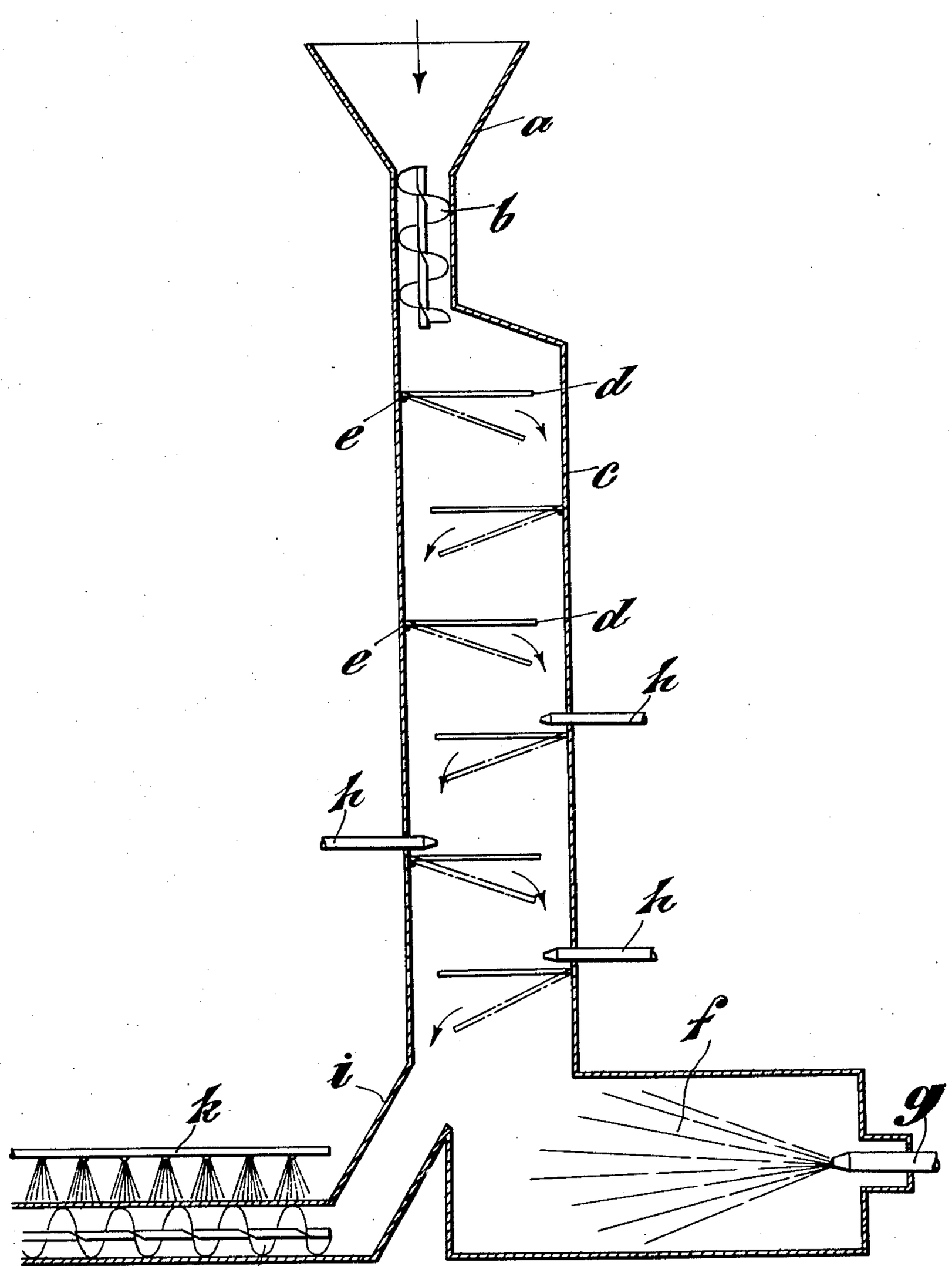
Oct. 7, 1930. H. E. COLEY 1,777,993

REDUCTION OF ORES, OXIDES, AND THE LIKE

Filed Nov. 2, 1923



Inventor
Henry E. Coley

By J. Kaplan
attorney

Patented Oct. 7, 1930 1,777,993

UNITED STATES PATENT OFFICE

HENRY EDWIN COLEY, OF LONDON, ENGLAND

REDUCTION OF ORES, OXIDES, AND THE LIKE

Application filed November 2, 1923, Serial No. 672,451, and in Great Britain November 10, 1922.

This invention relates to the reduction of ores, oxides and the like, and has for its object the reduction of the ores etc., more rapidly and economically than by the processes at present in use.

According to the present invention the reduction of the ores etc., is effected by heating them to a temperature not exceeding that normally used for their reduction and at that temperature injecting on to or into the heated ores etc., a hydrocarbon or suitable body containing hydrocarbon, so that the hydrocarbon is rapidly decomposed, producing carbon in an active or nascent condition effecting the reduction of the ores etc. The active or nascent condition of the carbon thus produced is shown by the rapidity of the reduction in comparison with reductions effected in the normal manner. The carbon so produced may be suitably described as carbon in statu nascendi.

In the application of my invention it is necessary to carry out the re-action in an apparatus of suitable construction, so designed that while the process is being carried out air may be excluded if desired from the apparatus and preferably so designed that the material to be treated may be passed continuously through the apparatus. The apparatus may be made of any suitable material but this material depends upon the nature of the ore or oxide to be treated and upon the temperature at which the re-action must take place. The apparatus may consist of a chamber or cylinder which can be rotated in order to provide agitation to the ores etc. to be treated, or provided with internal agitating means such as rotary baffles, or intermittent movement of the material so that the material is subjected to frequent agitation during its passage through the apparatus.

In order to clearly explain the method of the application of my invention I will describe the method adopted in the reduction of iron ore or oxide to the metal by aid of the accompanying diagrammatic drawing.

