(No Model.)

J. STURGEON.

APPARATUS FOR COOLING, DRYING, AND PURIFYING AIR.

No. 263,620. Patented Aug. 29, 1882.

Fig. 1.

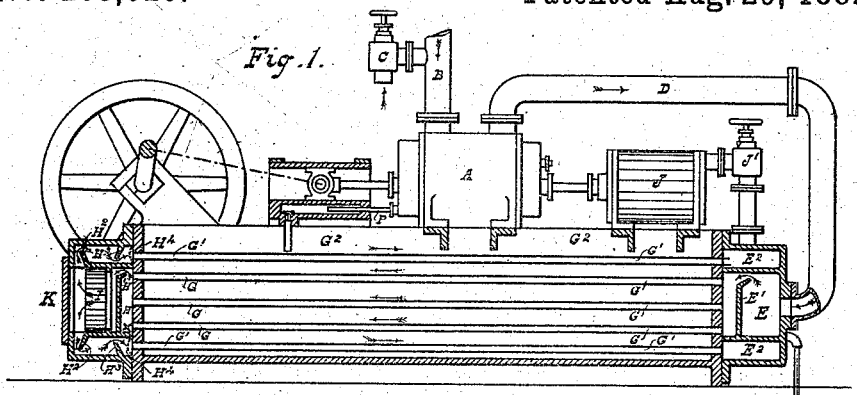


Fig 2

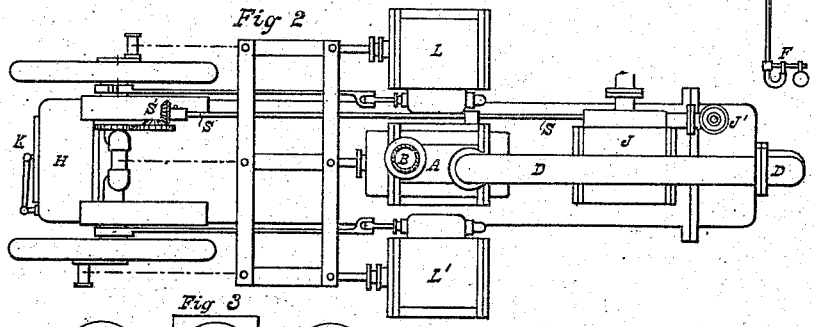


Fig 3

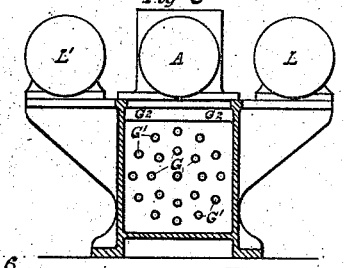


Fig 4

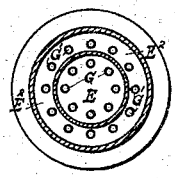
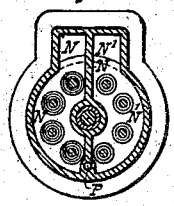


Fig 6



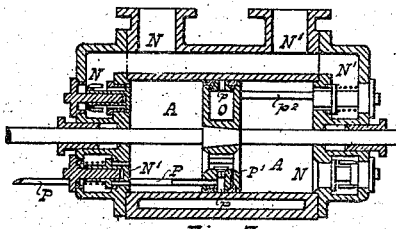


Fig. 5.

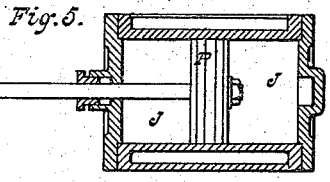


Fig 7

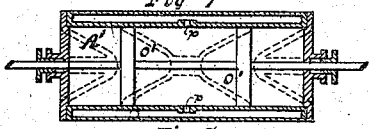
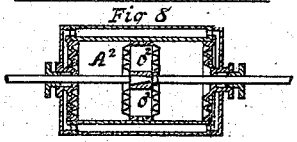


Fig 8



Witnesses
Wm. W. Church,
J. Egan Bull

Inventor
John Sturgeon By
Amos Broadus Atty

UNITED STATES PATENT OFFICE.

