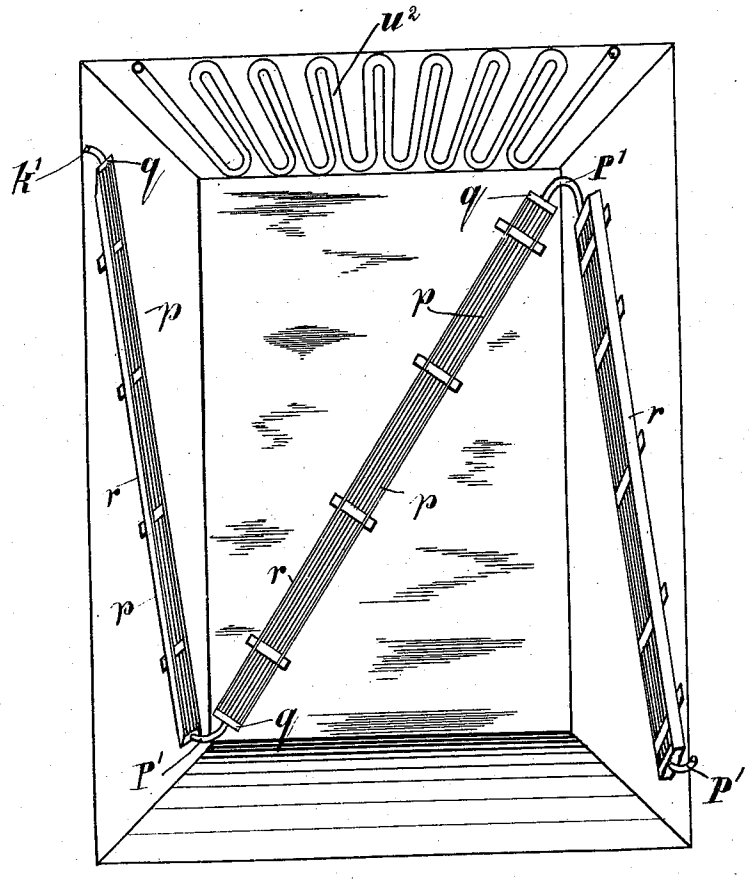
APPARATUS FOR AUTOMATICALLY REGULATING TEMPERATURE.

No. 478,373. Patented July 5, 1892.

Fig. 9.



Witnesses:
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UNITED STATES PATENT OFFICE.

ALEXANDER SHIELS, OF GLASGOW, SCOTLAND.

APPARATUS FOR AUTOMATICALLY REGULATING TEMPERATURE.

SPECIFICATION forming part of Letters Patent No. 478,373, dated July 5, 1892.

Application filed May 6, 1891. Serial No. 391,808. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER SHIELS, bachelor of medicine, master in surgery, and bachelor of science, a subject of the Queen of Great Britain, and resident of the city of Glasgow, Lanarkshire, Scotland, have invented an Improved Method of and Apparatus for Automatically Regulating Temperatures in Ships, Buildings, Rooms, and other Interiors or Places, of which the following is a specification.

This invention relates to an improved method of and apparatus for automatically regulating the temperature in interiors or places, and is especially applicable for regulating the temperature of ships' and railway-cars' refrigerating-chambers.

The invention consists in applying to one or a number of parts of the refrigerating-chamber or other interiors tubes, pipes, or equivalent, in which is contained, by preference, spirits or other liquid or a gaseous or other fluid. I prefer to use a spirit, as it is very sensitive, contracting or expanding under the slightest change of temperature. The pipe or pipes, as the case may be, are or may be conducted to a U-shaped tube or equivalent arrangement, preferably in the form of a bent tube, although it may be of any other suitable form or shape. The U-shaped tube contains or may contain mercury or other fluid or water or other liquid, or a gas or gases, or a combination of any or all of these. I prefer to use mercury, however. Fitted in or in connection with the siphon is a piston or float or equivalent, which is suitably connected by levers, rods, gearing, or otherwise to a valve or other suitable device, or to mechanism for either regulating the inlet to the chamber or interior of the heat or cold producing agency, or for regulating in cases—such as ships' and like refrigerators—the steam or other fluid-supply for driving the refrigerating engine or mechanism. The piston may be made to operate in any suitable manner a device for supplying or controlling the supply of electricity to a dynamo or other suitable power-generating device or mechanism, which power-generator may be the agency for producing or regulating the temperature in the interior. The pipes may have fitted to or in conjunction with them suitable supply and controlling valves or chambers for the liquid, fluid, or gas in said pipes or in the siphon. A second U-shaped pipe may be used as a governor to the main U-shaped tube, if so desired.

