(No Model.)

3 Sheets—Sheet 1.

G. M. WESTMAN.

ZINC FURNACE.

No. 401,088.

Patented Apr. 9, 1889.

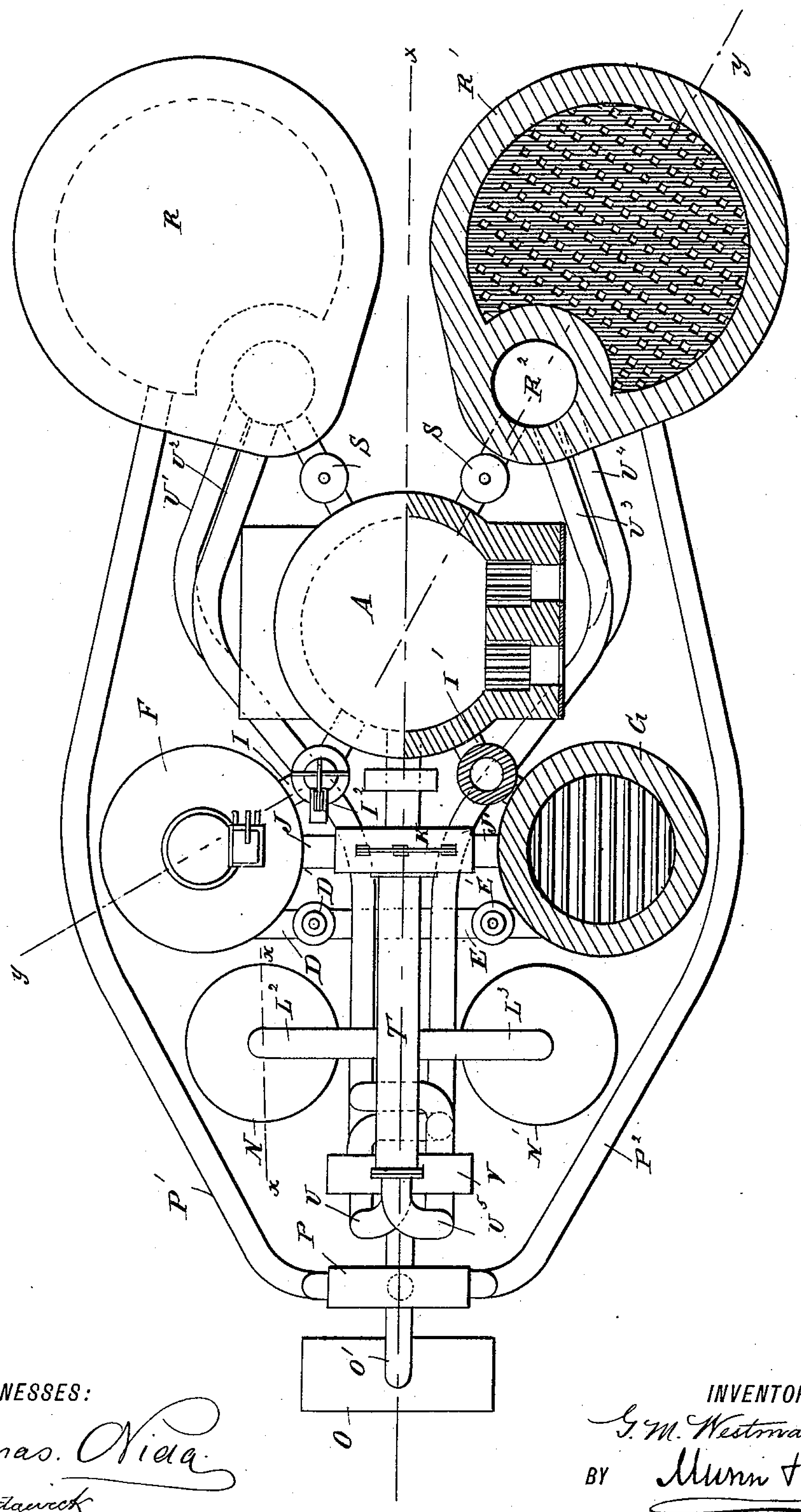

Fig: 1.