JOHN STURGEON, OF WESTMINSTER, COUNTY OF MIDDLESEX, ENGLAND, ASSIGNOR TO JOHN WILFRED DE VILLEMONT GALWEY AND GEORGE WILLIAM BAINBRIDGE, OF WARRINGTON, ENGLAND.

APPARATUS FOR COOLING, DRYING, AND PURIFYING AIR.

SPECIFICATION forming part of Letters Patent No. 263,620, dated August 29, 1882.

Application filed April 19, 1882. (No model.) Patented in England December 21, 1877, No. 4,863.

To all whom it may concern:

Be it known that I, JOHN STURGEON, a subject of the Queen of Great Britain, and a resident of 3 Westminster Chambers, Victoria street, in the city of Westminster, in the county of Middlesex, in that part of the United Kingdom of Great Britain and Ireland called England, engineer, have invented certain new and useful Improvements in Apparatus for Cooling, Drying, and Purifying Air, (for which I have obtained Letters Patent for Great Britain, No. 4,863, bearing date 21st December, 1877;) and the following is a full, clear, and exact description of my invention in such full, clear, and exact terms as to enable any one skilled in the art to which it appertains or is most nearly connected to make and use the same, reference being had to the sheet of drawings annexed to this specification, and to the figures of reference marked thereon.

My invention has for its object improvements in and appertaining to machinery and apparatus for cooling, drying, and purifying atmospheric air for refrigerating purposes.

It is well known that when a volume of air occupying a certain space at its normal temperature and pressure is compressed into a smaller space, the same quantity of heat that was distributed through its original volume and forming its natural temperature being concentrated into less space, the air must show a rise in temperature above that of the surrounding atmosphere. If the heat thus generated by the compression of the air be absorbed and carried off, so as to reduce the air in its compressed state to the same temperature as the surrounding atmosphere, or nearly so, and the compressed air thus cooled be made to do work and allowed to expand back into its original space or volume, a considerable lowering of the temperature will result. This well-known principle is applied in all descriptions of machinery for refrigerating by the compression, cooling down, and expansion of atmospheric air, the compression and expansion being generally effected by means of two cylinders—one for compressing and the other for expanding—having their pistons and rods geared together, so that the compressed air, while expanding in the one cylinder, is returning a portion of the power employed in compressing it by assisting to drive the machine. To cool the air while compressed by extracting the concentrated heat, it has hitherto been the practice before passing the compressed air into and through the receiver and cooling-tank to inject water into the compressing-cylinder, thus bringing the air and water into direct contact, and, in fact, mixing them. The objection to this plan is that the expanded cold air is charged with moisture, which rapidly forms large quantities of ice and snow, rendering the cold air unfit for direct application for most refrigerating purposes. Heat is also abstracted from the compressed air by surface-contact with cold surfaces, such as metal pipes and water-filled vessels.

My invention may be carried out by using compression-cylinders with a piston of the following construction: I make the piston hollow, with openings carried entirely through its periphery between the packing or piston rings. Into the hollow piston I fix a pipe turned on the outside and long enough to pass through a stuffing-box in the cylinder-cover and into a circulating pump-cylinder which is fixed outside in such a manner that at each stroke of the engine the pipe works a single-acting ram-pump and forces the water or its substitute through into the hollow piston and through the openings in its periphery and coming into contact with the interior surface of the cylinder, the water afterward escaping through another pipe, passing through the same or the opposite cylinder-cover; or the pipes may be applied as ram-pumps at both ends of the cylinder.

In lieu of a single hollow piston, the same object may be attained by using a duplex piston separated so as to form a chamber into which the water can pass and at the same time be in contact with the inside surface of the cylinder. The compressing-cylinder is surrounded with a water-jacket, through which a constant circulation of water is maintained. The water may be first admitted into the inte-

rior of the compressing-cylinder between the two pistons, being the center of the cylinder through an opening on the top and about the middle of the cylinder, and passing out through another opening or openings into the water-jacket or elsewhere, such water in no case coming in direct contact or mixing with the air in the top or bottom of the cylinder.

In lieu of the pipes before referred to for supplying the interior of the piston, the water or its substitute may be taken in through the piston-rod, which is made hollow for the purpose.

