No. 701,506. Patented June 3, 1902.

W. P. RICE.

METHOD OF TREATING AIR FOR COOLING AND MOISTENING SAME.

(Application filed Feb. 25, 1901.)

(No Model.)

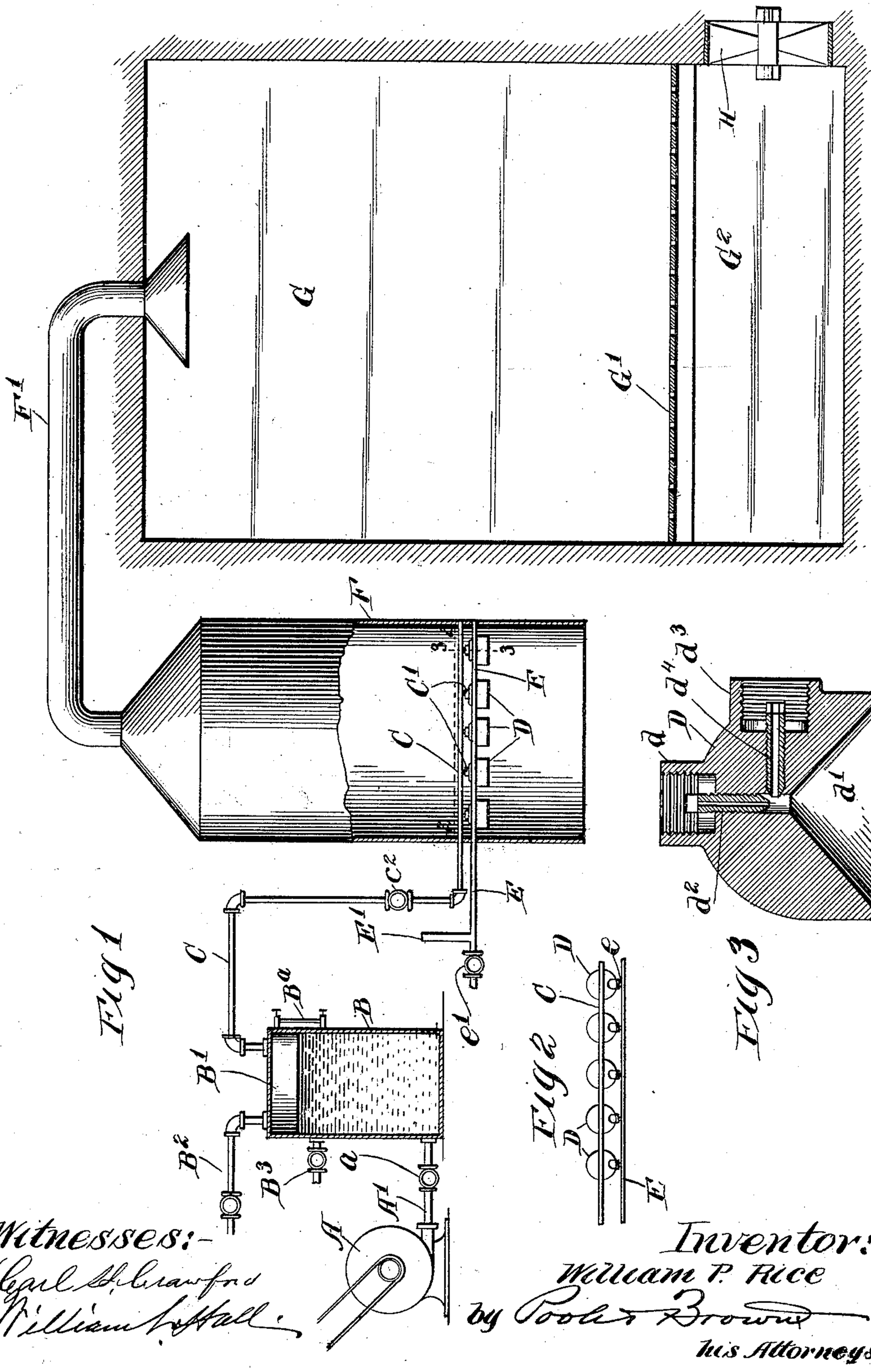

Fig 1 Fig 3 Fig 2

Witnesses:-
Carl G. Crawford
William Lovell.