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Fig: 2.

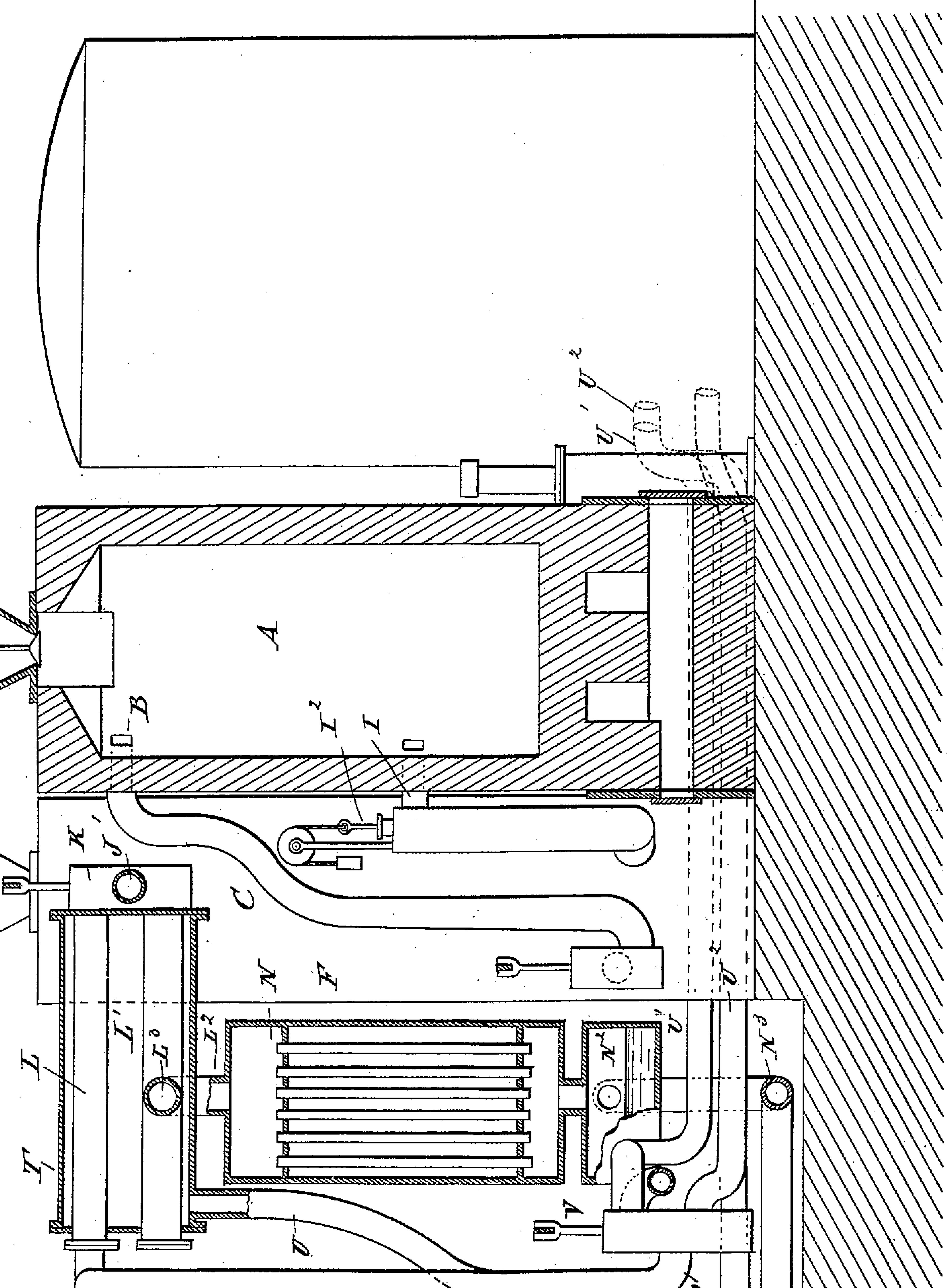

Fig: 4.