With my improved method, when the temperature in any part of the interior changes, the expansion or contraction of the fluid, liquid, or gas in the pipe or pipes affects the mercury or equivalent in the U-shaped tube, and so raises or lowers or otherwise actuates the piston or float, and by its means controls the agency for heating or cooling the interior.

The interior may be maintained at any desired temperature by regulating the supply of sensitive gas, fluid, or liquid to the pipes and by making the apparatus to conform therewith.

More than one U-shaped pipe may be used, and, if desired, the tubes leading to the U-shaped pipe or pipes may be dispensed with, the sensitive agency being contained in a separate vessel or in a part of the U-shaped pipe.

The apparatus may be modified in its details of construction to suit its application to different structures.

In order that my said invention may be properly understood, I have hereunto appended four explanatory sheets of drawings, showing by way of example a convenient way of carrying my invention into effect or practice.

On the drawings, Figure 1 is a front view, partly in section, of the apparatus. Figs. 1[a] and 1[b] are a side elevation and plan of the bridge *s*. Fig. 2 is a side elevation of part of the apparatus. Fig. 3 is a sectional view showing the interior of a refrigerating-chamber. Fig. 4 is an enlarged detail view, and Fig. 5 is an outside view of a chamber, showing connections for controlling the steam or other pressure-fluid to the engines. Fig. 5[a] is a detail view. Fig. 6 is a front view of the valve *b* with connection. Fig. 7 is a front view of the locking-bar *t*. Fig. 8 is a side view of the same. Fig. 9 is a perspective view of the interior of the chambers with the zigzag arrangement of tubes.

As shown on the drawings, the apparatus consists of a U-shaped tube *a*, fitted by straps C to the back *a'* of a box or casing *b*, which latter is or may be secured in any convenient

and suitable part of the refrigerating-chamber or other interior. The U-shaped tube *a*, which is partially filled with mercury or other suitable liquid or semi-liquid *c*, has working in it a piston *d*, made by two disks d' d^2, having suitable packing-rings around them, so that they may work tight in said U-shaped tube. The space between the disks d' d^2 is preferably partially filled with mercury, which also serves as a packing. The piston-rod *e* extends vertically upward and has fitted to or made in one with it a triangle e', having downwardly-projecting guides e^2 e^3. Supported by the bracket f' on the shelf *f*, carrying the U-shaped tube *a*, are links *g*, carrying rollers g' g^2. The rollers are also suspended from links g^3, pinned to vertical-moving bars *h* h', Fig. 2. The arrangement of links *g* g^3 forms a double toggle-joint. There are double toggle-joint and rod *h* at each side of the piston-rod *e*, as shown at Fig. 2. In Fig. 1 the front rod h' is removed so as to show the toggle more clearly. The upper ends of the rods *h* h' have spiral springs *i* around them. The springs are kept in position by collars i' on the rods and a bracket *j*, attached to the back of the box *b* or other part. The rollers g' g^2 have freedom to run on the inclined sides of the triangle e'.