The ore, etc., is first crushed to approximately ¼″ mesh and is allowed to pass, by means of a hopper *a* and a suitable mechanical delivery device *b* so designed that it is in itself a seal, into a tower *c* which is constructed of refractory material such as bricks, and which is provided with a series of baffles *d* at equal distances one above the other, so arranged that when at rest they are horizontal but can be tilted about a hinge *e* at suitable intervals of time or inverted so that the material held on the baffle while horizontal is transferred on to the next baffle, which, in its turn and at a suitable interval after the moment of the previous baffle, is similarly operated to deposit its contents on to the next baffle. The mechanism operating these baffles is designed so that the ores, etc., to be treated take a certain length of time to pass from the top of the tower to the bottom, which time in the case of iron ore or oxide is approximately 1½ to 2 hours. In order to raise the temperature of the material passing through the tower to the necessary temperature for the reduction to take place, the bottom portion of the tower is heated by a flame *f*, which may be provided by the partial combustion of a jet *g* of liquid hydrocarbon or of solid carbonaceous material such as coal. By means of this heating flame the tower is raised to a suitable temperature which reduces as the heat passes up the tower, so that each baffle is heated to a temperature rather higher than the one above it. By this means, the ores, etc., to be treated, in their passage down the tower become gradually heated to the temperature at which the reduction will take place, and at or about that point an injection of hydrocarbon or hydrocarbon containing body is made on to or into the material through the tuyères *h*. In the case of magnetite ore the normal temperature of reduction is approximately 1100° C., but I have found it possible to effect reduction at a temperature of about 950° C. The hydrocarbon is decomposed on coming into contact with the heated ores, etc., producing nascent carbon which effects the reduction of the ores, etc. To prevent reoxidation of the material after it has been subjected to the reaction referred to, the reduced material is transferred, preferably by

way of the passage *i* from the reducing tower, at a point below that at which the reduction is complete but above the point at which the heated flame is injected to a cylinder which is cooled and provided with means *j* for effecting internal agitation in such a manner that the material is moved through its length. This cylinder, which may be made in this case of iron, is externally cooled by means of a water spray *k* or by any other suitable device so that the reduced iron when it reaches the end of the cooling cylinder is at approximately atmospheric temperature and may be safely passed into the atmosphere without any fear of reoxidation.

