

1,002,577.

4 SHEETS—SHEET 1.



RA Balderson
G. L. Brinters.

James Gayler
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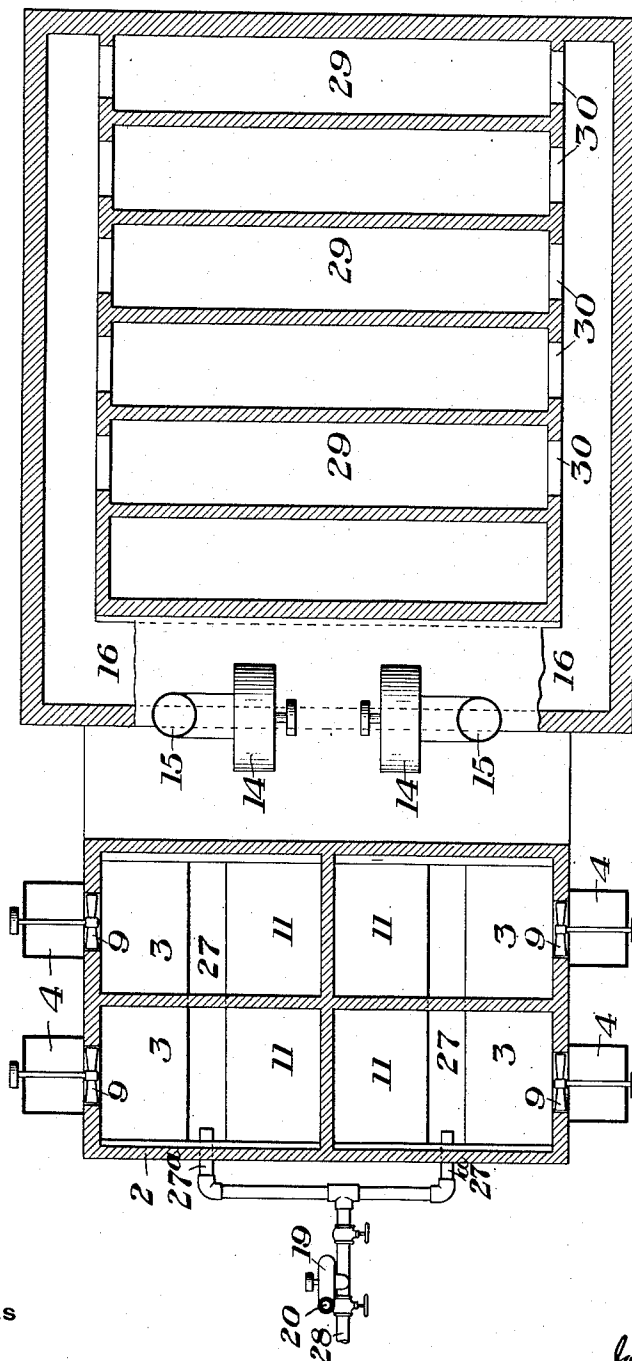
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J. GAYLEY.
METHOD OF DRYING AIR.
APPLICATION FILED JAN. 14, 1909.

Patented Sept. 5, 1911.

4 SHEETS—SHEET 2.

Fig. 2.



WITNESSES

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4 SHEETS—SHEET 3.

Fig. 3.