The long leg of the U-shaped tube *a* has coupled to it a pipe or tube *k*, leading to a three-way valve *l* of any ordinary construction. As the valve is turned in the manner hereinafter explained, it communicates by its ways with, respectively, the tube *m*, leading from the sensitive fluid or gas cistern *n*, (I preferably use alcohol as the sensitive agency,) and the pipe *k*, leading to the U-shaped tube *a*, or with the tube *m* and the pipe k', leading to the interior of the refrigerating or other chamber in which the temperature is to be regulated. The ways of the valve are so arranged, as shown, that when two of the ways 1 2 are opening a passage between the pipes *k* and k', which is the normal position, the way 3 from the tube *m* is closed. The cistern *n*, which may be of any convenient shape, is but partially filled with sensitive fluid, so as to allow room for expansion. n' is a filler with cock. *o* is a tube communicating with the pipe k' and the cistern *n*. It has a stop-cock o' on it for cutting off or regulating the supply of sensitive fluid to the pipe k'. In some cases, when the action is not required to be very sensitive and certain and where the changes of temperature are not excessive, the pipe *k* may be made in one piece with the pipe k' and the three-way valve be dispensed with. The pipe k' communicates with the tubes *p*, Fig. 3, of which there may be any number, running, preferably, zigzagwise round the inside of the refrigerating-chamber or other interior. The pipe k' communicates with a cast-metal box *q*, into which the pipes *p* are screwed. (See Fig. 9.) The pipes are or may be arranged at a diagonal to the walls, being grouped and held together by a wood or other casing *r*. The junction between the diagonal pipes of the one wall with those of the next is preferably made as shown—viz., of two cast boxes or headers *q* and short bent junction-pipes p'. The pipes *p* contain sensitive fluid and are closed at their terminal ends. In this view, Fig. 3, the box *b* is shown in section, with the regulating apparatus therein. The top ends of the rods *h* h' are shown connected together by a bridge *s*, (shown in side elevation and plan at Figs. 1^a and 1^b,) to which is pinned one end of a lever s', working vertically on a fulcrum s^2. The lever s' passes through an opening s^3 in the chamber A. The opposite end of the lever s' is pinned to a connecting-rod *t*, which is pinned to and works the arm t' of the valve *u*. The valve *u* controls and regulates the supply of cooling or other fluid or air or gas to the chamber A. When fluid is the cooling or heating medium, the valve is preferably a three-way one, the way u' leading the fluid back to the pumping-engine when the valve is turned, so as to cut off the supply to the pipes u^2, which may run along the ceiling, as in the "Chicago" process of refrigerating. The pipes u^2 are alone used for the heating or cooling fluid.

In cases—such as ships' refrigerating-chambers—where the temperature at times may rise, comparatively speaking, very high during the periods when the chamber is not used and when the vessel may be crossing the equator it is necessary to have a controlling arrangement for allowing the sensitive fluid the full limit of expansion without danger of bursting the U-shaped tube or the other tubes. A form of controlling device is shown at Fig. 1. It consists of a second U-shaped tube B, fitted to the casing *b* by a small shelf F and straps C. The small angle-iron D serves to support both the siphons *a* B. The U-shaped tube B has a piston *d* and piston-rod e^5; but there is no triangle e' fitted to said piston-rod. It merely has a cross-bar E fitted on it. G is a guide-bracket for the piston-rod. On the cross-bar E are two small insulated circuit-closers H H′, which, when the piston rises successively, come into contact with the terminals I I′ and J J′. The terminals are connected by wires to a battery of Leclanché cells or other electricity-generating apparatus. The shape of the circuit-closers H H′ and terminal pieces I I′ J J′, one of each of which is shown at Fig. 4, where it will be seen that the circuit-closers are each angled at the back, while the terminal pieces are correspondingly angled at the front. The terminals, which have a little movement in and out of the recess K, cut in the box or casing *b*, are each kept normally forced out by a spring K′. K^2 is the connection for the wire—say M′—from the magnet P. To prevent the terminal pieces being forced out too far by the springs, they are or may be each made with a groove L′, in which fits a stop-pin L^2, so that their movement is limited. L^3 is a non-conducting casing inclosing said spring-terminals. The wires M M′ N N′, Fig. 1, from said terminals

are connected to electro-magnets O P, secured to an insulated plate Z. Q is an armature on a T-lever R, pivoted at Q'. One end of the T-lever is linked by the rod R' to the arm R^2 of the valve *l*. The valve has also a second arm R^3, working in the slotted end of a sliding bolt T. The bolt T has grooves T' T^2 in it, which are alternately caught, as hereinafter explained, by the slides U U'. The slide U is connected to the piston-rod *e*, while the slide or rod U' is connected by a short arm *w* to the bar E. V is a weight for counterbalancing the weight of the rods R R'. W is a tube with cock W' on it for supplying fluid to the pipe X, which runs round the chamber alongside or above the pipes *p*.

