(No Model.) 6 Sheets—Sheet 1.

A. S. HASLAM.

REFRIGERATOR FOR COOLING AIR.

No. 261,708. Patented July 25, 1882.

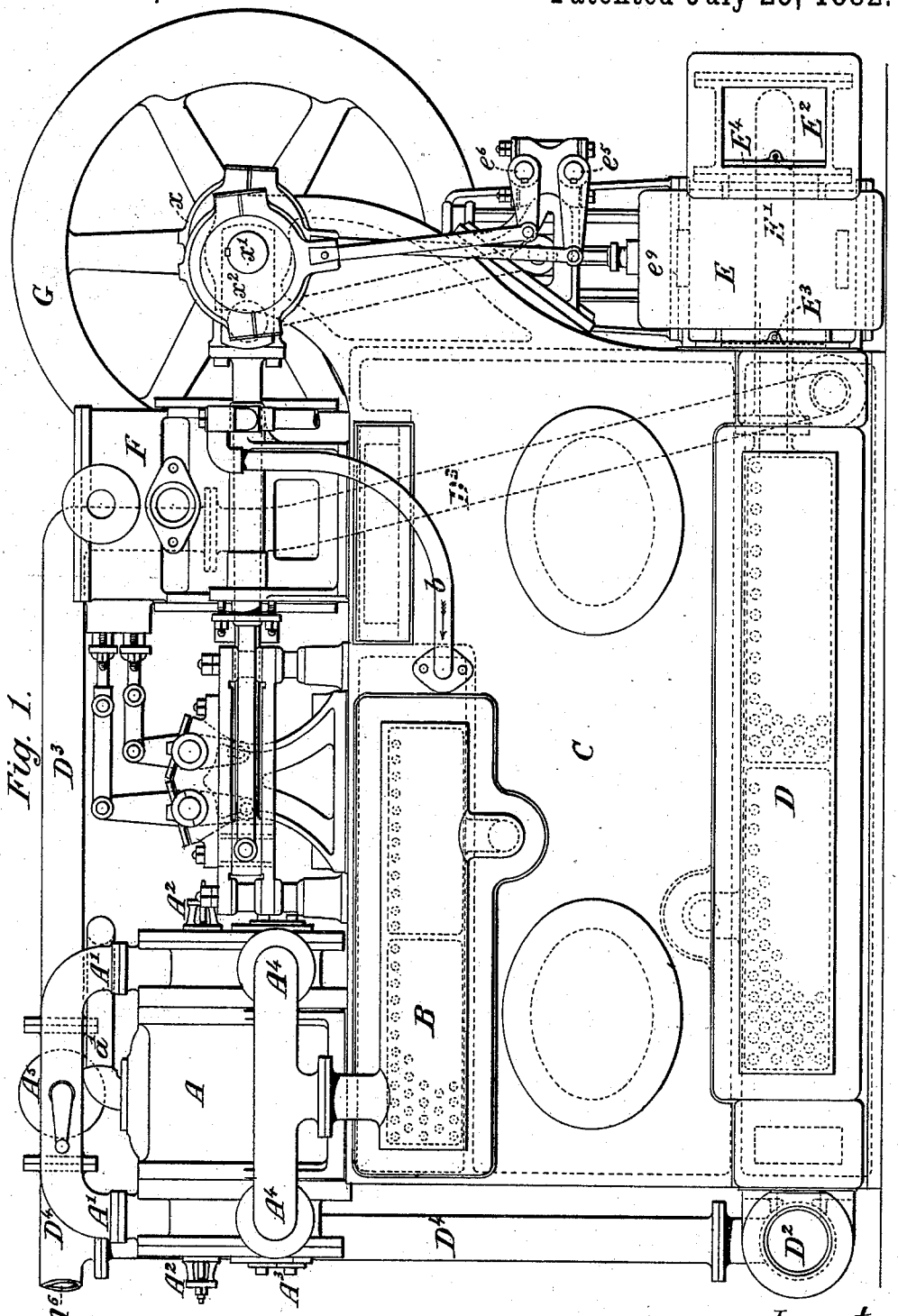

Fig. 1.

