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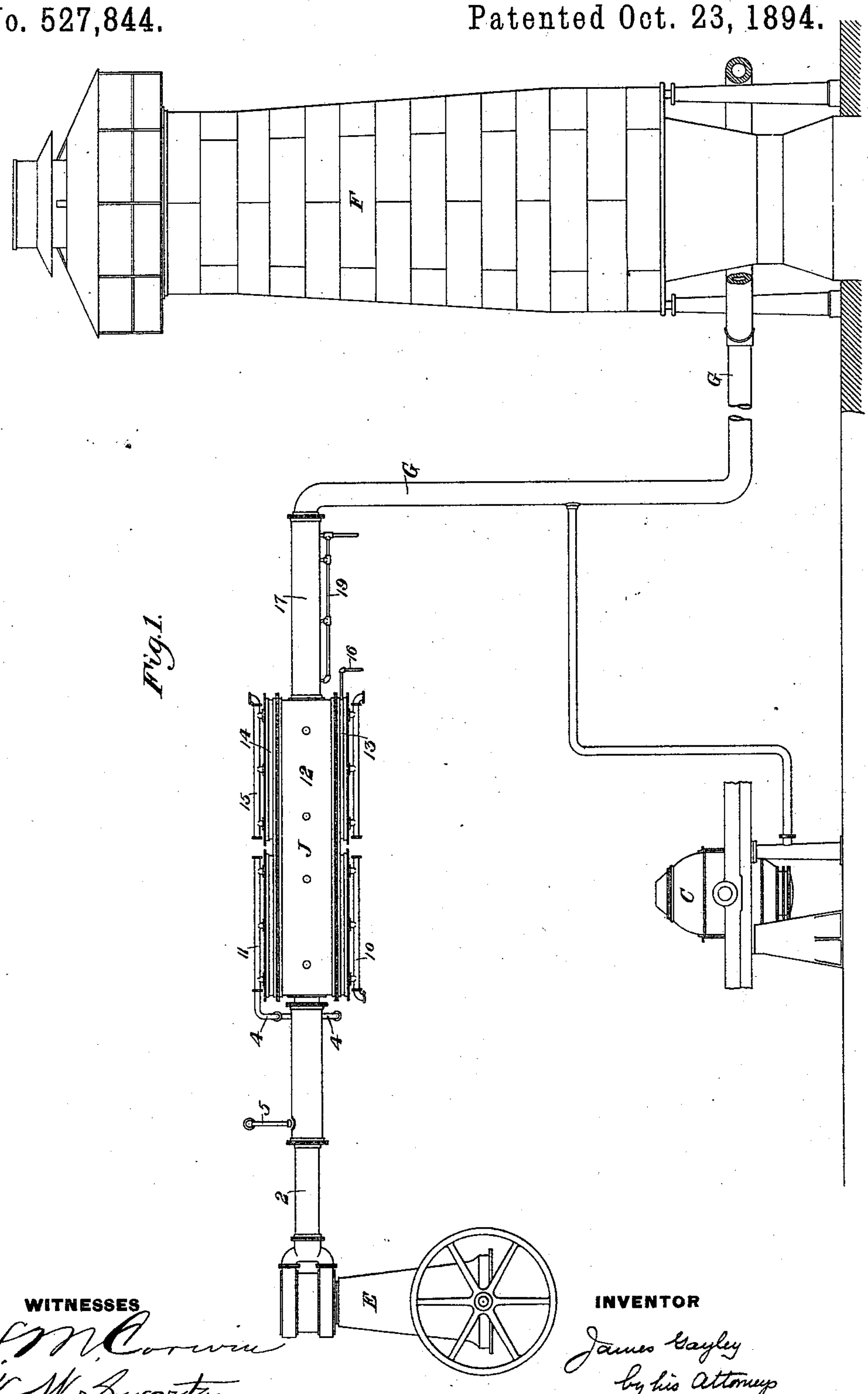