In the appended claims, by the language "an undecomposed hydrocarbon material having the property of decomposing at such temperature with the liberation of free carbon", I mean to include hydrocarbon materials which are of course decomposable at temperatures below the reduction temperature of the ore. So long as the hydrocarbon material used will decompose when brought into contact with ore at the reduction temperature, the requirements of my process are satisfied. Needless to say, a hydrocarbon material having a decomposition temperature of the ore can be, and usually is, used, since at temperatures in excess of its decomposing temperature it will of course be decomposed.

What I claim is:—

1. A process for reducing ores which comprises heating said ores to a reducing temperature and upon reaching said temperature injecting into the body of ore an undecomposed hydrocarbon, thereby producing nascent carbon.

2. A process for reducing ores which comprises heating said ores to a reducing temperature and upon reaching said temperature injecting into the body of ore an undecomposed liquid hydrocarbon, thereby producing nascent carbon.

3. The process of reducing oxidic ores which comprises maintaining a moving body of such ore in a shaft, heating the ore to the reduction temperature thereof and introducing into the ore, while at reduction temperature, an undecomposed hydrocarbon material having the property of decomposing at such reduction temperature with the liberation of free carbon.

4. The process of reducing oxidic ores which comprises maintaining a moving body of such ore in a shaft, heating the ore to substantially its reduction temperature and introducing into the ore, while at such reduction temperature, an undecomposed liquid hydrocarbon material having the property of decomposing at such temperature with the liberation of free carbon.

5. The process of reducing oxidic ores which comprises maintaining a moving body of such ore in a chamber, heating the ore to reduction temperature by means of hot gases passing through the chamber countercurrent to the ore, introducing into portions of such ore, which have reached substantially reduction temperature, an undecomposed hydrocarbon material having the property of decomposing at such temperature with the liberation of free carbon, and then cooling the reduction products thus produced while out of contact with air.

6. The process of reducing oxidic ores which comprises maintaining a moving body of such ore in a chamber, heating the ore to substantially reduction temperature by means of hot gases passing through the chamber countercurrent to the ore, introducing into portions of such ore, which have reached reduction temperature, an undecomposed liquid hydrocarbon material having the property of decomposing at such temperature with the liberation of free carbon, and then cooling the reduction products thus produced while out of contact with air.

7. A method of reducing ores or oxides which consists in passing through an air excluding vessel a current of the material to be reduced and heating it to substantially its reduction temperature by a hydrocarbon burner, the gases of combustion passing through the vessel and when said material is at the reduction temperature passing an undecomposed hydrocarbon in a countercurrent to the current of the material by introducing said hydrocarbon at a point in the vessel normally covered by the mass of material, said reducing hydrocarbon being decomposed and its constituents in part carried upwardly through said material by the upward passage of the gases of combustion from said burner, and cooling the reduced material while excluded from the air.

8. A method of reducing ores or oxides which consists in passing the material to be reduced downwardly through an air-excluding vessel, heating the material to be reduced to its reduction temperature by passing hot combustion gases over and through the material, and when said material is at its reduction temperature, introducing an undecomposed hydrocarbon into the material and passing it upwardly countercurrent to the flow of material, said hydrocarbon being introduced at a point normally covered by the material, whereby the thus introduced hydrocarbon is decomposed, nascent carbon is formed and the ore at that point reduced thereby, the reducing hydrocarbon being decomposed and its constituents in part carried through the material by the combustion gases.

In testimony whereof I affix my signature.

HENRY EDWIN COLEY.