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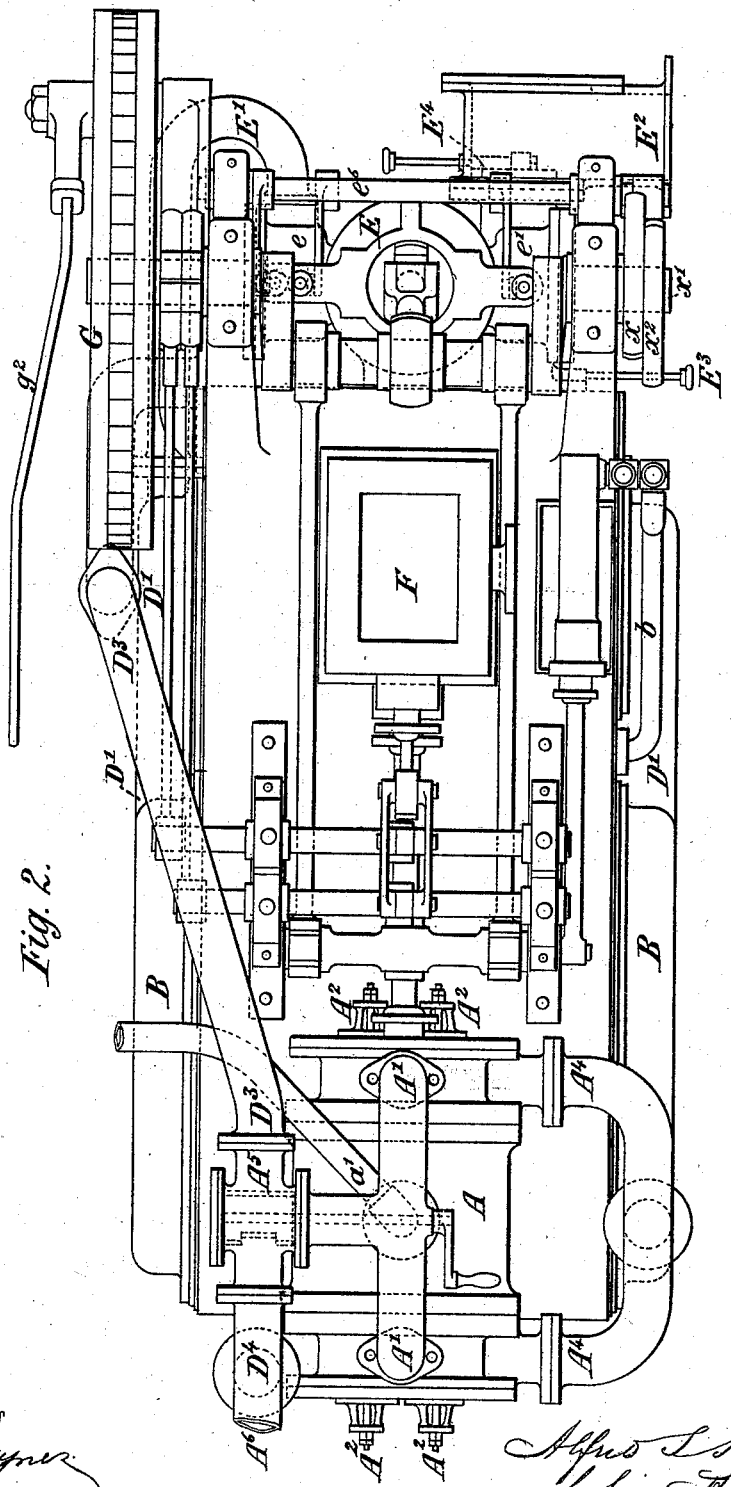

Fig. 2.

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REFRIGERATOR FOR COOLING AIR.

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Fig. 3*

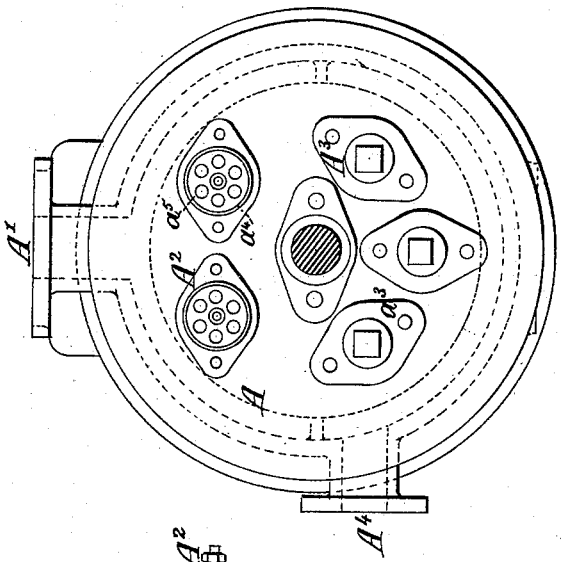

Fig. 3.

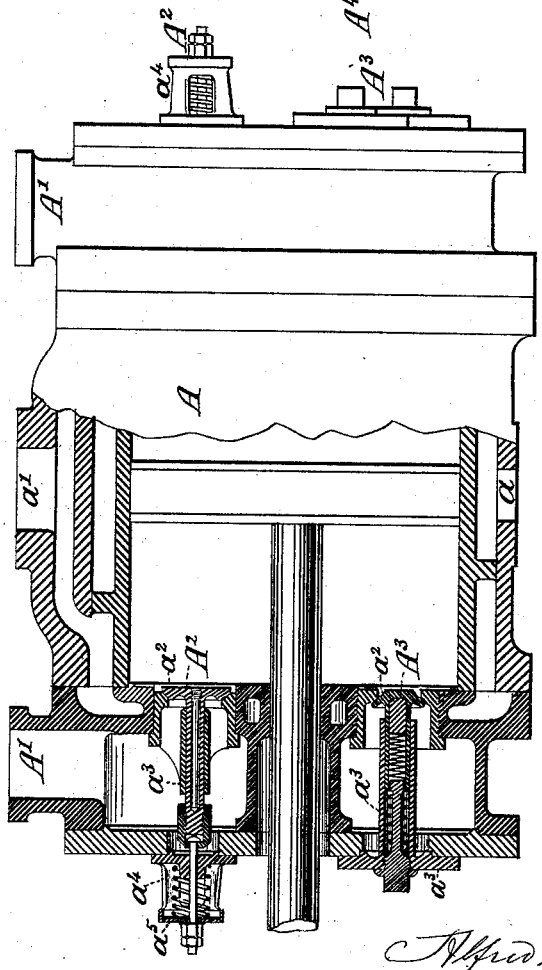

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Fig. 5.