Inventor:-
William P. Rice
by Poole & Brown
his Attorneys

UNITED STATES PATENT OFFICE.

WILLIAM P. RICE, OF CHICAGO, ILLINOIS.

METHOD OF TREATING AIR FOR COOLING AND MOISTENING SAME.

SPECIFICATION forming part of Letters Patent No. 701,506, dated June 3, 1902.

Application filed February 25, 1901. Serial No. 48,635. (No specimens.)

To all whom it may concern:

Be it known that I, WILLIAM P. RICE, of Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Method of Treating Air to Cool and Moisten the Same; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to a novel process of regulating the state of the atmosphere in a space or compartment with respect to its temperature or temperature and humidity.

The invention consists in the matters hereinafter set forth, and more particularly pointed out in the appended claim.

In carrying out the novel process constituting my invention I proceed generally as follows: A suitable gas, such as air, is placed under a considerable degree of compression, and the temperature of the gas is thereby raised to an extent corresponding to the amount of compression. The heat of compression is thereafter removed from the compressed and heated gas by transference thereof to a cooling medium, preferably a liquid, into contact or proximity with which the gas is passed. The compressed and cooled gas is thereafter allowed to pass in small jets from the space in which it is compressed to a space having a relatively low or normal atmospheric pressure and in the presence of atomized liquid, such as water. The expansion of the gas effects the atomizing operation, the liquid for this purpose being delivered in small quantities into the path of the expanding gas as it issues from the jets, and is thereby finely divided or atomized. A current of air is induced through the space in which such expansion and atomization take place to or through a place of use, as a room or compartment, in which air is to be attemperated. The current of incoming air is forced or drawn through said space and is cooled through the reduction in temperature occasioned by the evaporation of the finely-divided particles of liquid as the same become intermingled with or diffused through the incoming air. The expansion of the compressed gas against atmospheric pressure abstracts heat units from the water, and thereby to some extent augments the cooling effect on the induced current of air of the evaporating process. The incoming air is thus not only cooled, but takes up or absorbs the finely-divided particles of the liquid, thereby dampening or moistening the air, the amount of moisture taken up by the incoming air depending upon its original humidity and upon the degree of ultimate humidity which it is desired to impart to the attemperated air.

I have shown in the drawings an approved form of apparatus for carrying out my novel process, and said process will be more clearly understood when explained in connection with said drawings.

In said drawings, Figure 1 is a view, principally diagrammatic in its nature, of an apparatus designed to carry out my novel process. Fig. 2 is a plan view on line 2 2 of Fig. 1. Fig. 3 is a vertical section on line 3 3 of Fig. 1.

The apparatus herein shown is designed more especially for carrying out my process to deliver cool and moistened air to a space or compartment containing the malt-beds in a malt-house, the cool air being introduced thereto for the purpose of keeping the malt-beds in a suitably cool state and the air being charged with a given percentage of moisture to prevent the material becoming dry during this stage of its treatment. It will be clear, however, from a consideration of the foregoing that my process may be adapted to deliver cool and suitably-moistened air to other compartments where the same may be desired—as, for instance, it may be employed for cooling the atmosphere of living or working rooms, public halls, and other like places.

As shown in said drawings, A designates an air-compressor, which is operated from any suitable source of power and in which a gas, such as air, is compressed to a suitable degree of compression to produce the desired effect in atomizing water. The compressor herein illustrated is of the rotary type; but it is to be understood that any preferred type of compressor or pump may be employed as distinguished from a blower, a device of the latter kind being inefficient to produce the degree of pressure required. The discharge-pipe A′ of said compressor delivers the compressed gas to a cooling device B, which may

