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APPARATUS FOR PREVENTING TOP EXPLOSIONS IN BLAST FURNACES.

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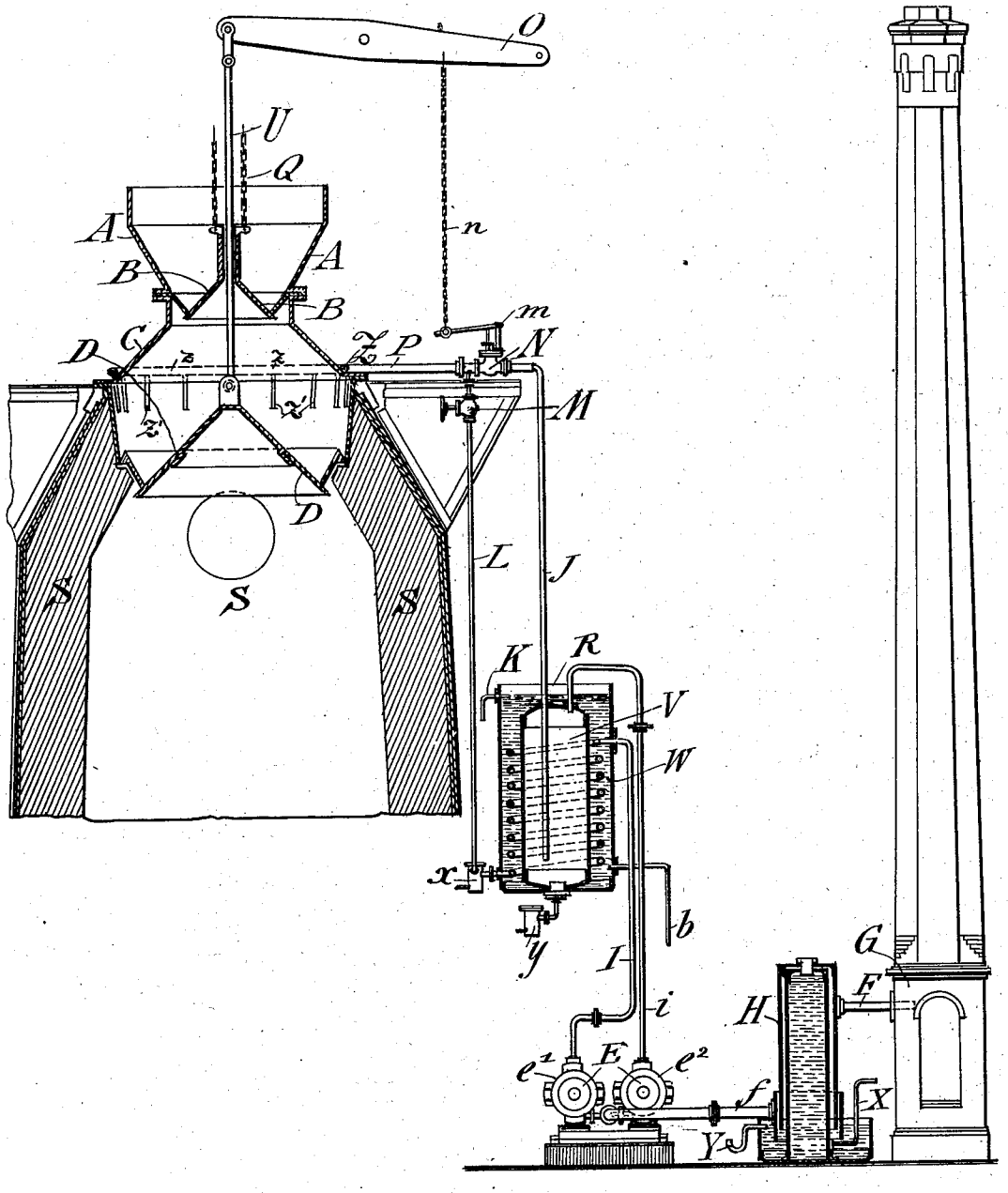
NO MODEL.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR PREVENTING TOP EXPLOSIONS IN BLAST-FURNACES.