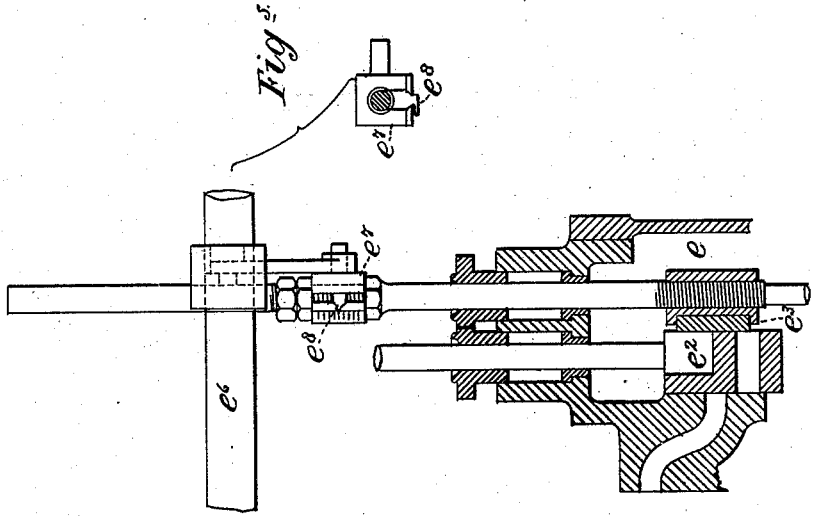

Fig. 4.

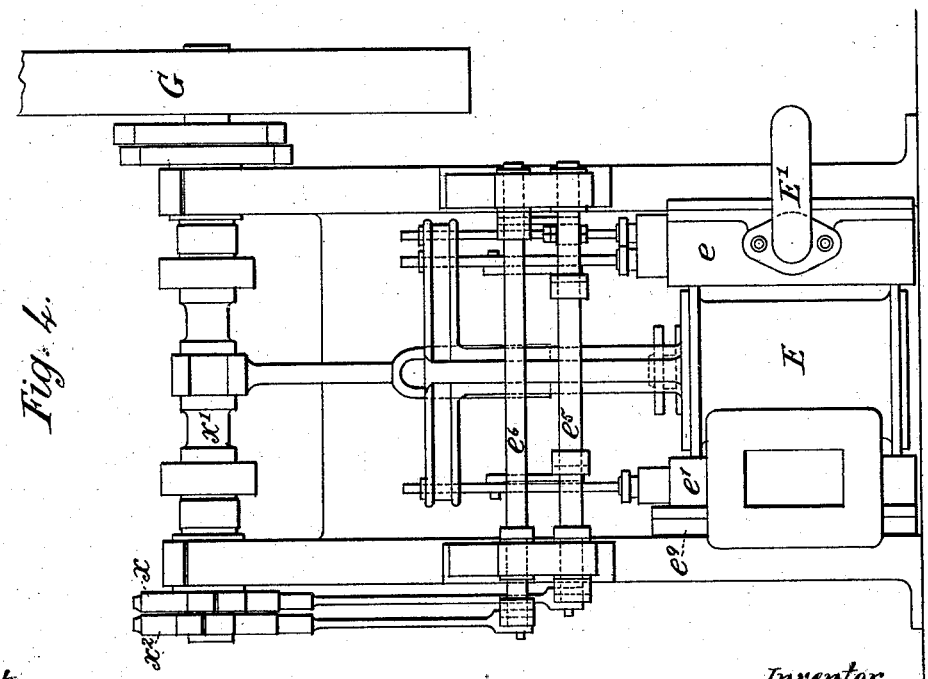

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Fig. 6.

