J. B. ROOT.

Air-Compressing Apparatus.

No. 196,253. Patented Oct. 16, 1877.

Fig. 1

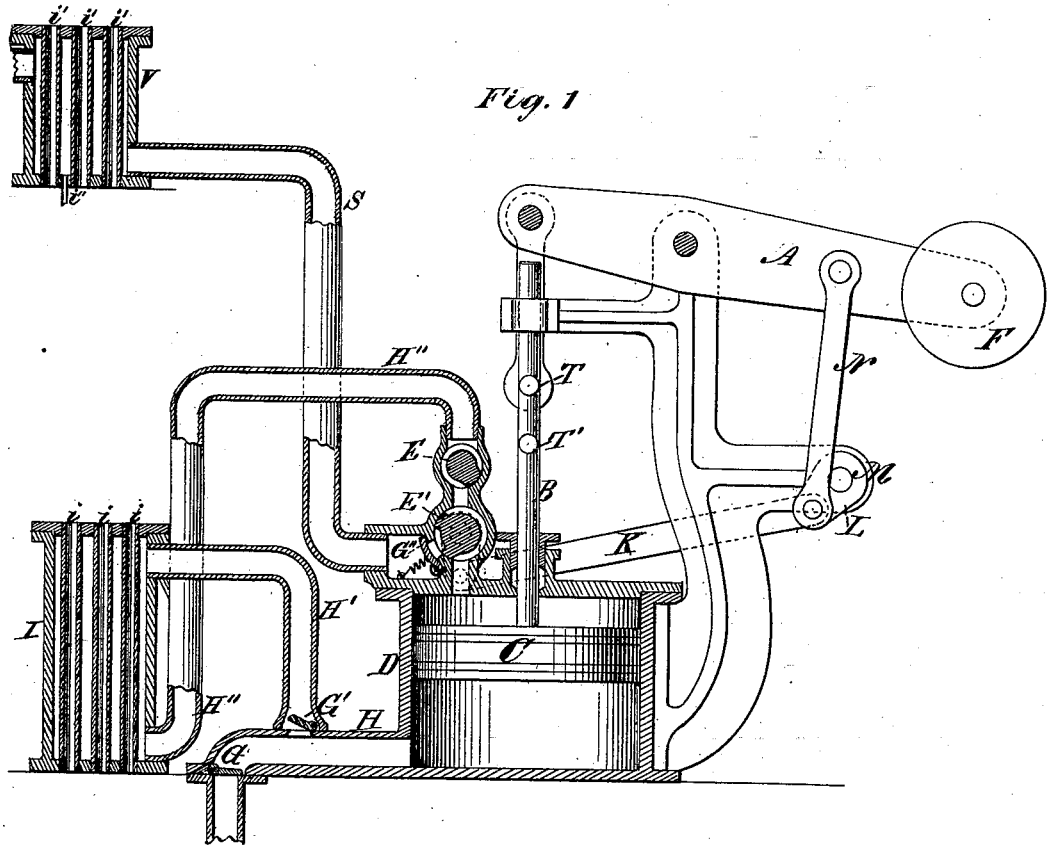
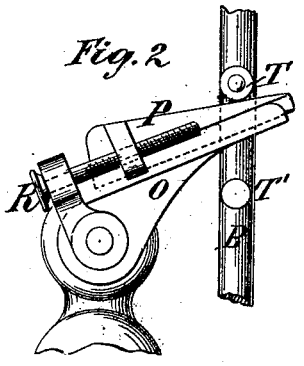


Fig. 2



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JOHN B. ROOT, OF PORT CHESTER, NEW YORK.

IMPROVEMENT IN AIR-COMPRESSING APPARATUS.

Specification forming part of Letters Patent No. **196,253**, dated October 16, 1877; application filed April 17, 1877.

To all whom it may concern:

Be it known that I, JOHN B. ROOT, of Port Chester, in the county of Westchester and the State of New York, have invented an Improvement in Apparatus for Compressing Air, for the purpose of obtaining heat therefrom, also applicable to the purpose of effecting refrigeration; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification.

My invention has for its object the utilization of power from windmills, water-wheels, or other cheap power derived from natural sources, in the production of sensible heat, and it is based upon the following established scientific principles:

First, when a permanently gaseous body is compressed a certain portion of its specific heat is rendered sensible, a rise in the temperature of the compressed gaseous body takes place, and the heat so rendered sensible may be transferred by radiation, conduction, or convection to any other body having a lower temperature. The work performed in the compression, except such portion as is consumed in overcoming the friction of the apparatus, has its mechanical equivalent in the heat rendered sensible in the compressed gas, and the heat rendered sensible, except such part of the same as may be lost by radiation from the compressing apparatus, may be utilized for any purpose to which heat generated by combustion may be applied.

