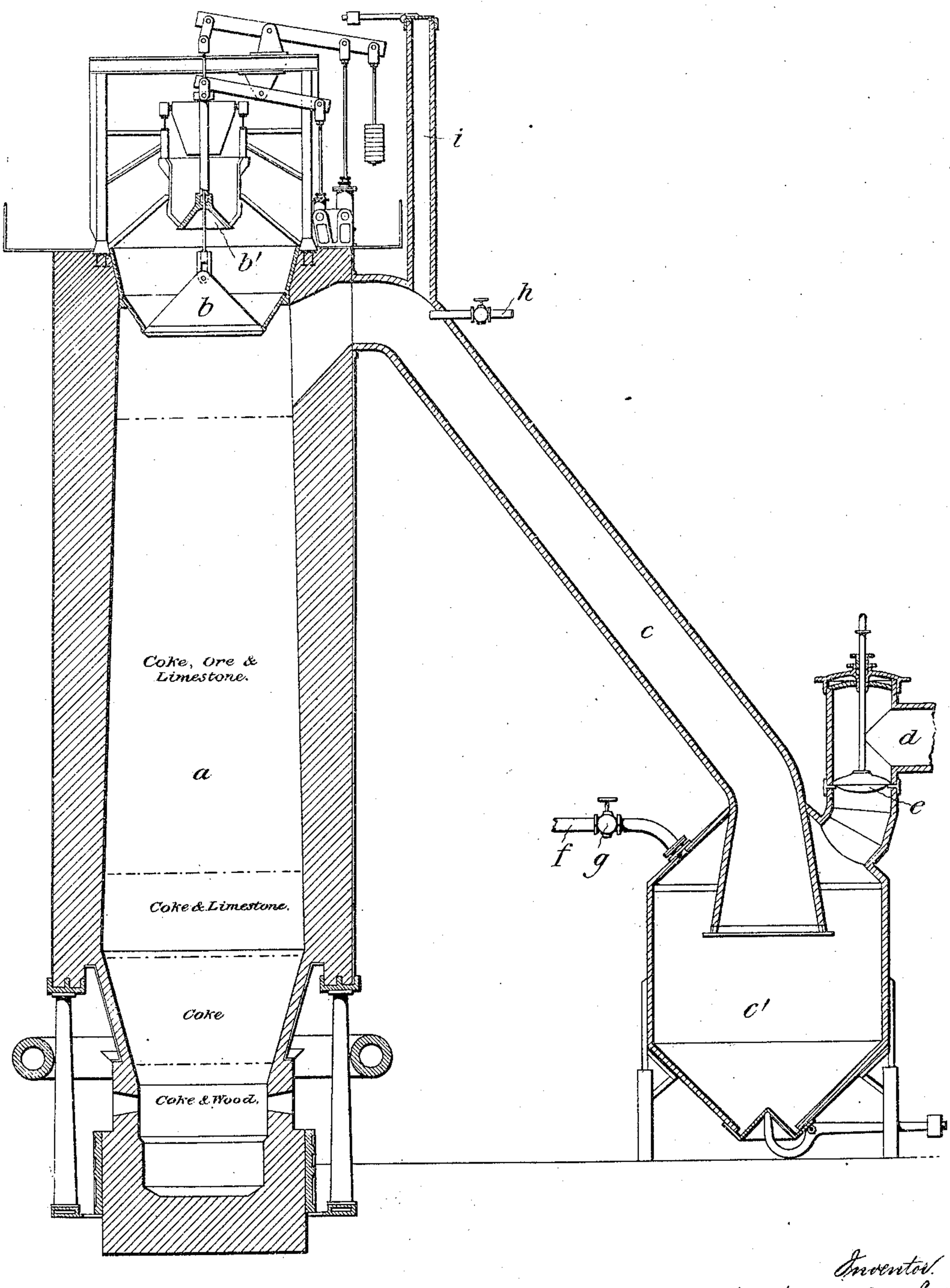
No. 789,844. PATENTED MAY 16, 1905.

J. W. DOUGHERTY.

ART OF CONTROLLING FURNACE GASES.

APPLICATION FILED AUG. 30, 1904.



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UNITED STATES PATENT OFFICE.

