J. T. JONES.

ORE REDUCING FURNACE AND PROCESS.

APPLICATION FILED FEB. 23, 1915. RENEWED NOV. 2, 1918.

1,289,800.

Patented Dec. 31, 1918.

3 SHEETS—SHEET 1.

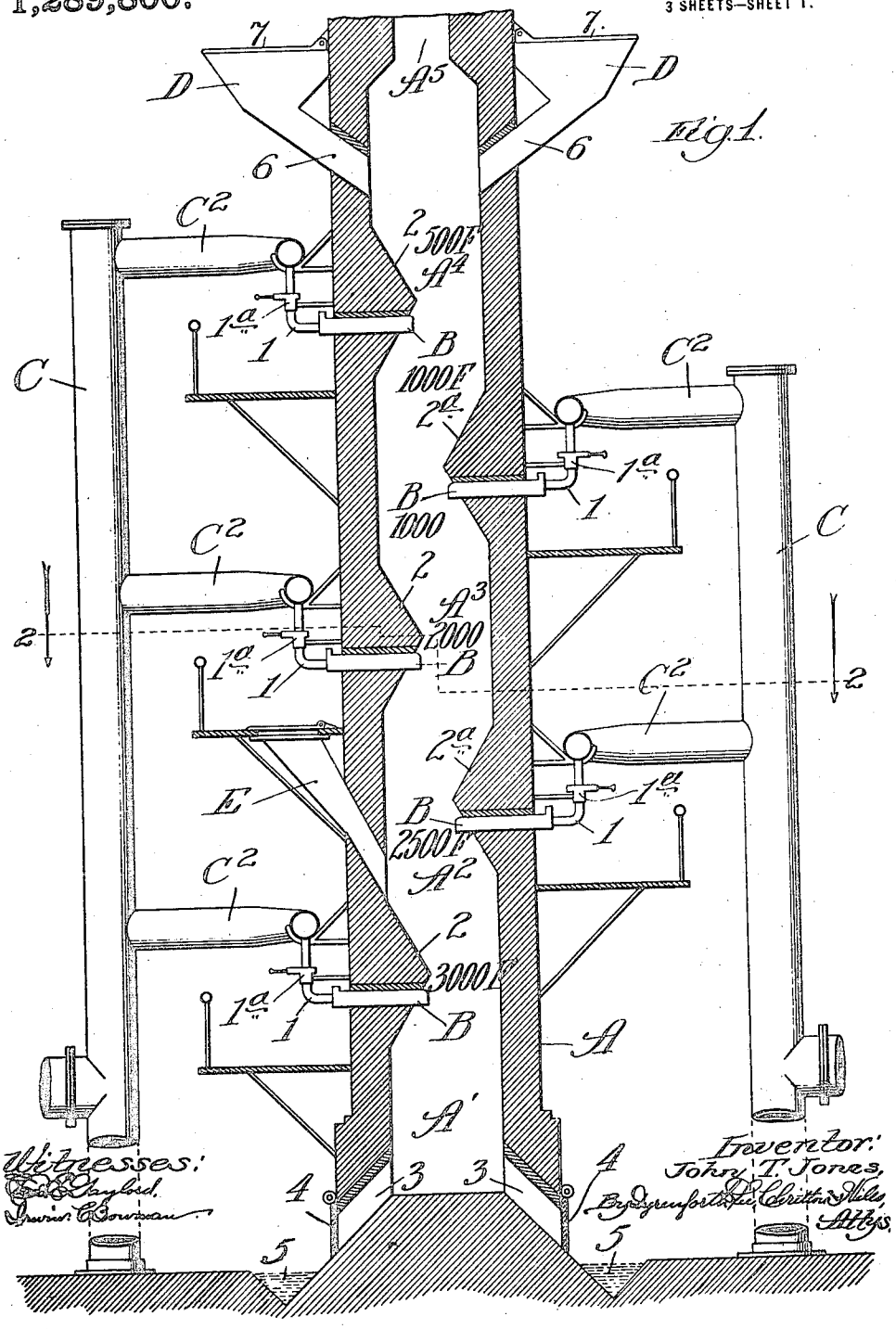


Fig. 1.