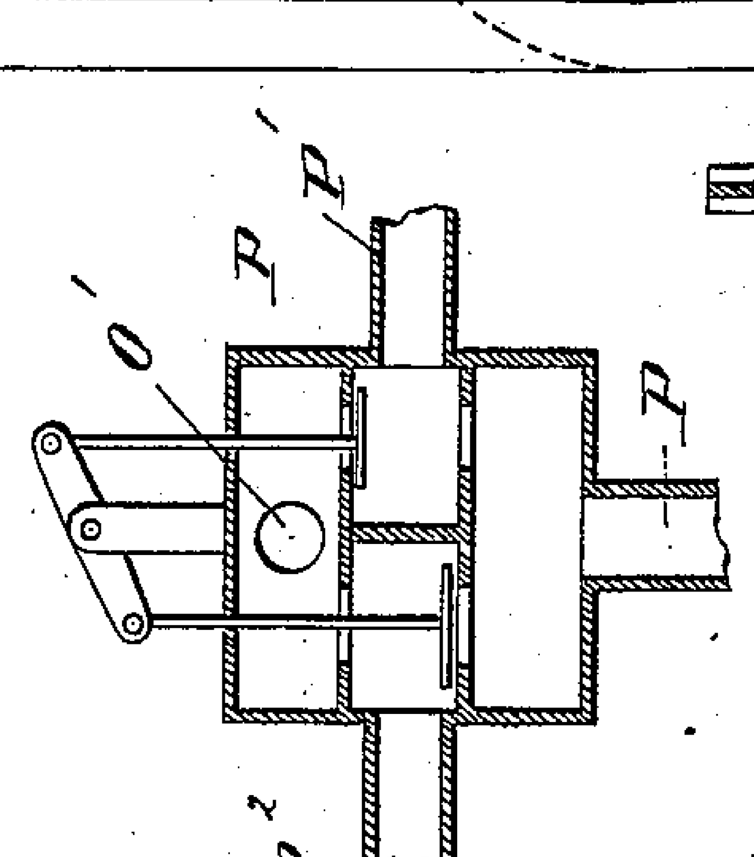

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Fig: 3.