Second, the greater the compression of the permanent gas the greater will be the elevation of temperature in the same, and the larger will be the quantity of sensible heat possible to extract from it for useful purposes.

Third, the gaseous body, after it has been compressed and the heat has been extracted from it till its temperature is lowered to, or even below, that which existed in it previous to compression, has remaining in it an expansive force, by virtue of which it will perform work, but in so expanding its temperature falls. In this condition it will extract heat by radiation, conduction, or convection from any body having a higher temperature, acquiring, by heat so extracted, an accession of expansive force.

Fourth, during the expansion of such permanent gas it is capable of performing useful work, no matter at how low a temperature the compressed volume of the gas may be at the commencement of its expansion; and though it can never reach its original volume under the original pressure without from some source recovering as much heat as has been extracted from it, yet, through the limits of its expansion, it acts precisely as do compressed gases at higher temperatures, in the actuation of motors which may be applied to the impelling of machinery or the compression of other volumes of the same gas for obtaining heat therefrom.

It is the last-named application—*i. e.*, the use of the expansion of compressed gaseous volumes from which heat has been extracted to aid successively in the compression of other volumes of the same aeriform body from which it is desired to extract heat—that is the principal feature of my invention, which, according to accepted theories of the correlation of forces, might be appropriately styled an "apparatus for converting motion of masses into heat."

My invention partly consists in the combination, with an air-compression pump, cooling-receiver, and a working cylinder in which the expansive force of the compressed air is utilized after cooling the air in the receiver, of a variable cut-off valve applied between the receiver and the working cylinder, for the purpose of regulating the compression of the air in the receiver and its expansion in the working cylinder, and thereby regulating the degree of heat obtained by the compression of the air.

The invention also consists partly in the combination, with such air-compression pump, cooling-receiver, working cylinder, and its piston, of a refrigerator connected with the eduction-passage of the working cylinder.

The invention further consists in the combination, with an air-compression apparatus in which the air is used expansively after compression, of a check-valve arranged within or applied to the exhaust-passage of the working cylinder in which the expansive force of the air is utilized after cooling said air in said receiver, and which, at the opening of the exhaust, prevents the entrance through said exhaust-passage of external air into the cylinder

when the air in such working cylinder has been expanded below atmospheric pressure.

In carrying out my invention, a separate cylinder and piston, either single-acting or double-acting, may be used for the compression-pump, and a separate cylinder and piston, either single-acting or double-acting, may be used as the working cylinder and piston; or the pump-cylinder and working cylinder may be combined in one, and the pump-piston and working piston may be combined in one by the use of a single cylinder containing a single piston, the air being admitted into the said cylinder at one end to be compressed, and being, after its compression on one face of the said piston, expelled from the same end of the cylinder, and the cooled compressed air being admitted to the said cylinder at the other end, to act by its expansion on the other face of said piston.

As the combination of the pump-cylinder and piston and the working cylinder and piston in a single cylinder and piston affords the simplest mode of illustrating and carrying out my invention, I have selected that mode for illustration and detailed explanation of its construction and operation.

Figure 1 in the drawing is a partial side elevation and a partial vertical and longitudinal section of the apparatus. Fig. 2 is an enlarged detail view of a variable cut-off device used in connection with the apparatus.

In Fig. 1, A represents a working beam, through which power is transmitted to the piston-rod B, connected with the piston C working in the cylinder D. This working beam is represented as receiving power through a connecting-rod, N, from a crank, L, on a shaft, M, which derives rotary motion from a water-wheel, windmill, or other prime mover; but instead of such working beam, connecting-rod, crank, and shaft, any other suitable means of transmitting power from a windmill, water-wheel, or other prime mover to the piston C may be employed.

When a working beam is used, it is advantageous to use a counterbalancing weight, F, on the end of the working beam remote from the end connected with the piston.

The air may be compressed on either side of the piston C, and the expansive force of the cooled air utilized on the opposite side of said piston to that which compresses the air; but in the example of my invention shown in the drawing the compression is performed in the cylinder D, below the piston, the lower face of which constitutes or acts as a compression-pump piston, the air to be compressed being admitted to the cylinder below the piston through the valve G, which also prevents the escape of the air during compression, after the manner of a pump-valve.

The forcible descent of the piston C forces the compressed air out of the cylinder D, through the pipes H H′ and the valve G′ into one or more receivers, I, the valve G′ preventing the return of the air through said pipes.