Fig. 5 shows an outside view of a refrigerating-chamber with lever arrangement for turning on and off the steam-supply to the refrigerating-engine. Passing along pipe Y Y' is the valve operated by levers *s' t t'*, as before.

Fig. 5^a shows the rods *h h'* as driving a crank *l'* on a shaft l^2, passing through the wall of the chamber. The shaft is carried in bearings and has a second crank l^3 on it, which operates the rod *t*, connected to the fluid or steam valve, as the case may be.

With this apparatus, when fitted to refrigerating-chambers, the action is as follows: In cases where there is great range of temperature, such as is caused by the refrigerating-chamber not always being used, and consequently the refrigerating-engine not always working, it is always advisable to have an auxiliary governing-siphon, as shown at Fig. 1. As the auxiliary siphon has but a single tube connected to it and as the variations of temperature to which the apparatus will be subjected are known with a fair amount of certainty beforehand, the U-shaped tube and piston-rod, with the relative parts, may be so proportioned that the maximum rise of temperature, with the consequent expansion of the sensitive agent, will not drive the piston out of the short leg of the U-shaped tube. When the temperature rises, as the U-shaped tube *a* is connected to a number of tubes *p*, and as therefore there is a large body of sensitive fluid, with a consequent large degree of expansion, as compared with the siphon B and its tube, the said U-shaped tube *a* will feel the expansion influence first, the mercury *c* will be compressed, and consequently the piston *d*, with rod *e*, will be forced upward. The forcing up of the piston-rod *d* forces up the triangle *e'* on it, and therefore pushes out the rollers *g' g²*, expanding the toggles and pulling down the rods *h h'* against the action of the springs *i*. The springs are not very powerful, merely being sufficient to draw in the toggles and rollers when the piston and triangle fall. The pulling down of the rods *h h'* actuates the lever *s'* or shaft l^2 and turns on a further supply of freezing fluid or air or gas, as the case may be, to the tubes in the refrigerating-chamber. Should the temperature still continue to rise, the triangle will rise until the rollers mount the inclined sides and run on the guides e^2 e^3. The supply-cock *u* will then be full open, so that the maximum supply of freezing-fluid will be circulated through the chamber. Should the temperature still rise, it is evident that unless some other arrangement is made the pipes will burst or the apparatus will break. To overcome this, the auxiliary siphon is used. As the temperature gradually rises, and as the piston in the U-shaped tube *a* rises with it, so does the piston *d* in the U-shaped tube B rise to a relative degree proportioned to the amount of expansive fluid in the pipe. As the piston rises the bar E rises and the circuit-closer H' thereon first comes into contact with the terminals I I', bridging them and causing the electric current to excite the magnet O and lock the armature Q in the position shown. The slide U is also at this time in the groove T' of the bolt T, so that the valve *l* is securely locked in the position shown, which is the normal position. As the bar E rises the circuit-closer H' overrides the terminals I I' and the circuit-closer H comes nearly into contact with the terminals J J'. This position represents the maximum temperature for the siphon *a*, any rise above which will damage or break it. The slide U is just now passing out of the bolt T. When the circuit-closer H closes in contact with terminals J J', the slide U has cleared out of the bolt, the electric current passes along the wires M M' and excites the electro-magnet P, thus attracting over the armature Q, (which is insulated from the T-rod R,) as the magnet O is dead, and turning the valve *l*, so that it opens communication between the pipe *k'* and the reservoir *n*. The excess of pressure in the pipes *p* and pipe *k'* can now pass into the reservoir and compress the air therein, instead of passing to the U-shaped tube *a*. Just after the valve *l* is turned, should the temperature continue to rise, the slide-rod U' passes into the groove T^2 in the bolt T, which has now been shot back, and locks it and the valve *l*. The temperature can now rise to the maximum without injury to the apparatus. The long slide-rod U' will still keep the bolt T always locked. When the temperature falls, the action is reversed.

The terminals I I' and J J' are so arranged in relation to the circuit-closers H H' that a space has to be traveled by the latter equal to a rise of six or eight degrees of temperature before the valve *b* is operated.