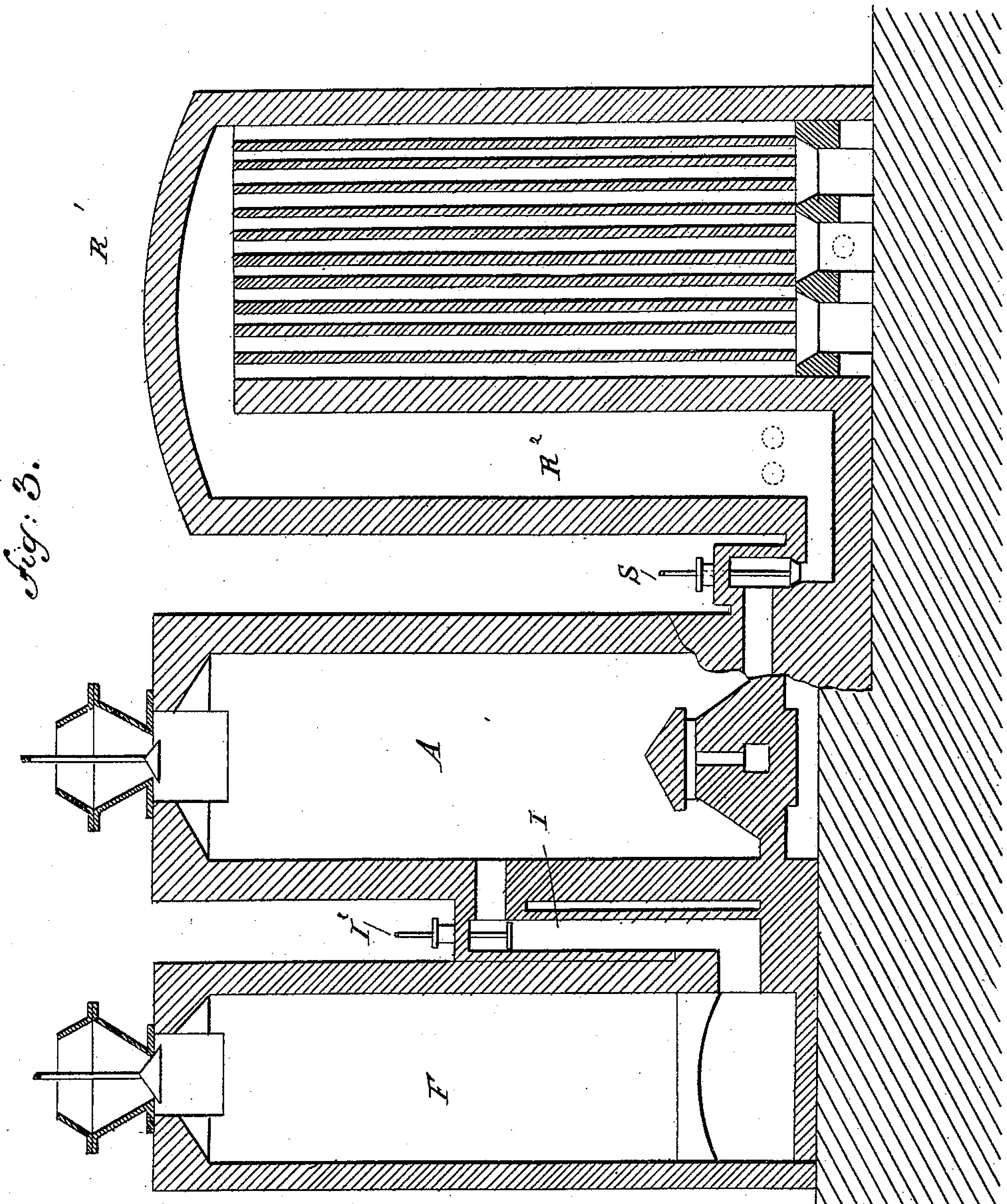


Fig: 5.