Said receiver may be supplied with vertical pipes or passages *i*, for the circulation of air or water to extract the heat generated by compression from said receiver; or it may consist wholly or in part of a system of pipes or radiators, or be otherwise constructed to afford convenience in extracting the heat therefrom for any specific purpose.

The cooled air is conveyed back from the receiver I to the cylinder D through the pipe or passage H″, to utilize its expansive force in said cylinder on the upper face of the piston C, which face constitutes, or is acted upon as, a working piston, the induction and exhaust of the said air to and from the upper end of said cylinder being controlled by an induction and eduction valve, E′, and a cut-off valve, E, as hereinafter described; but a single valve may be used, performing the functions of an induction and eduction valve and a cut-off valve; and I do not confine myself to any particular construction or arrangement of valve or valves, or cut-off device for actuating one or more valves for controlling the induction of compressed and cooled air, and the exhaust of the said air from the cylinder in which its expansive force is utilized.

The valve G″ prevents external air from entering the cylinder through the pipe S when the air above the piston has expanded below atmospheric pressure, and the valve E′ is opened to allow the exhaust of the same.

The oscillating valve E′ represented is constructed and operated to effect the induction of air to the cylinder throughout its whole downward stroke, and to effect the eduction of the air from the cylinder throughout the whole upward stroke, operating like an ordinary D slide-valve, without lap or lead. It is actuated by a rock-bar, through a connecting-rod, K, from a crank or an eccentric on the main shaft M. When the piston has risen to admit below it a volume of air to be compressed, the said valve E′ opens to admit compressed and cooled air above the piston, such air assisting to force said piston downward, thus assisting the prime mover.

The cut-off valve E enables the air above the piston to be used expansively, and it also regulates the compression of air by the piston, and, consequently, the rise of temperature in the air produced by compression, and the fall in temperature produced by the subsequent expansion. If the said cut-off valve should be adjusted not to close till the downward stroke of the piston is completed, there would be, practically, no compression of air in the cylinder, but simply a transfer of air from the cylinder to the receiver, and from the receiver to the cylinder; but if adjusted to cut off before the termination of the downward stroke, the compression of the air below the piston will be the greater the earlier in the stroke the cut-off is made, and the expansion of the air above the piston will also be proportionately greater; and, as the temperature of the air is the more elevated under a greater than under

a low pressure, the cut-off valve furnishes a most convenient means for the regulation of the temperature.

The said variable cut-off valve has attached to its spindle a rock-bar, O, Fig. 2, having thereon an inclined plane, P, which is adjustable longitudinally by an adjusting-screw, R; and the said valve is acted upon to close it through the said bar O and inclined plane P by means of a tappet, T, on the piston-rod B, the closing of the said valve to cut off the induction of cooled compressed air through the pipe H″ being effected sooner or later in the downward stroke of the piston, according to the adjustment of the said inclined plane. The tappet T′ on said piston-rod acts upon the under side of the rock-bar O to open said cut-off valve.

S, Fig. 1, is an exhaust-pipe for the expanded air, which, issuing from the cylinder in a very cold state, may be, if desired, utilized for refrigeration of water, cooling rooms, or for any other desirable purpose.

For various purposes I connect with the exhaust pipe, port, or passage a refrigerating-receiver, V, for cooling air, water, or other substances, which receiver may have pipes or passages *i′* for the circulation of gases or liquids, said receiver having a drip-pipe, *i″*, which, when the compressed-air receiver I is used as a steam-generator, may be used to convey pure water precipitated from cooled air to said steam-generator.

The apparatus furnishes a cheap and effective means for the production of either heat or cold, or both, where the cheap natural power of wind or water can be obtained. For some special purposes, in which economy is not a paramount consideration, such as the drying of chemicals by heated and artificially-dried air, even other power may be advantageously used to operate the apparatus, as by using the same air over and over its moisture may be precipitated in cooling, and the air may be reheated by compression.

I claim—

1. The combination, with an air-compression pump, a cooling-receiver for compressed air, and a working cylinder and piston, in and by which the expansive force of the compressed air is utilized, of a variable cut-off valve applied between the said receiver and said cylinder, for the purpose of regulating the compression of air in said receiver and its expansion in said cylinder, and thereby regulating the degree of heat obtained by said compression, substantially as described.

2. The combination, with said air-compression pump, said cooling-receiver, and said working cylinder and piston, of a refrigerator connected with the eduction-passage of said cylinder, substantially as and for the purpose set forth.

3. The combination, with an air-compression apparatus in which the air is used expansively after compression, of a check-valve arranged within or applied to the exhaust-passage of the cylinder in which the expansive force of the air is utilized, substantially as and for the purpose specified.

JOHN B. ROOT.

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