JOHN WEBSTER DOUGHERTY, OF STEELTON, PENNSYLVANIA

ART OF CONTROLLING FURNACE-GASES.

SPECIFICATION forming part of Letters Patent No. 789,844, dated May 16, 1905.

Application filed August 30, 1904. Serial No. 222,762.

To all whom it may concern:

Be it known that I, JOHN WEBSTER DOUGHERTY, a citizen of the United States, residing at Steelton, in the county of Dauphin and State of Pennsylvania, have invented certain new and useful Improvements in the Art of Controlling Furnace-Gases; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

My invention relates to the art of starting or "blowing in" of blast-furnaces for smelting of iron ores by controlling the furnace-gases to avoid explosions commonly attending the blowing in of such furnaces.

The object of this invention is to provide a means by which a modern blast-furnace may be started or blown in without danger of explosions and by immediate application of blast made to produce marketable metal, avoiding the dangers and the explosive results of the common methods.

At present the universal custom of blowing in blast-furnaces is to charge the furnace first with a large quantity of wood, then a large quantity of coke, then a quantity of coke with limestone, and then charges of ore, coke, and limestone in proper proportions, after which the wood is ignited and the charge allowed to burn for about twenty-four hours by natural draft, the products of combustion passing off through the hopper around the bell, left open for that purpose. While under natural draft with cold air combustion is imperfect and the furnace keeps comparatively cool and is liable for some time after blast is applied to work cold, producing iron which is not marketable and must afterward be resmelted at much cost of labor, fuel, and metallic loss. In the largest furnaces the quantity of such unmarketable metal produced while getting the furnace started is sometimes upward of one thousand tons.

The reason for not putting the blast on at once is the danger of explosion of the explosive mixture of the resultant gases and the air in the furnace-top, pipes, &c., for conducting the gases to the boiler and the hot-blast stoves where the gases are burned and utilized. Much time has to be allowed for the gases to displace the air contained in said pipes, &c., before it becomes safe and practicable to permit ignition of the gases under the boiler or in the hot-blast stoves without causing explosions liable to effect destruction of costly structures and wreck the furnace. It has frequently happened that after experienced furnace men have judged it to be safe to commence ignition and consumption of gas there still remained in the pipes, &c., sufficient air to form an explosive mixture of air and gas, which upon ignition exploded with great violence, causing great destruction.

Referring to the drawing, in which like parts are similarly designated, I have illustrated in section a double-bell furnace and the dust-collector of well-known type.

The blast-furnace proper is designated at *a* and is of the usual construction with a double bell *b b'* at the top and the down-comer *c* for carrying the furnace-gases to the dust-collector *c'*, from which these gases are distributed through pipes, as *d*, to the places of consumption.

In some structures there is a valve *e* controlling the gas to the pipe or pipes *d;* but in many there are no valves at this point, the only valves being at the device where the gas is to be consumed—boilers, hot-blast stoves, and the like.

After the furnace has been charged with proper starting materials all valves are closed, also any doors that may be in the pipe or pipes between the dust-collector and boilers or hot-blast stoves. The bell, if it is a single-bell furnace, or both bells, if it is a double-bell furnace that is to be blown in, are left open. I then inject steam into the dust-collector *c'* by a pipe *f*, controlled by a valve *g*. Steam from the boilers is admitted until there is seen a good flow of white vapor from the top of the furnace due to the ascending steam. The bell or bells are then closed and the bleeder or bleeders *i* are opened, first one of them until vapor is seen to rise from it, which is then closed, and then the other bleeder is similarly opened and

closed, if there happens to be two bleeders on the furnace. I now open valve *e*, or, if there is no valve at this point, open a valve at a point where the gas is to be burned, either at the boilers or stoves. The steam will now begin to work down to the opening thus made; but as soon as this opening has been made the furnace is lighted at the bottom, and after lighting it the hot-blast is turned on and in a few minutes steam will be found issuing from the opening made at the stoves or boilers. As soon as gas comes along in good quantities the steam is turned off and the gas is admitted to the stoves and boilers and burned. It will thus be seen that I drive out the air from the top of the furnace and its pipe connections as much as possible with steam, and thus cause a cushion of steam to be propelled in front of the furnace-gases, effectually driving out any residual air in front of it and avoiding the formation of an explosive mixture.