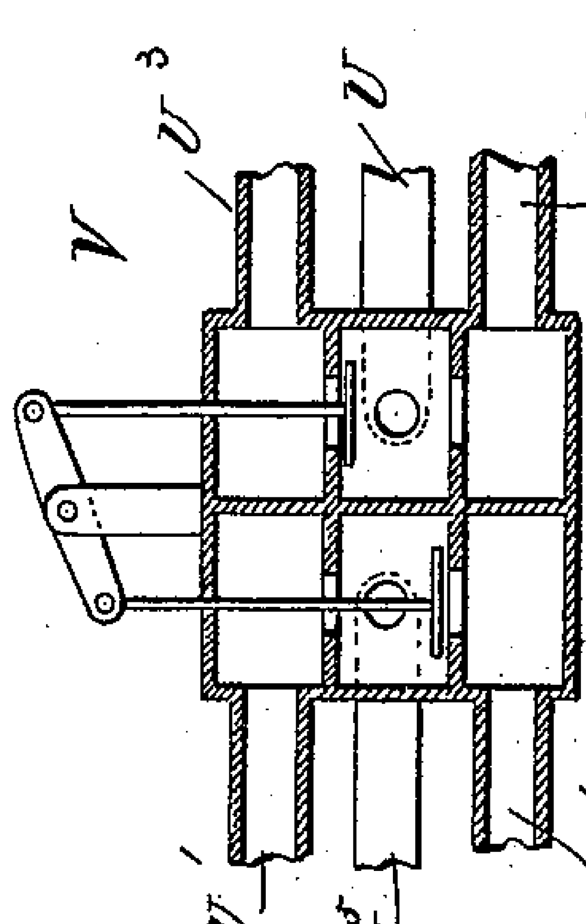
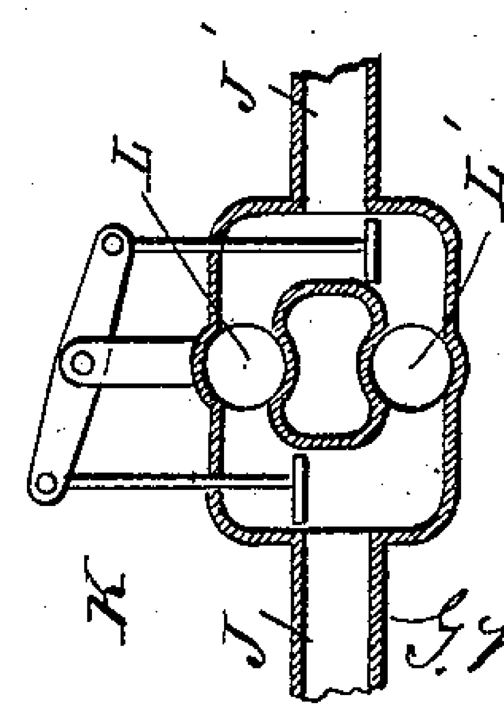


Fig: 6.



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UNITED STATES PATENT OFFICE.

GUSTAF M. WESTMAN, OF NEW YORK, N. Y.

ZINC-FURNACE.

SPECIFICATION forming part of Letters Patent No. 401,088, dated April 9, 1889.

Application filed May 1, 1888. Serial No. 272,428. (No model.)

To all whom it may concern:

Be it known that I, GUSTAF M. WESTMAN, a subject of the King of Sweden, at present residing in the city, county, and State of New York, have invented a new and Improved Furnace, of which the following is a full, clear, and exact description.

The object of the present invention is to provide a new and improved furnace to permit the reduction of iron or zinc ores, and the manufacture of phosphor, sodium, and other substances.

The invention consists in certain parts and details and combinations of the same, as will be fully described hereinafter, and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a plan view of the improvement with parts in section. Fig. 2 is a sectional side elevation of the same on the line x x of Fig. 1. Fig. 3 is a similar view of the same on the line y y of Fig. 1. Figs. 4, 5, and 6 are sectional views of valves for connecting various pipes, as hereinafter more fully described.

The reducing-furnace A, of any approved construction, is provided at its upper end with an aperture, B, leading to a pipe, C, extending downward on the outside of the furnace A and branching into the pipes D and E, each being provided with a valve, D′ or E′, respectively. The pipes D and E lead into the bottom of the condensing-furnaces F and G, respectively, which are alike in construction, each being filled with a suitable filling material, such as coke, &c.

Into the lower end of the reducing-furnace A lead the pipes I and I′, extending to the outside of the furnace A and connected with the bottom of the condensing-furnaces F and G, respectively, each of the channels I and I′ being provided with a valve, I^2, for closing the connection between the reducing-furnace A and the respective condensing-furnace F or G. From the tops of the condensing-furnaces F and G lead the pipes J and J′, respectively, to a valve, K, illustrated in Fig. 6, and arranged in such a manner that the two pipes J and J′ discharge into either of the two pipes L and L′, as is plainly seen by referring to the said Fig. 6. The pipe L′ is connected by the branch pipes L^2 and L^3 with the coolers N and N′, respectively.