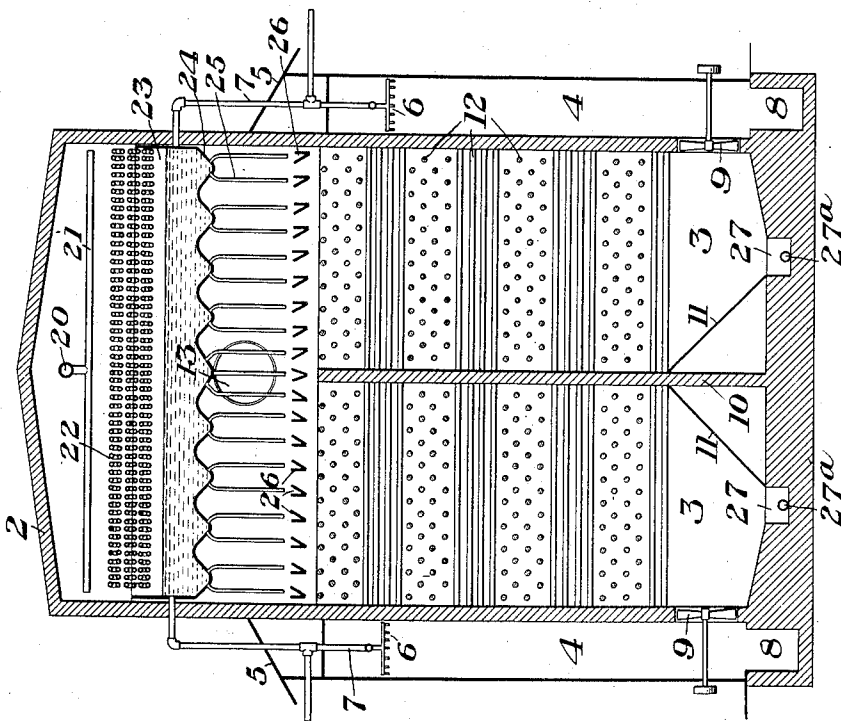
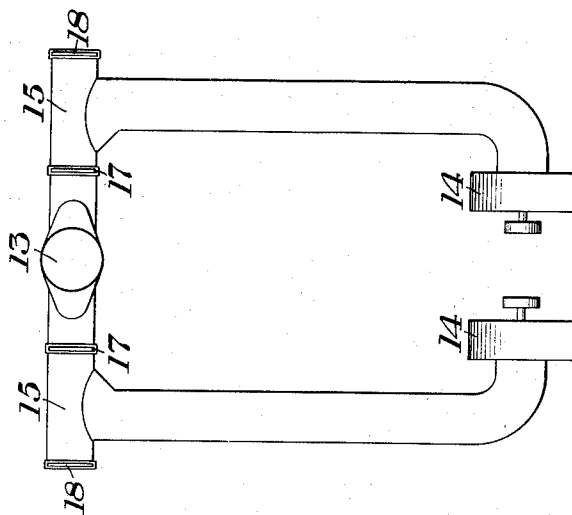


Fig. 4.



WITNESSES

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G. L. Winters.