WITNESSES

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W. W. Swartz

INVENTOR

James Gayley
by his Attorneys
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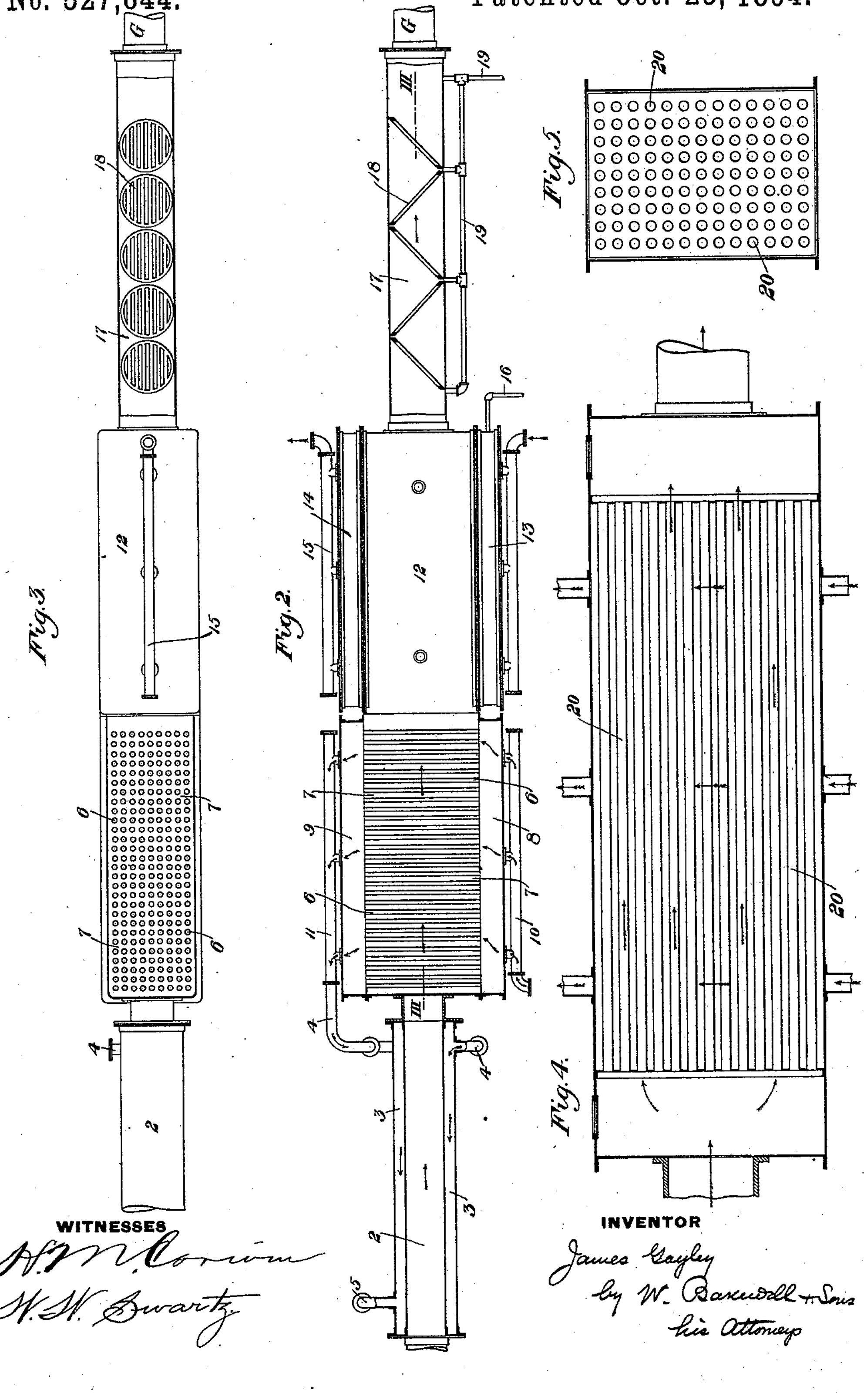

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JAMES GAYLEY, OF BRADDOCK, PENNSYLVANIA.

METHOD OF AND APPARATUS FOR EXTRACTING MOISTURE FROM AIR FOR BLAST-FURNACES.

SPECIFICATION forming part of Letters Patent No. 527,844, dated October 23, 1894.