The coolers N and N′ may be of any approved construction, preferably, however, provided with a cooling-chamber, through which the atmospheric air or water passes, as shown in Fig. 2. The gases passing through the coolers N and N′ pass through the pipes surrounded by the cool atmospheric air or water. Each of the coolers N and N′ discharges into a receptacle, N^2, connected by a pipe, N^3, with a blasting-engine, O, of any approved construction.

The blast-engine O discharges into a pipe, O′, connected with a valve, P, (shown in detail in Fig. 4,) and provided with the pipes P′ and P^2, leading to the bottom of the regenerators R and R′, respectively. The valve P is also connected with a pipe, P^3, leading to the chimney Q. The pipes O′, P′, P^2, and P^3 are so arranged that the gases from the blast-engine O can pass either to the regenerator R by means of the pipe P′, or to the regenerator R′ by means of the pipe P^2, and while one of the regenerators is connected with the pipe O′ the other regenerator is connected by its respective pipe with the pipe P^3, leading to the chimney Q, as is plainly understood by reference to Fig. 4, to carry off the products of combustion. Each of the regenerators R and R′ is provided with a channel, R^2, connected with the top of the interior of the regenerator and leading into the bottom of the reducing-furnace A. The valve S, located in the said channel R^2, serves to connect the respective regenerator with or disconnect it from the reducing-furnace A.

The pipes L and L′ are surrounded by a jacket, T, having an opening in its rim or in one of its heads leading to the outside. A pipe, U, leads from the jacket T downward and connects with a valve, V, located near the valve P and provided with pipes U′ and U^2, leading to the regenerator R, and also provided with pipes U^3 and U^4, leading to the regenerator R′. A pipe, U^5, extends from the valve V to the pipe L, so as to draw off any surplus gas not discharged to the coolers N and N′. The valve V is so arranged that the air passing from the jacket T to the pipe D and the surplus gas from the pipe L can be discharged into either of the regenerators R or R′ to be burned.

As shown in Fig. 5, the air from the pipe U passes into the pipe U′, leading to the channel R^2 of the regenerator R, and the surplus gas entering through the pipe U^5 passes to the same channel, R^2, of the regenerator R by means of the pipe U′. If the valve is reversed the air entering the pipe U can pass through the pipe U^3 into the channel R^2 of the regenerator R′, and the gas entering through the pipe U^5 can pass by the pipe U^4 into the channel R^2 of the regenerator R′.

The operation is as follows: When it is desirable to reduce zinc ores, for instance, then the reducing-furnace A is charged with zinc ores mixed with coal, and the condensing-furnaces F and G are preferably filled with coke. Now, when one regenerator, R or R′, is connected with the reducing-furnace A, the other regenerator is closed to the said reducing-furnace by the valve S. The reducing-furnace A is thus supplied with carbonic-oxide gas heated in the regenerator T or T′, and the gases now arising in the reducing-furnace can either be taken off at the top through the opening B or through the pipe I or I′, near the lower end of said reducing-furnace A. When the opening B is connected with the condensing-furnace G, the valve D′ in the pipe D is closed, while the valve E′ in the pipe E is opened, thus establishing a connection from the opening B through the pipe C and the pipe E with the condensing-furnace G. The valve I^2 in the pipe I′, connecting the reducing-furnace A with said condensing-furnace F, is open, so that the highly-heated gases in the bottom of the reducing-furnace A pass through the pipe I into the condensing-furnace F, while the gases of a lower temperature in the top of the reducing-furnace A pass through the opening B into the condensing-furnace G. Thus the condensing-furnace F is in operation to condense the zinc-vapors, while the other furnace, G, is cooled off by the waste gases coming from the top of the reducing-furnace A.