By increasing or decreasing the fluid-supply to the pipes *p* the expansion and contraction can be increased or diminished, as the case may be, and the proportions of the several parts of the apparatus be arranged to accord with the fluid-supply, so as to maintain

a certain range of temperature. In ordinary cases the single siphon *a*, with appurtenances, will be found sufficient.

The apparatus is adapted equally well for regulating high temperatures as well as low.

The sensitive agency may be made to act directly on a piston or float or its equivalent.

With this invention the temperature of interiors is regulated automatically, and in the case of refrigerating-chambers for meat the present great loss from inefficient regulation is thus avoided, as the chamber is kept at a constant temperature.

Having now fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In combination, the pipes for containing the sensitive fluid, the vessel *a*, connected therewith and having a fluid therein, the piston within the vessel, the piston-rod, the valve for controlling the supply of the refrigerating or heating agent, the connections to the said valve, including the rods *h h'* and the toggle-arms, and the means for operating the said toggle-arms, consisting of the triangle on the piston-rod, substantially as described.

2. In combination, the pipes containing the sensitive fluid, the vessel *a*, having a piston and containing a fluid to act thereagainst, the valve *u* for regulating the supply of the refrigerating agent, the connections from the said valve to the piston, the connections *k k'* from the said vessel *a* to the sensitive pipes, the valve *l* in said pipes, the reservoir *n* for the sensitive fluid, the pipe *m* therefrom to the valve, and the means for controlling the position of the said valve *l*, connected with the sensitive-fluid pipe and actuated by the fluid therein, substantially as described.

3. In combination, the main supply-valve for the refrigerating fluid, the means for controlling the same, including the vessel *a*, having a piston, and the connections between the same and the supply-valve, the sensitive-fluid pipes connected to the said vessel, the three-way valve *l*, the reservoir *n*, connected therewith, the means for controlling the said valve, including the second vessel B, having a piston and piston-rod, the intermediate connections between the same, and the valve and the pipe *x* for the sensitive fluid connected to the said second vessel, substantially as described.

4. In combination, the main supply-valve for the refrigerating agent, the controlling means therefor, the sensitive-fluid pipes in connection with the said controlling means, the valve in said connection, the sensitive-fluid reservoir *n*, connected to said valve, the controlling means for said valve, including the second vessel B, with its piston and the piston-rod and the intermediate operating connections, the locking-slide T, connected with the valve *l*, and the locking-guides U U', movable with the piston, substantially as described.

5. In combination, the main supply-valve for the refrigerating agent, the controlling means therefor, the sensitive-fluid pipe in connection with said controlling means, the valve *l* in said connection, the reservoir *n*, connected to the valve, the regulating means for said valve, including the vessel B, with its sensitive-fluid pipe *x* and its piston and piston-rod, the magnet, the armature, the connections between the same and the valve, and the open circuit in which the magnet is arranged, and the contact on the piston-rod for closing said circuit to operate the valve, substantially as described.

6. In combination, the main supply-valve, the controlling means therefor, the sensitive-fluid pipes connected with said controlling means, the valve *l* in said connection, the reservoir *n*, connected with said valve, the regulating means for the said valve, including the vessel B, with its sensitive pipe and piston and piston-rod, the magnets O P, the interposed armature, the connections therefrom to the valve, the independent open circuits, including the said magnets, and the contacts I I' J J', arranged in different planes and adapted to be engaged by contacts on the piston at different points in the movement thereof, substantially as described.

7. In combination, the main supply-valve, the controlling device therefor, including the U-shaped tube, the sensitive-fluid pipes, the connection between the same and the U-shaped tube, the piston in said tube, the piston-rod, and the connections from said rod to the main supply-valve, substantially as described.

8. In combination, the main supply-valve, the tube *a*, the piston therein connected with the said valve, the sensitive-fluid pipes, the reservoir *n*, connected therewith, and the three-way valve *l*, whereby the sensitive fluid may be directed to the tube *a* or to the reservoir *n*, substantially as described.

In witness whereof I have hereunto set my hand this 15th day of April, 1891.

ALEXANDER SHIELS.

Witnesses:
HUGH FITZPATRICK,
DUNCAN DEWAR.