INVENTOR

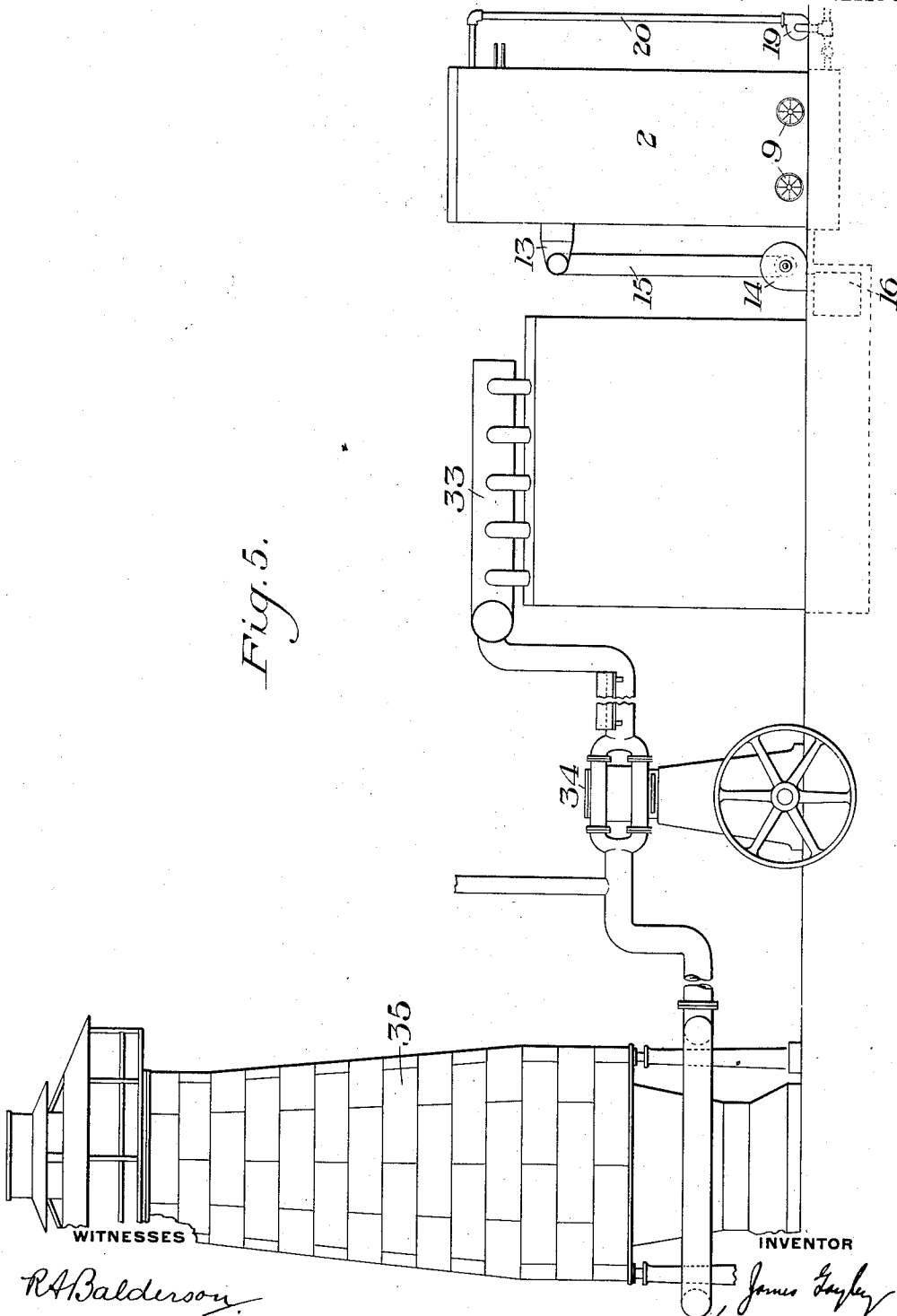
James Gayley
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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

JAMES GAYLEY, OF NEW YORK, N. Y.

METHOD OF DRYING AIR.

1,002,577.

Specification of Letters Patent.

Patented Sept. 5, 1911.

Application filed January 14, 1909. Serial No. 472,278.

To all whom it may concern:

Be it known that I, JAMES GAYLEY, of New York, in the county of New York and State of New York, have invented a new and useful Method of Drying Air, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a sectional side elevation of apparatus arranged to carry out my process; Fig. 2 is a horizontal cross section of the same; Fig. 3 is a vertical sectional view of the cooling tower; Fig. 4 is a detail view showing the piping connections between the cooling tower and the refrigerating building, and Fig. 5 is a side elevation showing the arrangement of the refrigerating apparatus, blowing engine and furnace.

My invention relates to the drying of air by refrigeration, particularly in connection with the use of the air blast for blast furnaces, steel converters, etc.

The object of the invention is to reduce the cost of installation for a refrigerating plant required to handle a given quantity of air throughout the year, and at the same time decrease the cost of operation.

The invention relates more specifically to a two-stage system, wherein the air is first exposed to direct contact with water in the first stage, and in the second stage is further refrigerated by contact with pipes or conduits in which a non-congealable artificially cooled fluid is circulated.

The invention consists in certain improvements of the cooling steps which give an advantage over ordinary two-stage processes heretofore employed.

In the systems of my prior patents which have been in use, the same apparatus has been used for refrigerating the air throughout the year, the cooling medium being circulated through pipe coils and the air blast being passed over these coils. A part of the moisture is taken out of the blast in the shape of rain and part of it in the form of snow or ice congealing on the coils. In the warm months, owing to the high temperature of the air and its higher content of moisture, the energy required to refrigerate it is much larger than during the winter months. Inasmuch, however, as a uniformly low content of moisture is required in order to obtain the best results, it is necessary to build a plant of sufficient size to handle the

maximum amount of moisture at the maximum temperature of the summer months, part of this plant, therefore, being idle during the winter months. My invention not only overcomes these difficulties with the indirect system, but also improves the two-stage system, wherein it has been proposed to first bring the air into direct contact with water in the first stage, and then into contact with conduits containing an artificially cooled liquid in the second stage.