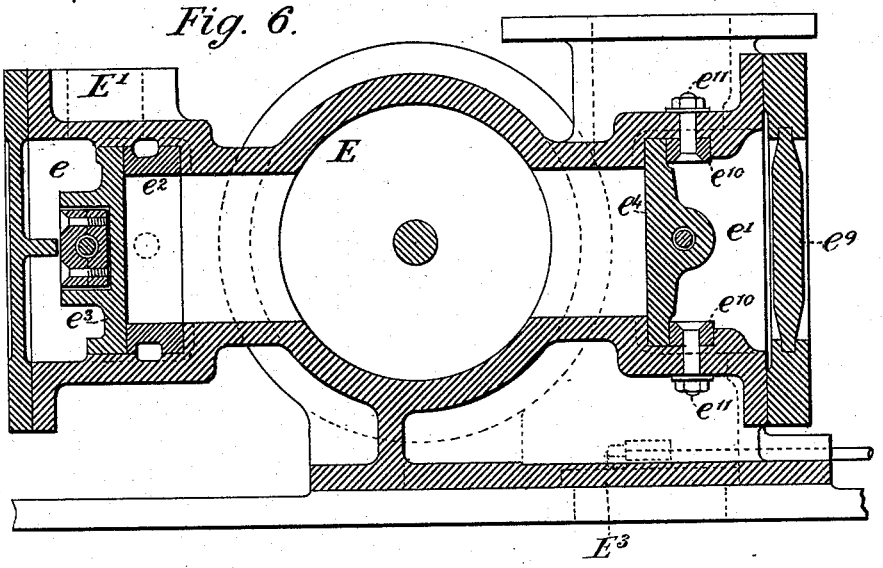
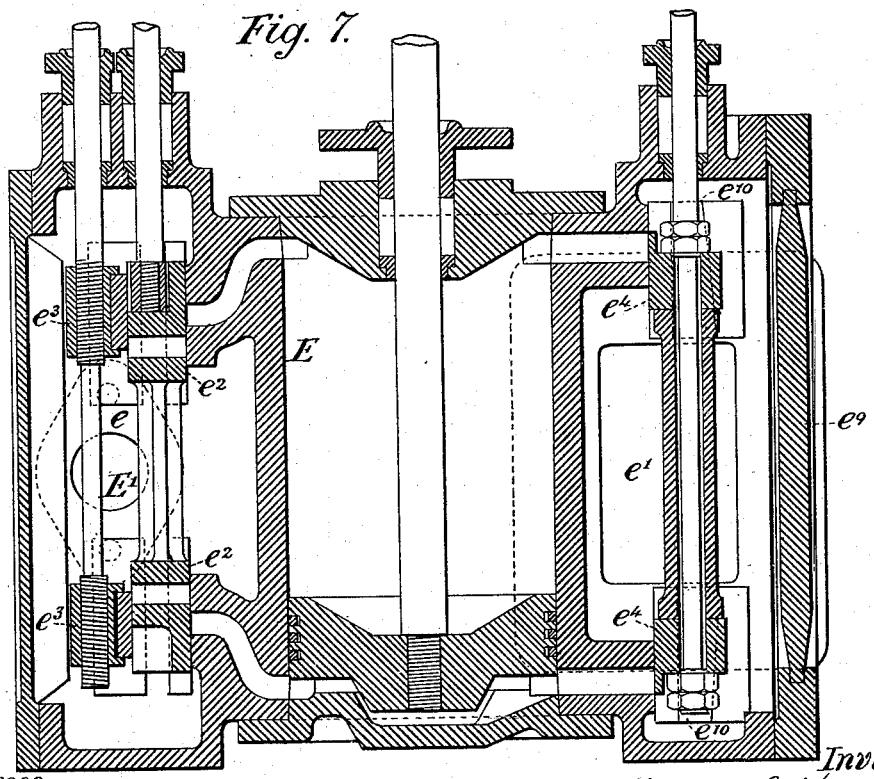


Fig. 7.



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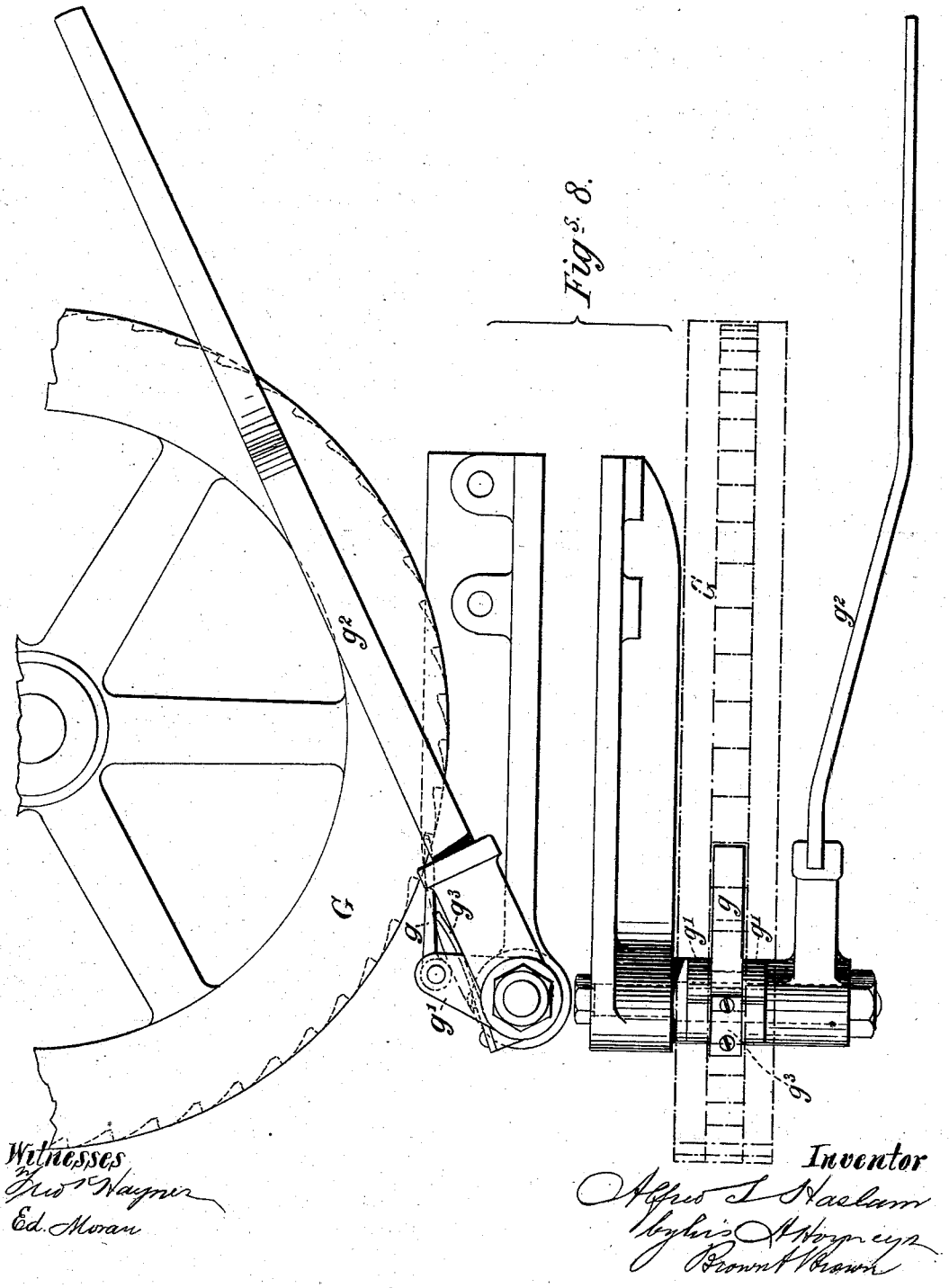

