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B. E. ELDRED.

PROCESS OF MANUFACTURING STEEL.

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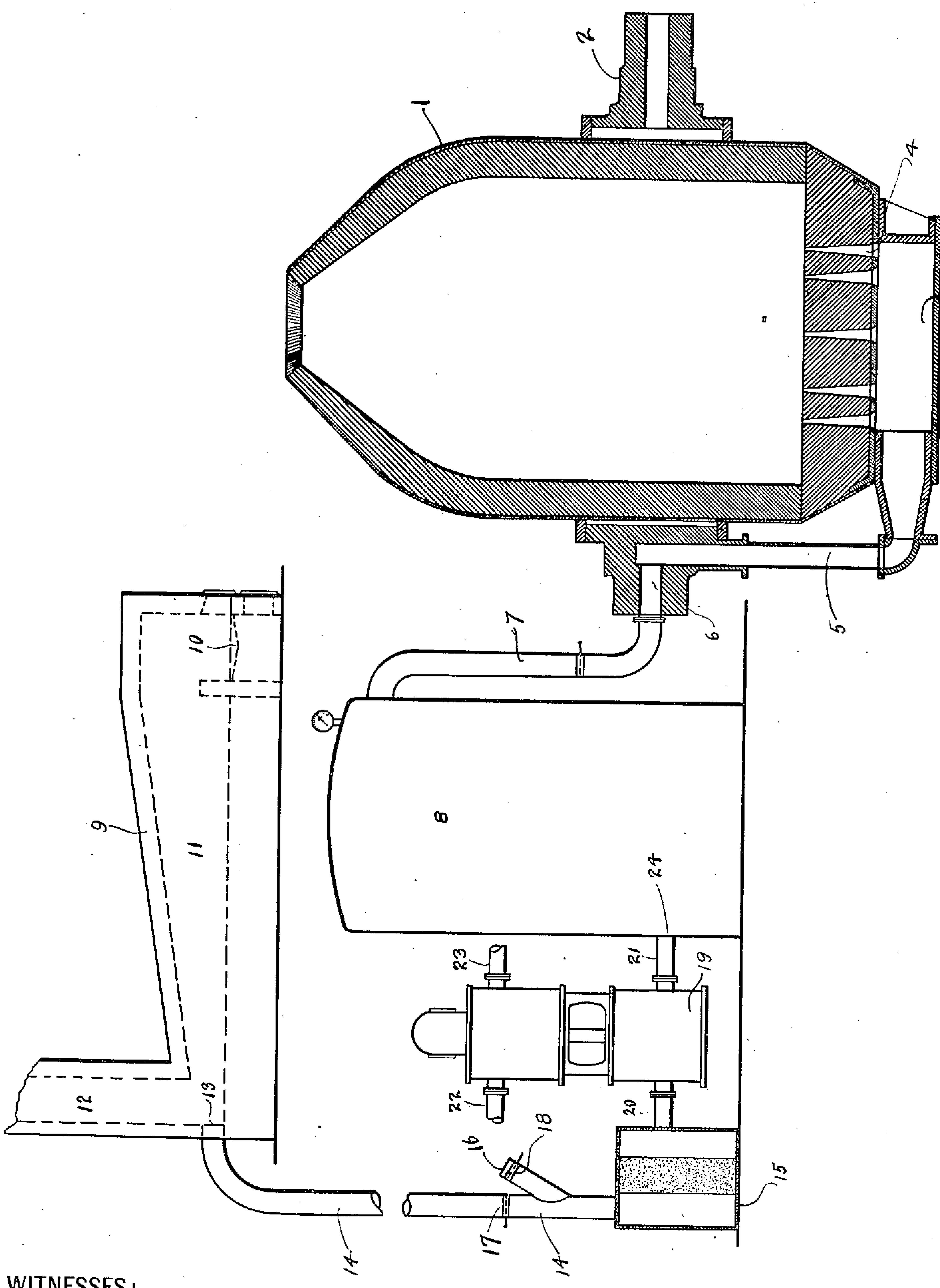

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PROCESS OF MANUFACTURING STEEL.

No. 843,592. Specification of Letters Patent. Patented Feb. 12, 1907.

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To all whom it may concern:

Be it known that I, BYRON E. ELDRED, a citizen of the United States, and a resident of New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Processes of Manufacturing Steel, of which the following is a specification.