be made of any preferred construction. As herein shown, said cooling device consists of a closed tank which is almost filled with water and into the lower end of which below the level of the water the pipe A′ enters. The upper end of the tank above the water-level therein constitutes a gas-space B′. Said tank is provided near the upper end thereof with a water-glass B^a, by which the level of the water in the tank may be ascertained, and said glass will desirably be provided with a thermometer to indicate the temperature of the liquid within the cooling-tank. The tank is provided with a valved supply-pipe B^2 and a valved discharge-pipe B^3. Leading from the gas-space in the top of the cooling-tank is a valved pipe C, through which the compressed gas after the heat of compression has been removed therefrom is discharged. Said pipe C is provided at its end with a plurality of discharge-nozzles D, (shown in detail in Figs. 2 and 3,) said nozzles having restricted discharge-orifices through which the compressed gas escapes in minute jets. The compressed gas is discharged through said nozzles against water or other suitable liquid, which is fed into its path in small quantities or drop by drop, and the expanding gas acts to atomize or finely subdivide the liquid, giving to the atomized liquid the characteristics of a mist or fog, the particles of which are so minute as to float or remain suspended in the air as distinguished from a finely-divided jet or spray. The expanding gas by acting against atmospheric pressure also operates to reduce to some extent the temperature of the finely-divided particles of liquid. A current of air is passed through the space in which said expansion and atomization take place. As herein shown, said discharge-nozzles are located in an inclosed air-shaft F, which communicates at one end with the space or compartment to be attemperated and at its other end with the outer air, and air is drawn through said shaft to the communicating space or compartment by means of a suitably-located fan. As before stated, the apparatus herein illustrated is constructed to supply cooled and moistened air to a malting-floor. In said drawings, G designates the malt-room, having a perforated malt-floor G′, upon which the material to be malted is placed. The upper end of the air-shaft F is contracted to form a pipe or conduit F′, which passes through the ceiling of the room and is provided with a flaring discharge end. The space G^2 below the perforated floor of the malt-room is closed, and said space is connected with an exhaust-fan H, by which the air is withdrawn from said space and from the malt-room, whereby a circulation is induced through the air-shaft and the room, the air passing downwardly through the malt-bed to keep the same suitably cooled and said air being exhausted by the exhaust-fan H. In this manner the air in the compartment G is renewed at short intervals, whereby the temperature of said compartment is maintained uniform.

The atomizing and discharge nozzles (shown in Figs. 2 and 3) are each made from a solid casting or shell, and each is provided in its lower side with a downwardly and outwardly flaring recess d', at the apex or small end of which is a hole through which the compressed gas escapes. Said shell is provided at its upper end with a nipple d, adapted for connection with a branch pipe C′, connected with the compressed-gas-discharge pipe C. d^2 designates a tube which is located within a passage in the shell extending from the nipple to the recess d' and constitutes the gas-discharge orifice of the nozzle, said tube having screw-threaded engagement with the shell. The shell of the nozzle is also provided with a lateral nipple d^3 for connection with a branch e of a water-pipe E, leading from any suitable source supplying water or like liquid. d^4 designates a short tube disposed at right angles to the tube d^2 and located in a lateral passage extending from the nipple d^3 to the contracted upper end of the flaring recess d' and having screw-threaded engagement with the shell. The discharge ends of the tubes d^2 d^4 are located in close proximity to each other. The pipe E is provided with a regulating-valve e' and is provided between the nozzles and the said valve with a stand-pipe E′, by which the water-head in the nozzles may be varied, the head in the pipe being varied by the manipulation of the valve e'. The pipe A′ is also provided with a regulating-valve a, by which the supply of air to the nozzles may be varied.

In the practice of the process the compressor is made of such size as to reduce the volume of the gas to the required degree of compression to produce the necessary atomizing action. The compressed gas passes through the water in the intercooler and is reduced to the temperature of the water, which latter is drawn from an available natural source. The cooling of the compressed gas by the passage of the same through water is preferred, for the reason that the water takes up the oils and other impurities from the gas, such as might be imparted thereto in its passage through the compressor. It may be desirable in warm weather or in warm climates to pass the gas or air through a preliminary cooling operation prior to compressing the same.

From an inspection of Fig. 3 it will be noted that the path of the expanded gas as it issues from the tube d^2 is directly across the path of water which issues from the tube d^4, so that said water is delivered directly into the path of the expanding gas. The discharge ends or nozzles of the water-tubes are made of small size and the head of the water is not great, so that the water issues from the tubes slowly or in minute quantities and preferably in the form of drops as distinguished from a solid stream. The amount of water