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UNITED STATES PATENT OFFICE.

ALFRED SEALE HASLAM, OF DERBY, COUNTY OF DERBY, ENGLAND.

REFRIGERATOR FOR COOLING AIR.

SPECIFICATION forming part of Letters Patent No. 261,708, dated July 25, 1882.

Application filed December 17, 1881. (No model.) Patented in England June 22, 1881, No. 2,740.

To all whom it may concern:

Be it known that I, ALFRED SEALE HASLAM, of Derby, in the county of Derby, England, engineer and iron-founder, have invented new and useful Improvements in Refrigerators, of which the following is a description.

This invention relates to a novel construction and arrangement of refrigerator for cooling air on the dry-air system—that is to say, without at any period of the cooling process bringing the said air into direct contact with the water used for such cooling. In this improved refrigerator the air to be cooled is first passed into a compressing-cylinder through improved suction-valves furnished with springs on the outside of the covers, which springs can be adjusted or replaced while the compressor is at work, the said cylinder and its valves being cooled externally by water circulating through helical passages formed in the jacket and covers thereof. The air leaves the compressing-cylinder by valves of special construction, which, with the inlet-valves, will be hereinafter more fully described, and passes thence through two or more sets of tubes within a condenser situate immediately beneath the said cylinder, around which tubes water is constantly circulating, whereby the temperature of the compressed air is lowered, and the air is caused to yield up a large portion of its watery particles. The air next enters an air-reservoir, and thence passes to a special apparatus, called a "collector and separator," situate below the air-reservoir and the condenser above named. The collector and separator consists of a series of tubes arranged in sets within a casing, the interior of which is brought into connection with the cold air from the meat-room or the expansion-cylinder, as may be desired, by a system of pipes and valves. The compressed air from the reservoir passes through the sets of tubes in the collector and separator, around which tubes the cold air from the meat-room or the colder air from the expansion-cylinder, as the case may be, is caused to pass, which air, by impinging upon them, greatly cools the compressed air passing through them. The compressed air next passes to the air-expansion cylinder, which is fitted with a novel arrangement of valves, allowing of adjustment, and a variable cut-off, and which are, moreover, readily accessible. The construction of this part of the refrigerator will be more fully described hereinafter. From the expansion-cylinder the cold air, at ordinary atmospheric pressure, passes to the meat-room or other structure the contents of which are to be cooled.

This improved refrigerator is specially designed for use on board ship, and it is for this purpose that its several parts, as well as the engine for operating the same, are combined, so as to be self-contained, and mounted on one bed-plate—an arrangement effecting great economy of space and the utmost efficiency in working. It has been found, however, that after the engine has ceased to work the large amount of energy stored in the compressed air within the reservoir and other parts of the apparatus is such that on slightly turning the fly-wheel the said air will drive the fly-wheel for some twenty revolutions. This starting of the fly-wheel, when at sea, is therefore attended with considerable risk to life, and in order to obviate this a novel arrangement of starting-gear is provided, by which gear the fly-wheel of this improved refrigerator may be started at a safe distance therefrom.

In addition to the general combination and arrangement of the several parts of the refrigerator in their relative positions, as above mentioned, which combination and arrangement are believed to be both new and useful, the refrigerator is constructed with improved devices for more effectually attaining the object in view. Thus the inlet and outlet valves of the compressing-cylinder and its spirally-channeled water-jacket, the collector and separator, the construction and arrangement of the air-expansion cylinder and its accessories, and the starting-gear for the fly-wheel of the refrigerator are each and all believed to be new and useful improvements, all working together for the economical and safe production of highly-cooled dry air. These several improvements will now be described in order, reference being made to the accompanying drawings, in which the same letters of reference indicate like parts.

Figure 1 is a side elevation of the improved refrigerator, and Fig. 2 is a plan view thereof.