My invention may further be carried out by constructing the cylinder-covers and water-containing piston of the compressing-cylinder with concentric projecting water-spaces, the water-spaces or projections on the piston fitting into the female spaces formed by the concentric water-spaces or projections on the cylinder-covers.

In further carrying out my invention I may fix the compression and expansion cylinders horizontally, the one behind the other, and geared together by continuation of the piston-rod from one to the other. The cylinders are set upon an iron bed, forming at the same time the cooling-tank or receiver for the air heated by compression. The cooling-tank or receiver is formed into compartments, the end compartments forming compressed-air chambers and the center compartment being the cooling-tank, which is constructed with a number of tubes passing through it, connecting the air-chambers, around which tubes a circulation of cold water is maintained. The receiving air-chambers are divided so that the air when compressed into the one has to pass through one set of tubes to the other air-chamber, returning through another set of tubes to the last chamber, or vice versa. The circulation of the compressed air is thus effected through the cooling-tubes, and the heat generated by compression is thus further absorbed and carried off. The air, being kept from direct contact with the water used for cooling, will be free from moisture, except that generally contained in the atmosphere in the form of aqueous vapor. The combined action of compression and of the discharge of heat from the air will tend to condense this aqueous vapor, and when most of it is thus discharged I carry it off by means of a trap or traps applied to the lowest parts of the compressed-air chambers where this condensed moisture accumulates. The trap consists of a tube hanging vertically downward and closed at the bottom by a valve weighted to open only when the pressure upon it exceeds the proposed pressure in the air-chambers. When sufficient water is collected in the tube or trap to overcome by its additional weight the spring or otherwise retained valve, the valve will open and allow the water to run out until the weight is relieved sufficiently to allow the valve to close again. To get rid of the remaining moisture in the air as far as possible, I apply in one or more of the compressed-air chambers, by preference the second receiving-chamber, a wire-work cradle or equivalent contrivance filled with carbon; or I use baffle-plates, tubes, or plugs of carbon, which, besides absorbing any noxious particles, also absorbs the moisture from the air while still under pressure, and consequently before such moisture can be precipitated in snow or ice by the cold produced when the air is expanded. Coke, pumice-stone, cinders, peat charcoal, or other suitable substance may be used for absorbing the moisture. I provide a suitable door to the chamber to facilitate the placing and removal of the absorbent substance.

To apply this my invention to, say, a meat-safe or refrigerator, I convey a pipe from the refrigerator close to the inlet-valves of the compressing-cylinder. As the air is drawn from the refrigerator or from the outside it is compressed into the air-receiving chamber, then passing through the tubes in the cooling-tank and through the absorbing apparatus in the air-chamber back to the other air-chambers, from which the expanding-cylinder is supplied, and from the expanding-cylinder air is discharged to the refrigerator in a cold dry state. By these means a continuous supply of pure cold air can be delivered in a sufficiently dry state and at a temperature which can be regulated at will by regulating the speed of the apparatus or the grade of expansion and the circulation of the water in the cooling-tank.

The construction of apparatus according to my invention will be understood by reference to the drawings, in which—

Figure 1 represents a side elevation of a refrigerating or cold-producing machine constructed in accordance with my invention, showing the cooling-tank and the two end chambers in section. Fig. 2 is a plan of Fig. 1. Fig. 3 is a cross-section through the cooling-tank. Fig. 4 is a cross-section through one of the end chambers. Fig. 5 is a longitudinal section, on an enlarged scale, of the compression and expansion cylinders. Fig. 6 is a cross-section of the end covers of the compression-cylinder, showing inlet and delivery valves.

A is the compressing-cylinder, into which the air passes from the refrigerating-chamber, or otherwise, through the pipe B, which has a valve attached at C for the admission of the external atmospheric air, which may be used when required. After compression in the cylinder A the compressed air passes through the pipe D to the chamber E, where it meets the baffle-plate E′, at which point much of the water contained in the air will be discharged, and is drained off through the pipe and trap F, the air passing round to the other side of the baffle-plate E′ in a much drier state, and thence through the inner set of tubes G G to the chamber H at the other end of the cooling-tank. Here it impinges on the baffle-plate H′,