Application filed January 6, 1894. Serial No. 495,894. (No model.)

To all whom it may concern:

Be it known that I, JAMES GAYLEY, of Braddock, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Methods of and Apparatus for Extracting Moisture from Air for Blast-Furnaces and Converters, 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 shows in elevation a blast furnace and a converter arranged in accordance with my invention. Fig. 2 shows the air-refrigerating apparatus in elevation, partly in longitudinal section. Fig. 3 is a plan view thereof, partly in horizontal section on the line III—III of Fig. 2; and Figs. 4 and 5 show, in vertical longitudinal section and in vertical cross-section respectively, a modified construction of the refrigerating apparatus.

The successful conduct of all metallurgical operations depends to a great extent on the uniformity of the various materials used in the process. In operating blast furnaces and steel converters, one of the most disturbing influences is the varying amount of moisture in the atmosphere, since in both these processes a large amount of air is consumed for the purpose of oxidation or combustion. The atmosphere holds in suspension quantities of aqueous vapor varying from .20 to 1.6 per cent. and its presence in these metallurgical operations is injurious, not only because it is decomposed in the parts of the apparatus where high heat is required, and thus absorbs heat, but the fluctuations in the quantity of moisture carried by the air, produce corresponding irregularities in the conduct of the process, and in the quality of the product. Thus, in the State of Pennsylvania, from the months of April to September, inclusive, the air contains at least fifty per cent. more moisture than the average for the other months of the year, and often for short periods of time the ratio of difference is very much greater. When it is considered that when a blast furnace uses per minute one thousand cubic feet of air containing one grain of moisture per cubic foot, one gallon of water enters every hour, and that the smaller blast furnaces use per minute eight thousand cubic feet of air, and the larger ones thirty thousand cubic feet, each cubic foot containing from two to eight grains of moisture, it becomes apparent that uniform conduct of the process is rendered practically unattainable. In consuming thirty thousand cubic feet of air per minute, containing two grains of moisture per cubic foot, sixty gallons of water per hour are delivered to the furnace, and when the air contains eight grains of moisture per cubic foot, two hundred and forty gallons are delivered per hour. As the decomposition of this large quantity of aqueous vapor is accomplished at the expense of heat, the varying conditions caused by the atmosphere alone will be readily appreciated. Thus, in the summer months, because of the greater content of moisture in the air, two hundred more pounds of fuel, on an average, are required to produce a ton of pig iron than in the winter months. These facts make it very difficult for the blast-furnace manager to secure uniformity of product. Variations in the content of moisture in the atmosphere produce irregularity in the operation of the furnace, and affect the quantity of fuel necessary to be used, and these varying conditions in turn make irregular the chemical composition of the pig metal with reference to their non metallic constituents, carbon, silicon, &c. The value of the product is thus often impaired, and the uncertainty of the result which will be attained in any given tapping of the furnace is a matter of most serious inconvenience.

In the operation of the Bessemer converters, the moisture of the atmosphere and its variations in amount are just as troublesome. Its presence in large quantity causes a cooling of the metal bath, which interferes with the uniform conduct of the process and often produces wasteful chilled heats. In order to obviate these bad effects, it is necessary to charge into the converter a pig iron containing a sufficiently large content of silicon to raise the temperature of the blow and thus neutralize the chilling effect of the moisture. Additional fuel in the blast furnace is required to produce such high silicon metal. All these sources of irregularity and expense in metallurgical operations are eliminated by use of my invention, by means of which I furnish for the furnace or converter an air-blast practically free from atmospheric moisture.

In order to fully understand the application of this device, I would explain that it is intended to be used with blast furnaces for the smelting of ores, with steel converters for the conversion of iron into steel. In all of these the air is used solely for the purpose of oxidation or combustion. Blast furnaces are now constructed with a height of ninety feet and a diameter of twenty-two feet. These are kept full continuously with a mixture of fuel, ore and flux, and these offer great resistance to the penetration of the blast, which is admitted at the bottom. It not uncommonly requires a pressure of fifteen to twenty pounds per square inch in the air-blast to penetrate this column of material. Likewise in the converter the air is forced through a bath of metal which frequently weighs fifteen tons, and requires a pressure of twenty-five pounds per square inch in the blast to penetrate it. The condensation of moisture from air in rapid motion and consumed in such large volumes, presents an entirely new set of difficulties not found in any other processes, and any attempt to remove the moisture from the furnace blast by the use of chemical agents having affinity for water must necessarily prove impracticable.