A is the compressor, to which the air to be compressed passes alternately by the branch pipes A′ A′ through the improved inlet-valves

A^2 A^2 at either end of the cylinder, and from which the compressed air issues by the outlet-valves A^3 A^3 and branch pipes A^4 A^4, by which pipes it is conducted to and through two or more sets of tubes in the condenser B, around which tubes water entering by the pipe *b* is constantly circulating. The covers of the said condenser B are divided by partitions to insure the air passing from one set of tubes to the other in succession. When two sets of tubes are used one of the covers only need be divided to guide the air through them; but if three sets are used each cover will require a division-plate for this purpose. The water, after flowing around the tubes of the condenser B, passes by an opening or a short vertical pipe to the jacket of the compressor A, and circulates around the cylinder and valves of the said compressor through spiral passages formed in the jacket and communicating with channels formed in the cylinder-heads, by which means the water is thoroughly turned over and its cooling-power utilized to its highest degree. The water, after thus externally cooling the compressor, passes off by the pipe *a'*. The compressed air, after leaving the condenser B, passes to the compressed-air reservoir C, situate immediately beneath the condenser B and compressor A. This reservoir serves to insure regularity in working the apparatus. Below the said air-reservoir is the collector and separator D, which consists of a box or casing fitted with a series of tubes in sets, arranged substantially in the same manner as are those of the condenser B. The compressed air, after leaving the reservoir C, passes thence into one cover, D', of the collector D, which cover is divided to keep separate the currents of air passing through the two sets of tubes, after the manner already explained with reference to the condenser B. The air passes through one set of tubes and back again through another set of tubes, around which tubes cold air from the meat-room, or from the expansion-cylinder E, is drawn by the compressor A, the direction of the air being controlled by a suitable arrangement of sliding valves.

D^2 is the return-pipe from the meat-room to the collector, and D^3 is the pipe from the collector to the compressor, by which the cold air from the meat-room is drawn through the collector D and around the tubes therein.

E is the expansion-cylinder, arranged midway of one end of the base-plate, its valves being worked by eccentrics on the crank-shaft of the engine F, by the piston-rod of which the compressor is worked. On the end of this crank-shaft the fly-wheel G is mounted. This fly-wheel of the refrigerator is provided with improved safety starting-gear, which will be more fully described hereinafter. The compressed air, having been still further dried and cooled within the tubes of the collector D, passes by the pipe E' to the expansion-cylinder E, which cylinder it leaves by the main cold-air tank E^2.

Hand sliding valves E^3 and E^4 are provided for regulating the direction of the cold air, as follows: Should it become necessary to admit extreme cold air to the interior of the collector, so as to freeze the moisture contained in the compressed air, it will only be necessary to close the valves by which the air from the meat-room is drawn into the collector D and to open the sliding valve E^3 between the expansion-cylinder E and the said collector, at the same time turning the cock A^5 so as to open the pipe D^4 and close the pipe D^3. During this operation the valve E^4 may be partially closed, if necessary. The compressor A will then draw extreme cold air by the pipe D^4 from the expansion-cylinder E through the collector D, causing it to impinge on the tubes placed therein; or, if desired, air may be drawn to the compressor from the outer air by a pipe, A^6, provided with a suitable cock or valve, which will be ordinarily kept shut.

It will be observed that in this refrigerator the air to be cooled is separated from the cooling medium throughout its circulation through the apparatus, and that all the parts are arranged with respect to each other, according to the natural sequence of the several stages of the process.

In some cases I may dispense with the air-reservoir C, maintaining, however, the relative positions of the other parts of the apparatus, either in a vertical or a horizontal direction.

The special points of novelty in the compressor A and its accessories will now be described.

Figs. 3 and 3* represent the compressor A in side elevation (partly in section) and end view, respectively. A' designates the inlet air-pipes; A^2, the inlet air-valves; A^3, the outlet air-valves, and A^4, Fig. 3*, the outlet for the compressed air. The water for cooling the compressor enters by the opening *a*, and, circulating around the cylinder in a double spiral direction, as clearly indicated in the drawings, leaves the cylinder by the outlet *a'*. It will be seen that the cylinder-covers are deeply channeled to form passages which communicate with the two spiral passages around the cylinder, and that the valves A^2 and A^3 are thus brought into close proximity with the cooling medium.

Each of the air-inlet valves A^2 consists essentially of a disk, a^2, having a hollow stem working in a fixed sleeve, a^3, and opening inward. The outer end of the hollow stem is screwed to receive a cap through which a spindle is passed. The spindle passes through the cover, and is surrounded by a coiled spring contained within a hollow casting, a^4, bolted to the outside of the cover. A disk, a^5, or its equivalent, is passed over the end of the spindle, which is threaded at its extremity to receive a nut, and by means of this nut the coiled spring may be compressed to any required degree, and thus necessitate a greater or less air-pressure to be exerted in order to open the valve. A washer of rubber, prefer-

ably protected by a metal rim, is secured to the inner end of the cap, and thus all shock to the working parts of the valves is obviated. The outlet-valves A^3 each consist of a disk, a^2, having a hollow stem working in a fixed sleeve, a^3, bolted to the outside of the cover. Into the center of this sleeve a rod is screwed, and its inner end bears upon a coiled spring contained within the hollow stem of the valve-disk a^2, which is thus kept upon its seat until the compressed air forces it outward. An additional coiled spring is contained within the sleeve a^3, and surrounds the fixed rod above named, thus preventing the outer face of the valve-disk a^2 from coming violently in contact with the end of the hollow sleeve a^3. By this construction of the inlet and outlet valves I obtain great strength of the working parts, combined with lightness and simplicity of construction, a large bearing-surface for the valve-stems, and easy access to the working parts from the outside. The compressed air from the compressor A next passes to the sets of tubes within the condenser B, which has been already described, wherein it is cooled by the flow of water around the said tubes, and without coming into direct contact with the cooling medium. From the condenser B the compressed air passes to the air-reservoir C, which reservoir, it should be remarked, is not absolutely necessary to my invention of a refrigerator for producing cold dry air, but which is preferably employed in combination with the upper parts of the apparatus, as already described with reference to Figs. 1 and 2, and serves to increase the efficiency by insuring the regular working of the machine. From the reservoir C the compressed air enters the collector and separator D, which consists of a casing fitted with a series of tubes through which the compressed air passes. This part of the invention has already been sufficiently described, and its construction and operation will be readily understood on reference to Fig. 1 and the aforesaid description. Its object is to still further dry and cool the compressed air, for which purpose it is fitly placed below the condenser B and reservoir C, and immediately before the expansion-cylinder E.