In carrying out my invention, I first pass the air upwardly through a cooling tower in the opposite direction to a spray or rain of water, preferably cooled to about 33° F. The air is preferably forced through this cooling chamber under a low pressure by means of a fan or suitable pressure device, and then passes to another fan or suitable pressure device by which it is then forced through a second chamber or chambers in which it is cooled by contact with cooling channels to or below a temperature of zero degrees C. The moisture in the air is preferably reduced to about 2.8 grains per cubic foot in the first stage, and to from 1 to 1.5 grains per cubic foot in the second stage. By this system the air blast is delivered to the indirect refrigerating chambers with a substantially uniform moisture content. I also provide for cutting out the cooling tower or towers during the winter months when the moisture in the air is relatively low and supply the air directly to the second chamber when desirable. I also preferably spray the air before it enters the cooling tower, these sprays being preferably supplied with the excess water used in the cooling tower itself.

The cooling of the water for the cooling tower is preferably carried out by means of an ammonia condenser which will require comparatively small energy, owing to the small degree of cooling, this resulting in a high back pressure under which the compressor will work economically. The refrigerating capacity of an ammonia compressor depends upon the number of pounds of gas it will handle in a given unit of time. The weight of ammonia gas handled depends upon the efficiency of the compressor, and upon the suction pressure at which the gas is delivered into the compressor. Since the weight of ammonia gas varies approximately as the absolute pressure, it follows that the refrigerating capacity of an am-

monia compressor working under a suction pressure of thirty pounds will have about fifty per cent. greater capacity than one working under fifteen pounds gage pressure.

- 5 This ammonia compressor cooling the water down to 33° F., will work at about forty-five pounds back pressure when cooling water from 80° to 33° F., so it will work under very economical conditions. The air 10 will leave the cooling tower at about 40° F., and with three grains per cubic foot or less moisture.

In the drawings, 2 represents the cooling tower which I have shown as divided into 15 four chambers 3, each provided with an external air duct 4, of sheet metal or other suitable material. The upper end of this duct 4 is open and preferably protected by a spaced apart roof 5. These ducts are of 20 considerable length and I preferably arrange spray devices 6 in their upper portion to which water is supplied through pipes 7. This spray will filter away the coarse impurities of the air and also cool it somewhat. 25 The lower ends of the ducts terminate in catch basins 8, where the dirty water is collected and led to the sewer.

The lower portions of the ducts open into the lower ends of the chambers 3, and the 30 ports are preferably provided with fans 9, which will force the air from the ducts into the cooling chambers against the resistance of the sprays in the chambers, of which I have shown four, formed by the parti- 35 tions 10.

I preferably arrange inclined baffle plates 11 at the lower ends of the cooling chambers opposite to the fans to deflect the air upwardly and as the air rises, it is preferably 40 split up by grids or grate-work which I have shown as consisting of round wooden poles 12, which are impregnated to resist the rotting action of the water, though any suitable arrangement of baffle plates may be 45 used. The function of these baffles is to give the largest possible contact between the up-going air and the downwardly trickling water or brine, as shown. At the top of the tower, the air is led through pipe 13, 50 to fans 14, through branch pipes 15, and thence to the basement air duct 16 of the refrigerating building. The branch pipes 15 are, as shown in Fig. 4, provided with valves 17, whereby the cooling tower may be shut 55 off from the refrigerating building fans and through valves 18, opened to allow the outside air to pass directly to these fans 14.

The water for the cooling tower is shown as being lifted by a pump 19 through pipe 60 20 to the top of the tower, and through a series of pipes 21, which are split longitudinally, from which it overflows evenly over the coils 22, carrying the ammonia at a low temperature which cools the water to just 65 above the freezing point. The overflowing

water collects in a tank 23, which forms the cross partition between the air chambers and the ammonia loft and in which a constant water level is maintained slightly below the coils. The bottom of the tank is 70 corrugated, as shown at 24, and from these corrugations the water is fed through a large number of pipes 25, to open troughs 26. The use of the corrugated bottom of the tank and the long pipes leading from it to 75 the troughs is especially efficient in cooling the air. An air space must be left between the tank and the grating to allow the unimpeded passage of the air to the outlet pipe 13, as a mist or water spray in this space 80 would hinder the air passage. The use of the pipes from the tank to the trough do not clog up or interfere with the air passage, but as they contain very cold water and are arranged in zig-zag or staggered 85 form, the air comes into intimate contact with them and is effectually cooled.