SPECIFICATION forming part of Letters Patent No. 721,418, dated February 24, 1903.

Application filed October 2, 1902. Serial No. 125,614. (No model.)

To all whom it may concern:

Be it known that I, RUDOLF BERG, a citizen of the United States, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Apparatus for Preventing Top Explosions in Blast-Furnaces, of which the following is a specification.

This invention relates to blast-furnaces, and has for its object to provide means for eliminating the objectionable and dangerous explosions in blast-furnaces, and more particularly the so-called "top" explosions. These explosions, as is well known, are caused by the combining of the gases in the furnace (technically known as "waste gases") with the free oxygen of the atmospheric air which intermingles with the charge of coke and ore and with the air which is drawn in by the suction action of each charge when it is dropped into the furnace. The waste gases coming in contact with the air-containing charge in the hopper are cooled, and the so-cooled gases are mingled with the free oxygen of the air in the hopper and will produce an explosive mixture therewith. This cooled mixture having a temperature below that of combustion will be drawn into the furnace with the charge and will explode when again heated to the combustion temperature. The extent of these explosions depends upon the volume of the explosive "air and gas mixture" formed. The lower the temperature of the air which permeates the charge and the lower the temperature of the exterior atmosphere the larger will be the volume of the explosive mixture formed. Hence it follows that during the winter months these explosions are most intense, and consequently most disastrous. These explosions are very objectionable, inasmuch as they impede the proper working of the furnace and are very dangerous to life and property.

The object of this invention is to eliminate these explosions by removing their cause; and the invention consists, essentially, of means for preventing the atmospheric air from mixing with the blast-furnace gases in the charges supplied by the hopper by forcing a sufficient quantity of compressed combustion-gases previously cooled through one or more pipes at the top of the blast-furnace into the charge of ore and coke contained in the chamber above the lower hopper, thereby forcing out the atmospheric air intermingled with the charge and preventing simultaneously any atmospheric air from entering into the blast-furnace by the dropping of the charge; and the invention consists, further, in cooling the compressed combustion-gases and forcing them into the lower hopper of the furnace, so as to insure the efficient working of the hoppers of the furnace; and the invention consists, lastly, of the specific construction of the apparatus for preventing the top explosions in blast-furnaces, which will be fully described hereinafter and finally defined in the claims.

The accompanying drawing represents a vertical central section through the top of a blast-furnace and coolers of my improved apparatus for preventing top explosions in the same.

Similar letters of reference indicate corresponding parts.

A blast-furnace of any approved construction is charged with the ore and coke by means of any suitable conveyer emptying into an upper hopper A. This hopper empties in turn on the opening of the bell B into the chamber C, which in turn on the opening of the lower bell D discharges its contents along the same into the cupola or stack S of the blast-furnace. Intermingled with the coke and ore is a considerable quantity of atmospheric air containing free oxygen; but a still greater quantity is drawn or sucked in with each charge from the outside of the furnace. It is this air, together with the cold coke and ore, which cools the upwardly-streaming hot gases of the blast-furnace, so that the oxygen of the air intermingles with the gases of the furnace and forms an explosive mixture. This mixture heated to the temperature of combustion explodes with considerable violence. To prevent these explosions—that is, to prevent the oxygen of the atmospheric air from mingling with the hot gases of the blast-furnace—means are provided for expelling the air from the charge in the coke and ore chamber, which is formed by the hopper, upper and lower bell, and up-