It should be especially noted that by the above construction and arrangement of apparatus the small amount of moisture in the air may be allowed to deposit within the tubes of the collector and separator D in the form of ice or snow without risk of stopping them, inasmuch as the system of cooling the compressor and the condenser tubes by the external application of water does not load the air with so much moisture as would, when passing through the collector, choke the tubes thereof with snow and cause a breakdown of the apparatus. Should, however, the pipes collect too much snow or ice, the current of air is reversed by the cock or valve A^5, fresh air being drawn into the machine and the circulation of cold air round the tubes being suspended. The air from the reservoir passing through the tubes at a higher temperature cleans the tubes from such ice or snow, and the air passing through the tubes is further cooled in its passage. The air, after leaving the collector D, is led by the pipe E′ to the expansion-cylinder E, the construction and arrangement of which will now be described. The receiving-chest and expansion-chest or snow-box of this cylinder are placed at opposite sides thereof, or, if preferred, one at the side and the other at the front or top. This arrangement permits of separate valves being used for the supply and exhaust, and the supply-valve under these conditions can be fitted with a variable cut-off, and the valves may be reduced to a small size, which diminishes the friction to a minimum and effects a saving of power. This arrangement permits of short straight ports being used in all connections in the exhaust—a matter of great importance in refrigerating apparatus. Air expanding under these conditions does not permit snow or ice to form in the said ports and obstruct the passage of air. The exhaust-valves can also be carefully adjusted to the face of the ports, and by reason of the expansion-chest not having to resist internal pressure its cover may be constructed of wood or any light non-conducting material, and made easily removable to clear the chest of any snow that may form therein. The rods which work the valves for admitting the air to and exhausting it from the expansion-cylinder derive their motion from an eccentric common to both through a rocking shaft, arms keyed thereon, and link-rods. The shaft carrying the eccentric just mentioned is furnished with a second eccentric for working the cut-off valve. This valve is connected by a link-rod to an arm of a rocking shaft, a second arm from which is jointed to the rod of the second eccentric.

In the accompanying drawings, Fig. 4 is an end elevation of the refrigerating apparatus, showing the expansion-cylinder. Fig. 5 shows on an enlarged scale the means for adjusting the cut-off and the indicator for regulating the extent of such adjustment. Fig. 6 is a horizontal section, and Fig. 7 is a vertical section, of the cylinder and its accessories.

In these figures, E is the cylinder to which the compressed air is conducted from the collector and separator through the pipe E′ e is the receiving-chest, and e' the expansion-chest or snow-box, placed respectively on opposite sides of the cylinder E, as shown in the drawings; or it may be one at the side and the other at the front or top of the cylinder, by which means separate valves are used for the supply and exhaust, thus allowing of a variable cut-off for the supply-valve and the use of valves of small size.

e^2 is the supply-valve, e^3 the adjustable cut-off valve, and e^4 the exhaust-valve. The valves e^2 e^4 are worked by an eccentric, x, common to both on the crank-shaft x', through the horizontal rock-shaft e^5 and arms keyed thereon, one of the arms being connected to the rod of the eccen-

tric, and the other two being connected to the rods of the supply and exhaust valves. The cut-off valve e^3 is worked by the eccentric x^2, through the rock-shaft e^6 and lever-arms keyed thereon, one of which arms is connected to the cut-off-valve rod by a suitable link. The cut-off-valve rod, it will be seen, is threaded at two points with right and left handed threads, respectively, to receive correspondingly-threaded blocks, which are made with recesses to carry the removable pieces serving as valve-faces, and together with them constitute the cut-off valves. The rod of this cut-off valve, it will be seen from Fig. 5, passes through a block, e^7, to which is attached one end of the link whereby it is actuated. This block e^7 is secured to the rod by means of the shoulder below it and the nuts above it. On slackening these nuts the rod may be rotated by a spanner applied to the hexagonal shoulder, and by its rotation will cause the threaded blocks, which carry the removable wearing-pieces serving as the faces of the cut-off valves e^3, to recede from one another or to approach one another, thus regulating the cut-off. The relative positions of the wearing-surfaces of the said cut-off valves e^3 with respect to the inlet-ports of the supply-valves e^2 may be ascertained with exactitude by the pointer e^8, which protrudes through a slot cut in the face of the block e^7, and which is caused to travel up or down the graduated face of such block as the cut-off-valve rod is rotated to the right or left. This traverse motion of the pointer e^8 is effected by its rear end being threaded (or formed with a tooth) and lying in close contact with a threaded portion of the cut-off-valve rod within the block e^7, as will be readily understood.