In the practice of my invention I remove the moisture from the air and render it dry, or so dry at least that the percentage of moisture contained in the air is small and practically uniform, by subjecting it to artificial refrigeration so that its temperature shall be reduced to zero centigrade, whereby the moisture is condensed and may be collected and withdrawn in the form of water, the air being fed to the furnace or converter under compression, and being maintained constantly under compression from the time it leaves the blowing-engine until it reaches the furnace.

Many forms of apparatus suitable to the practice of the invention may be employed. I have, however, devised a special apparatus for the purpose, which possesses many advantageous qualities for treating air traveling with a high velocity and is claimed specifically by me herein, although the broader claims of the application are not restricted to its use.

Referring now to the drawings, 2 is the pipe from which the air passes under high pressure from the air-cylinder of the blast-engine. This pipe, for a suitable portion of its length, is surrounded by a casing or chamber 3, having inlet and outlet pipes 4, 5, so that water may be caused to circulate through the chamber in order to cool the air which has been heated by compression of the blast-engine. From the pipe 2 the air passes into a chamber 6, which is made larger to give a greater area of contact, in which is a series of pipes 7, which extend across the chamber and at their ends open into chambers 8, 9. By reason of its greater conductivity of heat, the pipes 7 should preferably be made of copper. The water or other fluid for cooling the chamber 6 is admitted by a pipe 10 into the chamber 8, and thence it passes through the pipes 7 from one sub-chamber to the other until it emerges at an outlet pipe 11 which may conveniently be connected with the inlet pipe 4 of the chamber 3, so as to deliver the cooling fluids into the latter. The air being under a back pressure, does not expand on entering the chamber 6. A partial deposition of its contained moisture takes place, which is reduced to a mist by contact with the refrigerating surface of the pipes. After the air has passed through the chamber 6 it may enter a second chamber 12 similarly constructed, except that in this chamber I prefer to obtain a better chilling action by the use of ammonia as the cooling agent, and therefore construct the pipes 7 of iron. The cooling agent is preferably anhydrous ammonia, furnished by an ice-making machine of suitable design, which, on evaporation, produces a very low temperature, about 70 degrees below zero centigrade, though other refrigerants producing intense cold, such as carbonic anhydride, may be employed. I may, however, use in place of these refrigerants, in cases where a still lower temperature is required, cold air from any dry cold air compressor of suitable design, which, on expanding, will produce a temperature of 100° below zero centigrade. It enters the sub-chamber 13, and after passing through the pipes 7, in the manner above described, to the other sub-chamber 14, is taken away through the outlet pipe 15. The entering air is first cooled by the chamber 3. Its temperature is still more reduced by passing through the chamber 6 among the pipes 7, and in the chamber 12 under the intense cold produced by the ammonia, the temperature of the air is reduced below the freezing point, so that its contained moisture is precipitated on the outer surface of the pipes 7 and collects at the bottom of the chamber from which it may be drawn off through a pipe 16.

In order to provide against any of the precipitated moisture being carried along in suspension by the refrigerated air, I prefer to employ a chamber 17 containing a series of grids 18 with small metal ribs, and preferably placed in slanting position. These grids catch the suspended moisture or water, which runs down the ribs and is carried off by the drain pipes 19. The chamber 17 is made so much larger than the chamber 2 that there will be no retardation due to space occupied by the grids. I may also use a cooling chamber of construction shown in vertical section in Figs. 4 and 5, in which the air passes through a series of pipes 20, with the cooling agent surrounding them.

Having been cooled in the manner above described and its moisture extracted, the air is delivered to the blast furnace or converter, through the various pipes and passages usual to the operation.