As before stated, the grate-work or baffle plates and air chambers split up the descending water into a fine mist and break 90 up the ascending air into small currents which mix thoroughly therewith, thus effecting a maximum cooling of the air with a minimum amount of water. The water overflows uniformly from the open troughs 95 and is split up by the grate-work and evenly distributed. This water is collected at the bottom of the tower in ditches 27, and is drawn from these ditches by pipes 27^a, leading to pump 19, which again lifts the water 100 to the top of the cooling tower. The water is thus used over and over again, thus giving a gain in efficiency, owing to the low temperature of the water collected at the bottom of the chamber. A pipe connection 105 28 to the pump is used for starting. As the water trickling down the grate-work removes a majority of the moisture in the air, the water is augmented in amount, and to keep the water level in the upper tank constant, it is provided with pipe connections 110 to take away the overflow, this being preferably directed to the sprays 6 in the inlet ducts. This overflow water being very cold, increases the effective working of these pre- 115 liminary sprays.

Referring to the refrigerating building, this is shown as provided with a series of separate chambers 29, having lower valves 30, admitting air from the supply ducts, the 120 air rising among the coils 31 and passing through valves 32 in the branch pipes, connected to the off-take main 33. The coils in these refrigerating chambers are supplied with brine at a low temperature and the air 125 is preferably reduced to about zero degrees C.

In Fig. 5, 34 represents the blowing engine located between the drying apparatus and the blast furnace 35. This blowing 130

engine receives and measures the air, raises the pressure of the air and forces it to the blast furnace or point of use.

The advantages of my invention result from using water in the cooling tower at a temperature of about 33° F.; also from forcing the air through the system and more specifically by forcing air through the cooling tower and then forcing it through the second indirect cooling chamber or chambers. This overcomes the difficulties and uncertainty incident to drawing the air through these chambers. Another advantage lies in spraying the air before it enters the cooling tower and preferably using for this purpose the surplus water from the cooling tower. A further advantage results from providing the fan or forcing means between the cooling tower and the second stage chamber, as thereby I can cut out the first chamber and also provide more efficient operation of the second chamber. Any one of the second chambers is preferably smaller than the cooling tower, as the major amount of the moisture is taken out in the cooling tower and only about one-half of the remaining moisture is removed in the second stage. By providing the preliminary cooling chambers, the work of the refrigerating chambers is made uniform and continuous throughout the year, so that they may be properly designed for this continuous work. When the amount of moisture in the air is large, as through the summer months, the cooling tower will be used, as above described, while in the winter months, it may be discarded and air led direct into the refrigerating chambers, or the cooling chambers may be used in part, as desired. The operating cost is reduced and air with a substantially uniform content of moisture is produced.

By the word "capacity" in my claims, I refer to the cubical capacity of the indirect cooling chamber or chambers as compared to the cubical capacity of the direct or first-stage chamber or chambers, as distinguished from greater refrigerating capacity.

Many changes may be made in the form and arrangement of the preliminary cooling chamber or chambers, as well as in the refrigerating apparatus, without departing from my invention.

I claim:

1. The method of drying air, consisting in passing the air through a cooling tower, subjecting it therein to the direct action of water to reduce its moisture content, then passing it through a refrigerating chamber or chambers of greater capacity than the direct-action tower at a speed no greater than that in the cooling tower, and reducing the moisture therein to less than two and one-half grains per cubic foot, and then feeding the dried air to a metallurgical apparatus, substantially as described.

2. The method of drying air, consisting in passing it through a cooling tower, subjecting it therein to the direct action of artificially cooled water spray, then feeding it through a refrigerating chamber or chambers of greater capacity than the direct-action tower at a speed no greater than that in the cooling tower, and reducing the moisture therein to less than two and one-half grains per cubic foot, and then feeding the dried air to a metallurgical apparatus, substantially as described.