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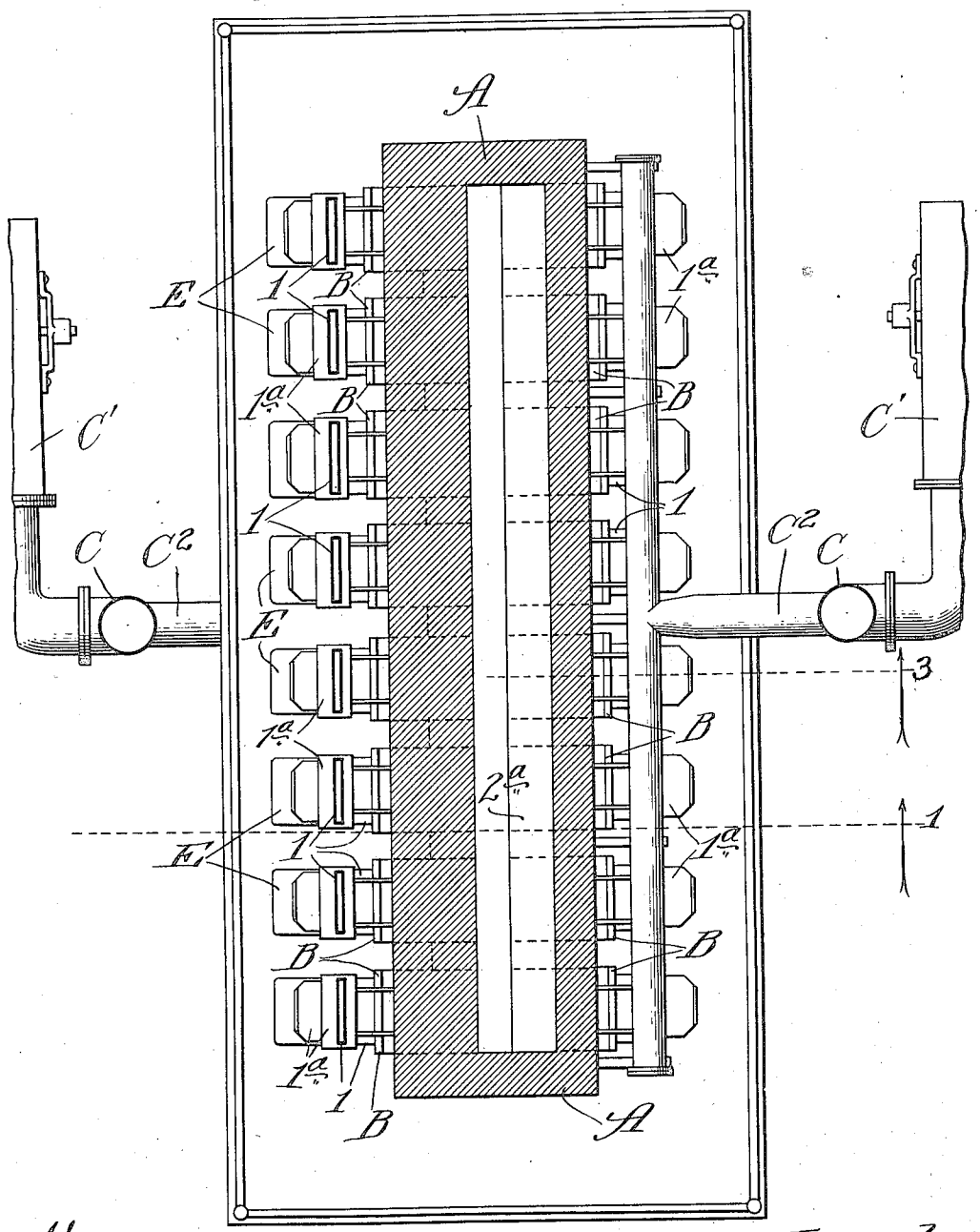
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3 SHEETS—SHEET 2.

Fig. 2.