The exhaust-valves e^4 are also capable of easy adjustment upon their rod by means of the nuts which hold the valve-surfaces in place upon the rod which works them. In order to set up or adjust the wearing-surfaces of the exhaust-valves to the face of the expansion-chest against which they work, wedge-shaped blocks e^{10}, Fig. 6, are employed. These wedge-shaped blocks are interposed between the outer face of the valve-pieces e^4 and inclined surfaces formed in the walls of the expansion-chest e'. The wedge-blocks are slotted to allow of their vertical adjustment, and they are then clamped securely by the clamping-bolts e^{11}. By these means both the upper and lower valve-pieces, e^4, can be forced against the face of the expansion-chest with any desired pressure. Access to these adjusting-nuts and wedge-shaped blocks may be easily had by removing the cover e^9 of the expansion-chest or snow-box e', which cover, by reason of there being no internal pressure of air to resist, is made of wood or other light non-conducting material, and may be consequently handled with ease.

The invention relates, lastly, to a simple arrangement of starting-gear for putting the engine of the refrigerator in motion when it has stopped on a dead-center. This arrangement consists in the use of teeth or notches cast on the side or, by preference, on the periphery of the fly-wheel G, as shown in Fig. 8, taking into which teeth is a pawl, g, mounted on a rocking piece, g', cut or formed in one with a socket, into which a hand-lever, g^2, is inserted, which lever serves to operate the rocking piece g' and pawl g, thus starting the fly-wheel. The pawl g is thrown into gear (when in action) with the teeth of the fly-wheel G by the upward pressure of a spring, g^3; but when the hand-lever is dropped the pawl will drop out of gear. The rocking piece g' and the hand-lever g^2, connected therewith, may be mounted upon a stud-axle carried by a bracket-bearing, as shown in the drawings; or it may be upon a standard bolted to the flooring or to the deck of the vessel.

Having now set forth the nature of my said invention of improvements in refrigerators, and having explained in what manner the same may be carried into practical effect, I wish it to be understood that I claim—

1. A refrigerator in which the air to be cooled passes, first, into a compressor, A, cooled externally by water flowing around its spirally-channeled cylinder and around the valves in its covers; secondly, into and through two or more sets of tubes in a condenser, B, situate immediately beneath the said compressor A, within which tubes the moisture in the air is condensed by the action of the water flowing around them; thirdly, to an air-reservoir—such as C—the greater part of which reservoir is situate immediately beneath the said condenser B, and serves also as a bed-plate for the engine F; fourthly, into and through the tubes of a collector and separator, D, the space within the said collector and around the said tubes being connected by pipes with the air-expansion cylinder E, the cold room, and the compressor A, as and for the purpose specified; fifthly, into an air-expansion cylinder, E, situate midway of the end of the refrigerating apparatus and vertically beneath the crank-shaft of the motive-power engine F, which engine is arranged on a level with the compressor A, and above the condenser B and air-reservoir C, the whole of the several parts above named being arranged substantially as and for purpose specified.

2. The combination of the compressor A, condenser B, collector D, expansion-cylinder E, and engine F, in the manner and for the purpose herein specified.

3. An air-compressor having spiral channels around its cylinder for the circulation of the water, whereby it is cooled, and channels in its end covers around the inlet and outlet valves of the compressor, whereby they may be cooled by the said water, the said inlet and outlet valves being constructed and arranged as and for the purpose set forth.

4. In an air-compressor, an inlet-valve consisting substantially of a valve-disk having a central stem (preferably made hollow for strength and lightness) working within a fixed sleeve, and connected by means of a buffed

cap-piece and a rod, or its equivalent, with a spiral spring contained within a casting situate on the outside of the cylinder-cover, the whole arranged and operating as and for the purpose specified.

5. In an air-compressor, an air-outlet valve consisting substantially of a valve-disk having a hollow stem working within a fixed sleeve fitted in the cylinder-cover, and accessible from the outside thereof, in combination with a rod situate within the hollow sleeve, one end of said rod bearing against a spiral spring contained within the hollow stem of the valve-disk, and a second spiral spring or an equivalent elastic medium placed around the rod situate centrally within said sleeve, whereby shock to the working parts is prevented, all substantially as and for the purpose specified.

6. In combination with the condenser of a refrigerating-machine, in the tubes of which condenser the compressed air is cooled by water circulating around them, a collector and separator wherein the compressed air is further cooled and freed from moisture, such collector and separator being constructed and connected by pipes and valves with the compressor, the expansion-cylinder, and the cold room in the manner and for the purpose specified.

7. In a refrigerating machine, an expansion-cylinder—such as E—fitted on one side or face with a supply-valve, and a cut-off valve made adjustable in the manner described, and on the opposite or an adjacent side or face with an exhaust-valve, which allows the expanded air to pass off through short straight ports, the said exhaust-valve being capable of adjustment in the manner shown and readily accessible from the snow-box, which is fitted with a cover of wood or other light non-conducting material, all substantially as and for the purpose specified.

8. In combination with the toothed fly-wheel of a refrigerator, the safety starting device hereinabove described, consisting substantially of a lever, g^2, in combination with a short arm or rocking piece, g', carrying a pawl, g, and a spring, g^3, as and for the purpose specified.

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