This invention relates to a process for the manufacture of steel by progressive oxidation of the impurities thereof in a manner akin in some respects to the Bessemer process. In the manufacture of steel by the latter method many difficulties have arisen, due to the impossibility of properly controlling the temperature of the molten mass. In blowing the converter with an air-draft the temperature of the steel will often rise to an extremely high point, giving rise to reactions which are injurious to the metal and misleading to the operator. In the Bessemer process the object is generally to burn off first silicon and then carbon. The oxidation of the former is productive of a very high temperature, owing to the fact that no gaseous products of combustion accompany this reaction and the gas escaping is small. The gas evolved is chiefly nitrogen from the air-blast. The heat loss as sensible heat is in consequence less than that occurring in the second stage of oxidation in which the carbon is burned, during which stage the volume of gas is much greater and the sensible heat losses are of far greater moment. It is in connection with the first stage of oxidation or silicon slagging stage that this process particularly concerns itself. As above stated, the oxidation should ordinarily proceed successively from silicon to carbon; but this sequence of oxidation occurs only when the temperature is held sufficiently low. It has been found that when the temperature rises above a certain critical point the oxygen of the blast shows a selective action or affinity for the carbon and burns the carbon out of the steel before the silicon is well oxidized. Reactions of this sort cause the production of poor material and often of steel containing a high content of silicon. They are furthermore misleading to the operator. Steam has been used in the past to some extent as a temperature-controlling agent; but because of its oxidizing action on the steel, its high cost of generation, its high specific heat, &c., it has been found a most unsatisfactory agent for temperature control.

At the high temperatures as reached in the manner above described, the nitrogen of the air-blast has been found to have a deleterious action on the steel. Nitrogen combines to a certain extent with the metal to form nitrids. Another portion is undoubtedly occluded, and this occluded portion cannot be removed, as is the case with oxygen by ferromanganese or spiegeleisen.

The object of this invention is to provide a means for temperature control in steel manufacture, which will eliminate the troubles due to the reversal of the order of the combustion of silicon and carbon, will prevent the formation of nitrids, largely reduce the amount of occluded gases, and in addition will have no deleterious action on the steel as regards oxidation or otherwise.

My invention consists in keeping the temperature in the converter during the oxidation of the silicon at a point below the critical temperature, at which preferential oxidation of the carbon begins by the introduction of a regulated draft-current containing an endothermically-acting agent.

Referring to the accompanying diagrammatic drawings, 1 shows a section of a converter of the conventional form having the trunnions 2, the air-chest 3, the twyers 4, the connecting air-pipe 5, trunnion air-inlet 6.

7 is an air-supply pipe having connection with the air-reservoir 8.

9 is a furnace having the grate 10, hearth 11, and stack 12.

At 13 is an outlet for the products of combustion through the passage or conduit 14. This conduit leads to the filter 15, where carbon in the solid form, tar, dust, &c., are removed. Interposed in this conduit is the air-inlet 16. The dampers or valves 17 and 18 in the conduit 14 and inlet-pipe 16, respectively, provide a means for the regulation of the amount of air and products of combustion or of oxygen and carbon dioxid entering the filter 15.

19 is an air-pump having the inlet 20 from the filter and the outlet 21, leading to the reservoir at 24.

22 and 23 are steam inlets and outlets, respectively.

The operation of the process with the apparatus as described is as follows: The products of combustion of the furnace 9 ordinarily passing up the stack as waste gases are drawn wholly or in part through the conduit 14 and filter 15 by the air-compressor 19. At the same time air is admitted through the inlet 16. This mixture is forced into the reservoir 8, from which it may be permitted to enter the converter 1. The converter having previously been filled with molten iron the blast will pass therethrough and oxidize the impurities. At the start of this operation a pure-air blast may be used, if desired; but as the temperature rises, due to the oxidation of silicon, the damper 17 should be gradually opened to allow of the introduction of carbon dioxid or products of combustion along with the air. The introduction of carbon dioxid results in a pronounced cooling action on the metal, and the quantity needed to prevent the temperature from rising to the critical reversal point may be determined by observation of the flame, &c. The action of the carbon dioxid in this manner is so pronounced that the temperature of the converter is under exact control. Carbon dioxid has proven to be a most responsive agent for temperature regulation, and in that respect is greatly superior to steam. The method of operation may be varied to suit the conditions, different types of apparatus, kind of steel required, &c. It is not necessary in the practice of my process to inject this gaseous mixture at the bottom only of the converter. It may also be introduced at the sides or top thereof, or through certain of the twyers the blast containing carbon dioxid may be introduced, while through others a pure-air blast may be injected. In some instances the filter may be dispensed with, especially in those furnace operations where coke-gas producers and the like are employed, which afford products of combustion containing little or no soot or dust. The air-inlet 16 has been diagrammatically indicated as in the inlet 14. It may be also located in the passage 20, and this in some cases is preferable, as it permits of the use of a smaller filter.