wardly-extending walls of the blast-furnace, and simultaneously preventing any outside atmospheric air from being drawn into the cupola of the blast-furnace by the dropping of the charge. For this purpose combustion-gases are drawn from any suitable smoke-stack near the blast-furnace, cooled, compressed, and forced into the lower coke and ore chamber C by means of pipes connected with said chamber on the top of the furnace. These gases are taken in hot condition from the smoke-stack G continuously and in sufficient quantities by the suction action of a duplex compressor through a pipe F and supplied to a cooler H, in which the gases are cooled by water, the water being supplied to the cooler by means of the pipe X and the hot waste water drained off by the pipe Y, the pipe Y being so arranged as to provide a hydraulic seal, so as to prevent any atmospheric air from coming in contact with the cooled gases. The cooled gases are passed through a pipe *f* and forced by cylinder e^2 of the duplex compressor E, by means of a pipe *i*, into a reservoir V, submerged into a tank R, so as to store therein a considerable quantity of the cooled combustion-gases. The tank R is provided with a pipe *b* for supplying water for cooling the stored gases in the reservoir, which water is drained off by the pipe K after it has throughly cooled the compressed combustion-gases in said reservoir. A pipe JP connects the lower end of the reservoir V with the chamber C, the pressure-reducing valve N being arranged in said pipe JP and actuated by the weighted lever *m*, chain *n*, and bell-operating lever O. On opening the valve N the cooled compressed gases are permitted to pass into the coke and ore chamber C, expelling thereby the atmospheric air intermingled with the charge and completely filling the coke and ore chamber C, so as to prevent any exterior air from mingling with the charge and from being drawn into the stack of the furnace by the dropping of the charge. No explosive gas and air mixture being formed in or by the "charge," explosions are absolutely prevented in the upper part in the blast-furnace.

Due to the intense heat of the blast-furnace, danger of fusion of the bell and hopper, or inoperativeness of the bell due to "buckling" under the influence of the heat, the case may arise that the resistance of the bell will not be sufficient to properly hold the large weight of the charge, so that it becomes desirable and advantageous to cool these parts, which is accomplished by cooling and compressing combustion-gases and forcing an ample supply of the cooled compressed gases against the affected parts. For this purpose the combustion-gases may be taken from any convenient source, preferably, however, as shown in the accompanying drawing, also from the chimney G by means of the pipe F, cooled by suitable means H and compressed in the second cylinder e' of a duplex compressor E. Similar to the before-described action of forcing the compressed gases into the cooling-reservoir V the gases are now forced under tension by means of pipe I into cooling-coil W at the interior of the tank R, from which coil they are forced through the pipes LP and the branches and openings *z* into the chamber C by the opening of the valve M. As soon as the pressure in the coil W exceeds the resistance of the pressure-reducing valve M it will permit the cooled gases to pass continuously into the chamber C. To get rid of accumulations of water drawn mechanically or entrained by the gases, suitable drip-collectors or water-traps *x* and *y* are connected with the lower ends of the cooling-coil W and reservoir V.

The operation of my apparatus is as follows: When the furnace is to be charged, the bell D is lowered and the contents of the coke and ore chamber C dropped into the furnace. As the main lever O simultaneously operates the bell D and valve N, a quantity of the cooled combustion-gases is supplied under pressure to the charge from the reservoir R. A considerable quantity of the compressed cooled combustion-gases passes through the pressure-reducing valve M into the pipe P and, together with the gases passing through the valve N and the pipe P, completely fill the coke and ore chamber C. These cooled combustion-gases being under tension expel all the intermingling air in and between the coke and ore, prevent any atmospheric air from being drawn into the furnace, so that no explosive mixture is formed, and at the same time thoroughly cool the upper parts of the furnace. When the chamber C has emptied its charge into the furnace, the bell D is again closed by the main lever O, which will simultaneously close the valve N. The chamber is again charged from the upper hopper A by the lowering of the bell B. In the meantime the pressure will rise in the coil W until the pressure-reducing valve M will be opened by the increasing pressure in the same, whereupon the cooled combustion-gases will cool the heated parts, completely fill the chamber C, and expel by its greater pressure the air intermingled with the charge of coke and ore, thereby completely replacing the air and at the same time providing a seal so as to prevent any atmospheric air from being sucked into the stack of the furnace and absolutely obviating thereby explosions in the upper part of the furnace.