3. The method of drying air, consisting in passing it first through a cooling tower or towers, subjecting it therein to the direct action of water, then feeding it through a refrigerating chamber or chambers of greater capacity than the direct-action tower at a speed less than that in the cooling chambers, wherein it is exposed to the cooling channels or pipes and its moisture reduced to below two and one-half grains per cubic foot, and then raising the pressure and forcing it to a metallurgical apparatus, substantially as described.

4. The method of drying air, consisting in passing it through a cooling tower, subjecting it therein to the action of artificially cooled water at a temperature of about 35° F., then passing it through a refrigerating chamber of greater capacity, whereby the current of air is retarded therein, and then feeding the dried air to a metallurgical apparatus, substantially as described.

5. The method of drying air, consisting in passing it through a cooling tower, subjecting it therein to the action of artificially cooled water at a temperature of about 35° F., then passing it at a speed no greater than in the cooling tower through a refrigerating chamber of greater capacity than the direct-action tower, and reducing the moisture therein to less than two and one-half grains per cubic foot by reducing the temperature of the air to or below a temperature of zero degrees C., and then feeding the dried air to a metallurgical apparatus, substantially as described.

6. The method of drying air, consisting in feeding it upwardly through a cooling tower, subjecting it therein to a spray or rain of artificially cooled water, then supplying pressure thereto and forcing it through a chamber or chambers containing refrigerating pipes or devices, reducing it to or below zero degrees C. therein, and then raising its pressure and forcing it to a metallurgical apparatus, substantially as described.

7. The method of drying air, consisting in spraying the air preliminary to its entering a cooling tower, then feeding the air upwardly through a cooling tower and subjecting it therein to the direct action of artificially cooled water, then feeding the air

from the cooling tower through a refrigerating apparatus containing refrigerating pipes or devices, and then feeding said dried air to a metallurgical apparatus, substantially as described.

8. In the drying of air, the steps consisting of feeding it through a cooling tower, subjecting it therein to the direct action of water, collecting the water from the cooling tower, returning and re-using a portion of said water in the sprays within the tower, and spraying the air on its way to the tower with surplus water collected from the tower, substantially as described.

9. The method of drying air in three stages, consisting in first spraying the air with water, then feeding it to a cooling tower, passing it upwardly therethrough, subjecting it to a dropping spray or rain of artificially cooled water therein, then feeding it through a refrigerating chamber or chambers, and then feeding the dried air to a metallurgical apparatus, substantially as described.

10. The method of drying air in three stages, consisting in spraying the air with water, then passing the air upwardly through a cooling tower, and exposing it to artificially cooled water descending in a spray therein, passing it through a refrigerating chamber or chambers, and reducing it to or below zero degrees C., and utilizing waste water from the tower for the preliminary spraying of the first stage, substantially as described.

11. The method of drying air, consisting in passing the air through a cooling tower, subjecting it therein to the direct action of

water to reduce its moisture content, then passing it through a refrigerating chamber or chambers of greater capacity than the direct action tower at a speed no greater than that in the cooling tower, and reducing the moisture therein to less than two and one-half grains per cubic foot, and then raising its pressure and forcing it to a metallurgical apparatus, substantially as described.

12. The method of drying air, consisting in passing it through a cooling tower, subjecting it therein to the direct action of artificially cooled water spray, then passing it through a refrigerating chamber or chambers of greater capacity than the direct action tower at a slower speed than in the cooling tower, and thereafter raising its pressure and forcing it to a metallurgical apparatus, substantially as described.

13. The method of drying air, consisting in passing it upwardly through a cooling tower, subjecting it therein to the direct action of dropping artificially cooled water spray, then passing it through a refrigerating chamber or chambers, where it is exposed to cooling channels or pipes and its moisture reduced to below two and one-half grains per cubic foot, and then raising the pressure and forcing it to a metallurgical apparatus, substantially as described.

In testimony whereof I have hereunto set my hand.

JAMES GAYLEY.

Witnesses:

W. S. REED,
JOHN H. GEWECKE.