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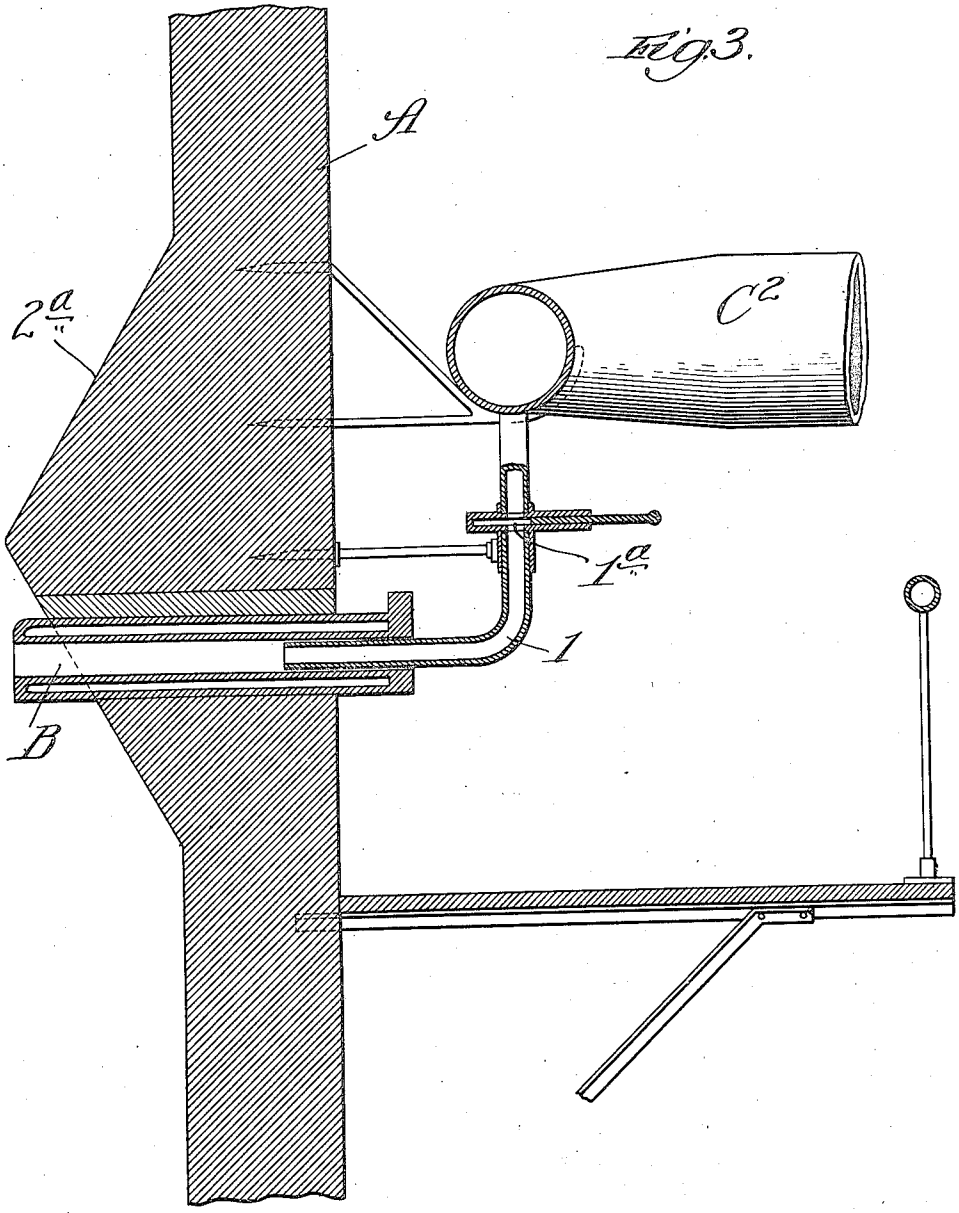
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3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

JOHN T. JONES, OF MARQUETTE, MICHIGAN, ASSIGNOR TO NEW METALS-PROCESS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

ORE-REDUCING FURNACE AND PROCESS.

1,289,800. Specification of Letters Patent. Patented Dec. 31, 1918.

Application filed February 23, 1915, Serial No. 9,908. Renewed November 2, 1918. Serial No. 260,913.

To all whom it may concern:

Be it known that I, JOHN T. JONES, a citizen of the United States, residing at Marquette, in the county of Marquette and State of Michigan, have invented a new and useful Ore-Reducing Furnace and Process, of which the following is a specification.

The present invention relates to furnaces adapted to the practice of a bathless method of recovering metals from metal oxid or carbonate ores, or the like. The improved furnace is adapted to the practice of an improvement upon the process described in the application of John M. Longyear and myself, No. 9,889, filed in the United States Patent Office of even date herewith, the process referred to constituting an improvement upon the process set forth in the application of Albert G. Jones, No. 827,358, filed March 26, 1914.

The present invention is illustrated in its preferred embodiment in the accompanying drawings, in which—

Figure 1 represents a broken vertical sectional view of an ore-reducing furnace constructed in accordance with the invention, the section being taken as indicated at line 1 of Fig. 2; Fig. 2, a plan section taken as indicated at line 2 of Fig. 1; and Fig. 3, an enlarged broken, vertical section taken as indicated at line 3 of Fig. 2.

In the construction illustrated, A represents a furnace-shaft comprising a soaking-pit A′, a superposed de-oxidizing chamber A^2, and a plurality of superposed pre-heating chambers A^3, A^4; B, B, a plurality of series of adjustable twyers extending through the side walls of the furnace and disposed at a plurality of different levels; C, C, stand-pipes which may contain air under small pressure, the air being supplied by a fan or compressor C′; C^2, laterals extending from the stand-pipes and communicating through pipes 1 with the adjustable twyers B, the pipes 1 being provided with regulating-valves 1^a; D, D, means for charging a mixture of distilled solid fuel (coke or charcoal) and ore-portions substantially isolated therein into the upper portion of the furnace; and E, means for charging fresh solid fuel containing hydrogen and hydro-carbons (coal or wood) directly into the de-oxidizing chamber A^2.