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

1. In a blast-furnace, the combination, with the coke and ore chamber at the upper part of the blast-furnace, of means for supplying compressed and cooled combustion-gas to said chamber, substantially as set forth.

2. In a blast-furnace, the combination, with

the coke and ore chamber at the upper part of the blast-furnace, of means for periodically supplying cooled and compressed combustion-gas to said chamber, substantially as set forth.

3. In a blast-furnace, the combination with the coke and ore chamber at the upper part of the blast-furnace, of means for continuously supplying compressed and cooled combustion-gas to said chamber for cooling the upper working parts of the furnace, substantially as set forth.

4. In a blast-furnace, the combination, with the coke and ore chamber at the upper part of the blast-furnace, of means for continuously supplying compressed and cooled combustion-gas to said chamber, and of means for supplying periodically an additional supply of combustion-gas to said chamber, substantially as set forth.

5. In a blast-furnace, the combination, with the coke and ore chamber at the upper part of the blast-furnace of a supply-pipe for compressed and cooled combustion-gas, a pressure-reducing valve in said supply-pipe, and means for forcing a continuous supply of compressed and cooled combustion-gas into said chamber, substantially as set forth.

6. In a blast-furnace, the combination, with the coke and ore chamber at the upper part of the blast-furnace, of a smoke stack or flue, means for cooling the combustion-gas drawn from the smoke-stack, means for compressing the cooled combustion-gas, a storage-tank for the compressed and cooled gas, and a supply-pipe, connecting the smoke-stack, cooling, compressing and storing means with the coke and ore chamber, substantially as set forth.

7. In a blast-furnace, the combination, with the coke and ore chamber at the upper part of the furnace, of a smoke-stack, a cooler for the gases drawn from the smoke-stack, a pipe connecting the smoke-stack and cooler, a compressor, a pipe connecting the cooler and compressor, a storage-tank for simultaneously cooling and storing the compressed gases, a pipe for connecting the compressor with the storage-tank, and a pipe for connecting the storage-tank with the coke and ore chamber and a pressure-reducing valve in the pipe connecting the storage-tank with said chamber, substantially as set forth.

8. In a blast-furnace, the combination, with the coke and ore chamber at the upper part of the furnace, of a smoke-stack, a cooler for the gases drawn from the smoke-stack, a compressor, a storage-tank, pipes connecting the smoke-stack and cooler, cooler and compressor, and compressor and storage-tank, a cooling-coil in the storage-tank also connected with the compressor and pipes connecting the storage-tank and cooling-coil with the coke and ore chamber, and pressure-reducing valves in said pipes for supplying separate quantities of cooled and compressed combustion-gas to said coke and ore chamber, substantially as set forth.

9. In a blast-furnace, the combination, with the coke and ore chamber at the upper part of the blast-furnace and the delivery-bell for the same, of a supply-pipe for supplying compressed and cooled combustion-gas to the coke and ore chamber, a pressure-reducing valve in said supply-pipe, and means for simultaneously actuating the delivery-bell, and pressure-reducing valve for supplying the combustion-gas under pressure to said chamber, to force out the atmospheric air in the same and prevent it from passing into the furnace, substantially as set forth.

10. In a blast-furnace, the combination with a coke and ore chamber provided with side openings and the delivery-bell of said chamber, of a main pipe encircling said chamber and connected by branches with said openings, a supply-pipe for the cooled and compressed combustion-gas, provided with a pressure-reducing valve, and mechanism connected with said delivery-bell and pressure-reducing valve for supplying periodically with the opening of the bell a quantity of cooled combustion-gas to said chamber, substantially as set forth.

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

RUDOLF BERG.

Witnesses:
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P. F. TOOLE.