Products of combustion may be derived from any suitable source, such as heating furnaces of various sorts or from calcining kilns and the like, which often afford products of combustion containing a greater percentage of carbon dioxid than that present in products of ordinary combustion. From a limekiln, for instance, the proportion of nitrogen is low and that of carbon dioxid high by virtue of the gaseous products of decomposition of the calcareous material. It is possible also to withdraw products of combustion from the converter itself, although these at certain stages of the blow exhibit so great a paucity of carbon dioxid that reliance must be had chiefly upon the nitrogen, which largely constitutes the gas at this stage of the operation. A reduction in temperature at this period by the use of nitrogen is to some degree possible; but the injection of nitrogen reduces the temperature of the converter only through the deportation of sensible heat, whereas carbon dioxid under similar circumstances is split up, its constituents entering into other combinations by reactions which are endothermic in character, so that the introduction of carbon dioxid is much more effective for keeping down the temperature in the converter than if it merely acted by the deportation of sensible heat, as does nitrogen.

In the conduit 14 a cooling apparatus may be placed provided the gases from the furnace 11 are too hot to be handled safely by the air-compressor. The conduit 14 often has to be of considerable length, in which case the radiation therefrom may prove sufficient to secure the desired reduction of temperature. Otherwise an apparatus having a positive cooling action ordinarily should be inserted in the conduit 14. When the gases of combustion are obtained from a steam-boiler furnace, they have, owing to their transit through the boiler-flues, been subjected to a cooling action sufficient to enable their being handled in the compressor without danger. The addition of cold air through the air-inlet on the suction side of the compressor also reduces the temperature of the gases entering the compressor.

By the use of this process advantages of great commercial importance are obtained. The possibility of controlling the temperature of the converter by means of a non-oxidizing agent which is ordinarily a waste product and without cost is of great commercial significance. The use of carbon dioxid in this manner solves the troubles heretofore experienced in accomplishing a proper consecutive and rapid removal of silica and carbon. The carbon dioxid or the products of combustion in this respect appear to have a catalytic action, resulting in an acceleration of oxidation of the silicon, carbon, sulfur, &c., and thereby enabling a "blow" to be made in a much shorter time than that required in ordinary practice. By my process there is from this standpoint, at least, no limit to the rapidity of the blasting, and I am therefore enabled to use converters of larger dimensions than those heretofore employed.

My process for the manufacture of steel enables the production of a metal resembling open-hearth steel at a cost very much less than the latter. It therefore enables me to substitute Bessemer steel for open-hearth steel in many of those large fields of consumption from which Bessemer steel has heretofore been debarred, owing to its brittleness and lack of strength.

Having now described my invention and shown in what manner it may be practiced and in what respect important advantages are secured over those obtaining in the present practice of this art, I claim and desire to secure by Letters Patent—

1. The method of preventing premature oxidation of carbon during the making of steel by the pneumatic or Bessemer process, which consists in maintaining the temperature during the oxidation of the silicon at a point below the critical point at which selective oxidation of carbon in preference to silicon begins, by introducing a diluting non-oxidizing endothermic agent into the draft-current in the proportion necessary to maintain such temperature.

2. The method of preventing premature oxidation of carbon during the making of steel by the pneumatic or Bessemer process, which consists in maintaining the temperature during the oxidation of the silicon at a point below the critical point at which selective oxidation of carbon in preference to silicon begins, by introducing carbon dioxid into the draft-current in the proportion necessary to maintain such temperature.

3. The method of preventing premature oxidation of carbon during the making of steel by the pneumatic or Bessemer process, which consists in maintaining the temperature during the oxidation of the silicon at a point below the critical point at which selective oxidation of carbon in preference to silicon begins, by introducing furnace-gases into the draft-current in the proportion necessary to maintain such temperature.

4. The method of preventing premature oxidation of carbon during the making of steel by the pneumatic or Bessemer process, which consists in maintaining the temperature during the oxidation of the silicon at a point below the critical point at which selective oxidation of carbon in preference to silicon begins, by introducing cooled furnace-gases into the draft-current in the proportion necessary to maintain such temperature.

5. The process of controlling the temperature in a Bessemer blow which consists in continuously admixing with the air-blast varying amounts of a diluting endothermic gas, said amounts being proportioned to the observed tendency of the Bessemerized metal to rise in temperature above a desired point.

6. The process of controlling the temperature in a Bessemer blow which consists in diluting the air-draft used with progressively-increasing amounts of an endothermic gas.

7. The process of controlling the temperature in a Bessemer blow which consists in diluting the air-draft used with progressively-increasing amounts of products of combustion.

Signed at New York city, in the county of New York and State of New York, this 17th day of May, A. D. 1905.

BYRON E. ELDRED.

Witnesses:
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A. M. SENIOR.