delivered to the nozzles may be varied by regulation of the valve *e'*. The effect of this is that all of the water issuing from the nozzles is finely subdivided or atomized and is driven outwardly with considerable force into and through the incoming current of air, as herein shown, in a direction opposite to the direction of travel of the air-current, whereby the water quickly becomes intimately intermingled with the incoming air in the form of a mist or fog, the minute particles of which are so small as to float or remain suspended in the air, and which therefore become diffused therethrough. As a result of the finely-divided condition of the water and its diffusion through the incoming air rapid evaporation of the liquid particles takes place, the water being taken up by the air to suitably increase the percentage of moisture therein and the evaporation of the finely-divided particles of cooled liquid by the incoming air causing a considerable reduction of the temperature of the air. The evaporation of the liquid is promoted and increased not only by the fine subdivision of the liquid and consequent greater surface area presented to the action of the air, but also by the rapid renewal of the air to the space in which the liquid is atomized, it being obvious that the greater the velocity of the incoming air, or, what amounts to the same thing, the greater the rapidity with which the finely-divided particles of liquid carried by the jets of expanded air are driven into and diffused through the incoming air, the more rapid will be the evaporation of the minute particles of the atomized liquid. Owing to the favorable conditions for evaporation specified—to wit, the fine subdivision of the liquid by the expanding air, the frequent renewal of the air, and the rapid passage of the finely-subdivided particles of the liquid through the air—all of the liquid delivered into the path of the incoming air will be taken up by the air, and owing to the regulation of the supply of liquid, as aforesaid, the exact degree of humidification of the incoming air may be obtained as required.

It has been found in the use of prior air cooling and humidifying processes in which water in the form of jets or spray is thrown into or through the current of air to be cooled and humidified that the use of about three hundred gallons of water per minute is required for attemperating and cooling air supplied to a malting-room at the rate of thirty thousand cubic feet per minute, the air supplied being of average humidity and being cooled to the extent necessary for malting. It has also been found that the quantity of water actually required to be evaporated to so cool the quantity of air named when of average humidity is only about three and one-half gallons per minute. I have found by actual test in the use of my novel process hereinbefore described, wherein compressed and cooled air is employed to atomize or minutely subdivide the water and the air to be cooled is furnished in a normally dry state or without being previously artificially humidified, so that all of the water used is evaporated and acts by its evaporation to cool the air, only the amount of water above named—to wit, three and one-half gallons per minute—is required for cooling and humidifying air of average humidity furnished to a malting-room at the rate indicated—namely, thirty thousand cubic feet per minute. In other words, I obtain the cooling effect due to the evaporation of all of the water used, together with such additional cooling effect as may be due to the expansion of the compressed air against atmospheric pressure, and as a consequence the quantity of water necessary to be supplied by pumping or otherwise is in my process only a little more than one per cent. of that required in such prior processes heretofore used in malting.

It has been found in practice in the use of my novel process that by the use of about three and one-half gallons of water per minute for thirty thousand cubic feet of air to be cooled incoming air at a temperature of 104° Fahrenheit may be reduced to about 64° Fahrenheit, incoming air at 90° Fahrenheit may be reduced to about 61° Fahrenheit, and incoming air at 80° Fahrenheit may be reduced to about 60° Fahrenheit. For good results in malting it is necessary that the air be reduced to the neighborhood of 61° Fahrenheit, and experience with prior processes has shown that when the outside temperature is as high as 90° Fahrenheit it is not economically practicable to reduce the temperature of the air much, if any, below 80° Fahrenheit, with the use of water in such large quantity as three hundred gallons for thirty thousand cubic feet of air.

It follows from the above that by the use of my novel process a very great saving is afforded not only in the quantity of water used and the cost of water-supply, but in the expense of pumping it. Moreover, in such prior processes it has been found necessary to save expense of water-supply that the same water be repeatedly used, with the great disadvantage that the water soon becomes contaminated with bacteria, and deleterious effects therefore arise, which are entirely avoided in my process.

I claim as my invention—

The process which consists in inducing a current of air directly from a source of natural humidity to or through a space to be cooled, placing a gas under compression to materially reduce its volume, removing the heat of compression from said gas, permitting the cooled and compressed gas to expand into said current of air, and delivering into the path of the expanding gas water in such quantity that the expanding gas acts to atomize the water and disseminate the same through the air-current in the form of a mist or fog; the said air-current being supplied from a natu-

ral source in such quantity and humidity that the particles of liquid forced or carried thereinto by the expanding gas are at once evaporated and the air-current is thereby cooled and at the same time suitably humidified.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 23d day of February, A. D. 1901.

WILLIAM P. RICE.

Witnesses:
WILLIAM L. HALL,
FRANK JACKSON.