The arrangement just described can be reversed by closing the valve E′ in the pipe E and opening the valve D′ in the pipe D, and by closing the valve I^2 in the pipe I, leading from the reducing-furnace A into the condensing-furnace F, and by opening the valve I^2 into the channel I′, leading from the reducing-furnace A into the condensing-furnace G. In this case the zinc-vapors are condensed in the condensing-furnace G, while the condensing-furnace F is cooled off by the gases of a lower temperature coming from the top of the reducing-furnace A. The gases after passing through the respective condensing-furnace F and G pass into the pipes J and J′, and by means of the valve K are directed into the pipes L and L′, leading from said valve K. The air passing through the jacket V, surrounding said pipes L and L′, partly cools the gases passing through the pipes L and L′. The gases from the pipe L′ pass into the coolers N and N′, and are still more reduced to a lower temperature, and then pass into the receptacle N^2, in which they are purified from dust which settles in the bottom of the receptacle. The gases are then drawn into the circulating blast-engine O, which discharges through the pipe O′ into the valve P, from which the gases are led into the respective regenerator R and R′ used for supplying the reducing-furnace A with heated carbonic-oxide gas. The other generator, R, which is not connected with the reducing-furnace A, is used for burning the surplus gases which pass from the pipe L into the valve V, and from the latter, with a sufficient mixture of air, entering through the pipe U, passes into the channel R^2 of the other regenerator, R′, to be burned in the usual manner.

It will be seen that either of the regenerators R and R′ can be used for supplying heated carbonic oxide to the reducing-furnace A, while at the same time the other regenerator, not used for this purpose, is employed to burn the surplus gases in connection with other gases derived from an outside source. It will further be seen that a continuous stream of gases passes through the reducing-furnace, the condensers, the coolers, blasting-engine, and regenerators, and the said gases are used over and over again for condensing and for supplying the necessary heat in reducing.

In defining my invention with greater clearness, I would state that in the reduction of zinc ores it is not only necessary that the gases should convey heat enough for the operation, but also that they should be absolutely free from oxidizing matters. Ordinary producer gases made through introducing air into coal cannot be free from carbonic acid.

In the circulating gases that I intend to use the oxygen is taken from the zinc oxide and the carbon from the fuel, and, as herein described, I avoid the admixture of air or oxygen with the gas. The solid carbon mixed with the zinc ore acts as the reducing agent. The reduction of zinc oxide cannot be effected by means of carbonic oxide alone—a fact that is practically demonstrated by the oxidation of zinc when heated in contact with carbonic acid CO_2, and theoretically by the greater amount of heat developed by the combustion of zinc than by the combustion of carbonic oxide with the same quantity of oxygen. Moreover, when no air is introduced in the furnace, a chemical change of the gases cannot take place, and thus the only object of the carbonic oxide gas is to introduce from the outside the heat necessary to the reducing operation, which consequently is of the most material importance in my process.

In the reduction of zinc ores it has by this system been possible to make a considerable saving in time, labor, and fuel as compared with my former system. The condensation of the zinc-gases in mixture with permanent gases depends exclusively upon the tension of the zinc-gases. With this process one must entirely regulate the gas-outlets, so that only the surplus of permanent gases may follow the zinc-gases. While the zinc that follows the above escaping gases will condense inside the reduction-furnace and enrich with zinc the lower escaping gases, these will go off with the zinc-gases in maximum tension. When all the permanent gases follow the zinc-gases, only so much of their sensible heat can be utilized as the difference in temperature by their inlet in the reduction-furnace and the temperature at which the zinc is gasified.

Considerable quantities of heat can be delivered for preheating the charge after their temperature has gone below the boiling-point of the zinc, and evidently the heat of the gases will be more fully utilized when a larger quantity passes through the whole furnace. By this system passes through the whole furnace one (to the whole circulating mass of gas) corresponding part, which must be considered as an important circumstance. As the surplus gases consequently are drawn off by their formation the circulating stream of gas will be of a constant volume. An indirect advantage by this arrangement is, that the blower need not transport the new-made gases, which go directly to be burned in the regenerator. Therefore by this system can more heat than formerly be transported with the same power.