In the foregoing description of the method of using my improvement it should be understood that where I mention "hot blast" it is on the assumption that the furnace I am about to blow in is near another furnace already in operation, as is usual in large works, where the plant usually embraces several furnaces, in which case blast that is heated in hot-blast stoves in regular operation may be conducted to the furnace blowing in.

When applied to an isolated furnace or where hot blast cannot be had until the stoves of said furnace become heated up—say with gas produced by said furnace—it is obvious that the blast which I will apply immediately after lighting the furnace will necessarily be cold, in which case more time will be required to bring the furnace to good condition than if hot blast were immediately available; but nevertheless freedom from danger of explosions will be secured and the time requisite for obtaining good marketable iron will be greatly shortened by the use of my improvement.

I may also inject steam at one or more places; say also at the top of the down-comer, as shown at *h*.

In a hundred-foot furnace recently blown in by me the above procedure was used, the gas being first admitted to the Kennedy burners at the stoves, while from the top of the furnace to the place where the gas was lighted is about five hundred feet. Steam was admitted to the dust-collector through a two-inch pipe under a pressure of eighty pounds. The furnace produced iron twenty-four hours earlier than by the old method of blowing in and at the same time produced marketable iron from the start with not the semblance of the least explosion when the gas was turned on. In case the down-comer and dust-collector are completely cold it is well to give them a preliminary heating, most conveniently done by building a fire in the dust-collector and allowing the smoke to ascend the down-comer and pass out of the top of the furnace. This will heat the pipes and prevent too great a condensation and consumption of the steam.

After a stop in blowing it is also advisable to inject steam in the pipes before the blast is again put on and the gas again lighted, so as to avoid explosion.

After the blast has been turned on it may be desirable to light the gas at the top of the furnace, at the same time turning on the steam, and when a good flow of steam is obtained close the top of the furnace and send the mixture of gas and steam to the points of use—boilers or stoves. The steam will decrease the temperature of the gases to below their critical temperature as well as act as a diluent to prevent explosions. It will also assist the blast to blow the gas through the down-comer and other connections to the points of use.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. The art of controlling furnace-gases, which consists in placing in front of the gases emanating from the furnace a body of an inert gas or vapor in sufficient quantity to prevent explosion, substantially as described.

2. The art of controlling furnace-gases, which consists in placing in front of the gases emanating from the furnace a body of steam in sufficient quantity to prevent explosion, substantially as described.

3. The art of starting or blowing in blast-furnaces, which consists in driving the air from the furnace and its gas-pipe connections by means of steam, then starting the furnace and applying forced blast to generate gas and drive the steam and any remaining air in front of said gases, substantially as described.

4. The art of blowing in blast-furnaces, which consists in placing a body of steam in the top of the furnace and in the pipes between the furnace and place of use of the gases, and then turning on the blast, and driving the steam and air in front of the gases by reason of the energy of the blast, thereby avoiding explosion, substantially as described.

5. The art of blowing in blast-furnaces, which consists in forcing air out of the gas-pipes and connections by means of steam and then turning on the blast to force a body of steam in front of the furnace-gases to the point of their consumption, substantially as described.

6. The art of blowing in blast-furnaces, which consists in first heating the gas-conveying pipes leading from the furnace, then driving out the air therein by steam and then turning on the blast, whereby a body of steam will be driven through said pipes in advance of the gases, substantially as described.

7. The art of blowing in blast-furnaces, which consists in temporarily injecting into the furnace-gases emanating from the furnace

proper a body of steam sufficient to prevent the formation of an explosive mixture and using the gases at a suitable point of consumption after the connections with the furnace have been cleared of air by said body of steam, substantially as described.

8. The art of controlling the gases of metallurgical furnaces using blast, which consists in temporarily injecting a body of inert gas or vapor in front of the furnace-gases in sufficient quantity to prevent explosion and in a direction opposite to the natural flow of said gases, and then applying blast to the furnace, substantially as described.

9. The art of blowing in blast-furnaces, which consists in filling the top of the furnace, the gas-pipes and their connections with steam, lighting the furnace, throwing on the blast and venting the steam from the furnace and pipes at the points of consumption of the gases from said furnace, substantially as described.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

JOHN WEBSTER DOUGHERTY.

Witnesses:
W. H. NELL,
ROSS M. FREY.