In Fig. 1, F represents a blast furnace, into the tuyeres of which the delivery pipe from the desiccating apparatus delivers the dried air. G is the blast pipe connected with the blast furnace, as shown. The air being compressed by the blast engine E, passes through the refrigerating apparatus J (which is the same in construction as that shown in the figures on the second sheet of the drawings), and is delivered to the blast furnace through the tuyeres. In similar manner it is delivered to the converter C.

When the air is cooled subsequently to its compression, the air-cylinder of the engine should, preferably, be jacketed, and cooled by flowing water in order to reduce the great increase of temperature of the air which the compression causes.

It will be readily observed that on account of the air being constantly in rapid motion and under pressure, and the enormous volume required, the methods usually employed for extracting a portion of the moisture from small volumes of air in applying it to drying grain, cooling rooms, &c., are not applicable to blast furnaces and converters, since in many of these methods the air is allowed to expand, which in itself is the most serviceable refrigerating process, and simplifies the operation to a great extent, while in my process there is no substantial expansion of the air prior to its introduction into the furnace.

The mechanical retardation of the current by partitions and grids is avoided in my device, the grid-chamber being of such area that the space between ribs is sufficient to allow the volume to pass through without retardation.

In my apparatus the current of cooling fluids passing through a series of pipes, is directly across that of the air currents, by which I maintain in this short travel a much lower temperature than in such appliances where the currents of air and cooling fluid are longitudinal.

The advantages of my invention will be appreciated by those skilled in the art. By rendering the air dry or practically dry by refrigeration as described above before it is introduced into the furnace or converter and supplying such dry air in large quantities under constant compression, the amount of moisture is made practically uniform from day to day and from year to year. It is thus made easy for the blast-furnace manager to secure uniformity in the character of metal produced by the furnace notwithstanding varying meteorological conditions, and without that close supervision which is necessary in furnace practice heretofore in common use. I believe I am the first to make this result possible.

I claim—

1. The method of feeding the air-blast to blast furnaces or converters, which consists in cooling the air artificially to 0° centigrade, thereby causing its moisture to be eliminated or reduced to a small and practically uniform percentage, feeding the dried air under compression into the furnace or converter, and maintaining it constantly under compression from the time it leaves the blowing-engine until it enters the furnace; substantially as described.

2. The method of feeding the air-blast to blast furnaces or converters, which consists in compressing the air, passing it under compression into an enlarged chamber, but without substantial expansion therein, and cooling it in said chamber to at least 0° centigrade, thereby causing its moisture to be eliminated or reduced to a small and practically uniform percentage, feeding the dried air into the furnace or converter, and maintaining it constantly under compression from the time it leaves the blowing engine until it enters the furnace; substantially as described.

3. The combination with a blast furnace or converter, of a refrigerating chamber, an air outlet which leads therefrom to the furnace or converter and is of smaller diameter than the chamber, and an air compressor, connected to the chamber whereby the air is maintained under compression during its passage from the compressor to the furnace or converter; substantially as described.

4. The combination with a blast furnace or converter, of a refrigerating chamber having a series of pipes arranged to conduct the refrigerating fluid across the direction of the air current, an air outlet which leads therefrom to the furnace or converter and is of smaller diameter than the chamber, and an air-compressor leading to the chamber whereby the air is maintained under compression during its passage from the compressor to the furnace or converter; substantially as described.

5. The combination of a blast-furnace or converter, a pipe for delivering compressed air thereto, a refrigerating chamber in the line of said pipe, means for cooling the air therein by a liquid refrigerant, and an air compressor, leading to the chamber, whereby the air is compressed and maintained under compression until it enters the furnace or converter; substantially as described.

6. The combination with a blast furnace or converter, of a pipe for delivering compressed air thereto, a refrigerating chamber of larger diameter than the pipe, a moisture-precipitating chamber also of larger diameter than the pipe and into which the air passes from the refrigerating chamber, and having grids over which the air passes, and a pipe leading from the moisture-precipitating chamber to the furnace or converter; substantially as described.

In testimony whereof I have hereunto set my hand.

JAMES GAYLEY.

Witnesses:
C. C. TEETER,
J. E. MITCHELL.