and any further water discharged is drained off by a trap, similar to that shown at F, placed at the point marked X. The compressed air thus further dried then passes to the other side of the baffle-plate H′, then through the wire-work cage I, filled with charcoal or other suitable substance, which further absorbs the damp and abstracts deleterious particles from the air. The air now passes over the baffle-plates H^2 to the outer annular space of the chamber, meeting the baffle-plates H^3 and the wire-gauze or perforated covering H^4, all of which assist in further drying the air, which then passes through the outer range of pipes G′ to the chamber E^2, where it is received in a dried, purified, and cooled state through its treatment in the tank pipes and chambers, the pipes G G′ being surrounded with cold water, and the surface-contact cooling the air in its passage through the pipes. From the chambers E^2 the air is admitted to the expansion-cylinder J through the stop-valve J′. The air, after performing work in the expansion-cylinder J, passes through the exhaust-pipe, and the expanded air is led to the refrigerator in an intensely cold, dry, and pure state, the air circulating through the refrigerator and back to the compressing-cylinders, or otherwise.

The cooling tank and chambers H may be provided with drain-tubes at all the low points where the moisture discharged from the compressed air is likely to collect. The chamber H is provided with a hinged door, K, to enable the wire-work cage I to be readily removed and replaced when the carbon or other absorbing and purifying material with which it is filled requires renewal. The air-cylinders A and J are driven by means of the steam-cylinders L L′ through the crank-shaft M, the whole being mounted on and carried by the cooling-tank G^2, as shown.

A constant circulation of cold water through the hollow piston O of the compression-cylinder may be maintained through the pipe P, the check-valve P′, and the outlet-pipe P^2. The water circulating through the hollow piston comes in contact with the interior surface of the cylinder A through the openings *p*, and effects the necessary lubrication without coming into direct contact with the air, and also serves to further cool the cylinder and air.

Fig. 7 is a sectional elevation of a cylinder, showing another mode of internal cooling of the cylinder, and thereby the air under compression. In this example two pistons are used, fastened to one rod at sufficient distance apart to allow of the full piston travel without overrunning the openings *p*, through which water is admitted into the space O. The cooling-surface may be further increased by arranging the piston and covers in the form shown by the dotted lines, or by corrugating the piston and covers, as shown at Fig. 8.

Having now described my invention and shown how the same may be put into operation, I claim—

1. The process of cooling, drying, and purifying atmospheric air for refrigerating purposes, which consists in compressing the air and passing it while still under compression through chambers provided with baffle-plates and absorbents, in combination with a nest of pipes and a water-tank and expanding the air through an expansion-cylinder, where it performs work, all substantially as described.

2. In the cooling, drying, and purifying of atmospheric air for refrigerating purposes by means of compression, surface-cooling, and, after expansion, the process of extracting the heat and moisture by surface-cooled tubes, baffle-plates, and absorbents while the air is still under compression, substantially as described.

3. The combination, in a cold-air-producing machine, of a compression-cylinder with a cooling-tank having air-chambers provided with baffle-plates and moisture-absorbing devices, such chambers being connected by a nest of pipes and one chamber communicating with the expansion-cylinder, all substantially as described.

4. The construction and arrangement of the compressing-cylinder A, the cooling-tank, and accessory parts G^2, the expansion-cylinder J, and the steam-cylinders L L′, substantially as shown, for the purpose specified.

5. In an air-compressing cylinder, the combination of the hollow piston O with the water-circulating pipes P P^2 and the opening *p*, all substantially as set forth.

6. In an air-compressing cylinder, the construction of the piston O′ and the cylinder A′, substantially as shown, and for the purposes specified.

7. In an air-compressing cylinder, the construction of the piston O^2 and the cylinder A^2, substantially as shown, and for the purposes specified.

8. The arrangement and construction of cylinder and piston, consisting of corrugating the ends of the cylinder and corrugating the top and bottom of the water-piston, as herein described, and substantially as shown in the drawings.

In witness whereof I, the said JOHN STURGEON, have hereunto set my hand and seal this 25th day of March, 1882.

JOHN STURGEON. [L. S.]

Witnesses:

EBENEZER ELLIOT,

WILLIAM POLLARD,

Both of 14 *Seaside Road, Eastbourne.*