In order to produce phosphorus I use the furnace in a similar manner as above described in reference to the treatment of zinc ores. The metaphosphate is mixed with charcoal, silicic acid, and asphaltum in the form of briquettes, and the latter are subjected to a white heat in the reducing-furnace A with the exclusion of oxidizing substances, so that phosphor is distilled according to the following formula: $2Ca(PO_3)_2+2SiO_2+10C=2CaSiO_3+P+10CO$.

Instead of using metaphosphate of lime, I may employ orthophosphate of lime.

Sodium is similarly produced as follows: The carbonate of soda is well dried at a high temperature, and then mixed with well dried and pulverized charcoal and chalk ground to a very fine powder, the success of the operation depending in a great degree on the fineness of the mixture. The latter is formed into bricks with an addition of asphaltum. The chalk is for the purpose of making the mixture less fluid and more porous. The bricks are subjected to a preliminary calcination, which is continued until all moisture and carbonic acid cease coming off. The bricks are then further treated in the reducing-furnace, as above described in reference to zinc.

When the furnace is to be used for reducing iron ores, the reducing-furnace A is charged with the ore to be reduced in the usual manner. The furnaces F and G are filled with coal and now become coke-furnaces. When the blast-engine O is set in motion, the latter draws in the carbureted gases from the condenser F and G through the pipe L′, the coolers N and N′, and the pipe N^3. The carbureted gases are exhausted by the engine O into the valve P, from which the gases pass to the respective regenerator R and R′, are very highly heated, and rise to the top, from which they pass into the respective channel R^2, which leads the carbureted and heated gases into the bottom of the reducing-furnace A. The carbureted and heated gases now pass through the ores held in the reducing-furnace A, thus reducing the ores.

The gases arising in the reducing-furnace can either be taken off at the top through the opening B or through the pipe I or I′, near the lower end of said reducing-furnace A.

When the opening B is connected with the coke-furnace G, the valve D′ in the pipe D is closed, while the valve E′ in the pipe E is opened, thus establishing a connection from the opening B, through the pipe C and the pipe E, with the coke-furnace G. The valve I^2 in the pipe I′, connecting the reducing-furnace A with the coke-furnace F, is open, so that one (to the new-made gases) corresponding part passes through the pipe I into the coke-furnace F, while the circulating gas passes at the top of the reducing-furnace A through the opening B into the coke-furnace G.

The arrangement just described can be reversed by closing the valve E′ in the pipe E and opening the valve D′ in the pipe D, and by closing the valve I^2 in the pipe I′ and opening the valve I^2 in the pipe I.

In the coke-furnace connected with the reducing-furnace A at the lower outlet a small quantity of air is introduced, thus producing ordinary producer gas, which, together with the surplus gases from the reducing-furnace, go through the pipe L to the valve V to heat one of the regenerators.

By the inlet of air the coal is transformed into glowing coke, which, after reversing the valve I^2, D′, and E′, serves for carbureting the circulating gases. When the coke in the latter furnace is cooled to such degree that the gases are no more carbureted, the coke in the other furnace has during the time been heated to be used for the carbureting. In this manner no interruption takes place. The carbureted gases are drawn from the top of the condensers by the action of the blast-engine O and pass into the pipes L′, from which they pass to the cooler, &c., as above described. Other ores—such as manganese—are treated in a similar manner, but in mixture with coke, to that above described in reference to iron ores.

Instead of the herein-described shaft-furnace for reducing lump ore, I will, for reducing pulverized ore, use an open heat furnace with one or more compartments in which the ore is spread over the bottom of the furnace and the gases pass over the ore.

The same observations as were made by the description of the zinc process with regard to the outlets may here be made.

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

In a furnace, the combination, with a reducing-furnace, of regenerators connected alternately with the reducing-furnace, condensers, each connected by two or more pipes with the said reducing-furnace, coolers connected with the said condensers, and a blast-engine connected with the said coolers and the said regenerators, substantially as shown and described.

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Witnesses:

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