The furnace-shaft A may be of any suitable construction and of any desired shape. It is preferred to make the furnace-shaft of rectangular cross-section, the width of the shaft being relatively small and the horizontal length of the shaft being as large as desired, depending upon the capacity desired. The internal short dimension of the shaft may be four to eight feet. One lateral wall of the furnace-shaft is provided with a series of internal projections 2, and the other lateral wall of the furnace is provided with a series of internal lateral projections 2^a, which are staggered with relation to the projections 2; that is, the projections 2 are disposed at a plurality of levels, and the projections 2^a are disposed at a plurality of levels between the levels at which the projections 2 are located. The upper walls of each set of projections slope downwardly and toward the opposite wall of the furnace; and the lower walls of the projections are undercut. The result is to provide an upright zig-zag channel of substantial, but relatively narrow, width, and of comparatively large horizontal length, giving somewhat the effect of a great rectangular chimney with a single upright zig-zag form passage adapted to contain a stack of superposed burden-sections of a comparatively few feet in thickness corresponding with the horizontal transverse dimension of the furnace-shaft, and of a comparatively large horizontal length, corresponding with the long horizontal dimension of the furnace-shaft. The internal projections of the furnace-shaft are of such substantial character as to almost, but not quite, support the burden-sections, the purpose being to prevent undue compacting of the materials in the furnace and the crushing of the distilled fuel, which would interfere with the practice of the bathless metallizing process. The adjustable twyers B are associated with the internal projections of the lateral walls of the furnace, and may extend a greater or less distance into the furnace, being adapted to afford supplemental supports for the burden-sections, as well as to introduce air into the burden-sections at a plu-

rality of levels. The twyers are so adjusted as to permit a slow downward gravitation of the burden-sections; and the internal projections of the furnace walls are so limited and sloped as to permit this action to occur, while preventing the direct transmission of crushing force from the top to the bottom of the stack of materials undergoing treatment.

At the lower end of the soaking-pit A′ is provided discharge means, shown as comprising inclined passage-chutes 3 guarded by doors 4, through which the unconsumed solid fuel, gangue, and metals in solid form, may be discharged into water-baths 5. The discharge means illustrated is to be regarded as a conventional form of any suitable discharge means.

The means D shown for introducing distilled solid fuel (coke or charcoal) and ore into the upper portion of the furnace comprises hoppers having chutes 6 extending through the lateral walls of the furnace, the hoppers being equipped with closures 7. The devices D are to be regarded as conventional examples of any suitable means for introducing solid fuel and ore into the upper portion of the furnace.

The means E comprises a hopper or hoppers, and it is to be understood that such form is selected merely for the purpose of illustration.

Assuming the furnace to be in operation, the stack of materials fills the furnace from the bottom to the chutes 6, thus forming a zig-zag stack of materials divided into burden-sections having independent supports afforded by the rudimentary staggered bottoms 2, 2^a, which, while sufficient to prevent the transmission of crushing stress from the top to the bottom of the furnace, will nevertheless permit the slow settling of the stack of materials as materials are withdrawn from the bottom of the furnace. The stack of materials is replenished by the proper charges of distilled solid fuel and ore-portions substantially isolated therein, introduced through the charging-devices D at the top of the furnace; and the supply of distilled solid fuel is replenished by fresh solid fuel introduced through the charging-device E directly into the de-oxidizing chamber A^2, it being understood that the fresh solid fuel supplies within the de-oxidizing chamber hydrogen gas and carbo-hydrates which are highly efficacious in the metallizing operation, while the distilled solid fuel which is thus produced serves as a constant source for replenishment of distilled solid fuel.

Air is supplied through the lowermost twyers to the chamber A^2 in limited quantity, but sufficient to produce in the chamber A^2 a high-temperature de-oxidizing medium and a metal-fixing zone. The temperature in the lower portion of the chamber A^2 should exceed 2000° F. for iron, and usually a temperature of 3000° F. is ample for reducing iron-ores, ferro-manganese ores, and the like. Much depends upon the character of the ore, however. In dealing with lean ores containing some natural flux, too high a temperature is desirably avoided. The air supplied at the other levels of the furnace is so regulated as to afford a progressive reduction in the temperature as the top of the furnace is approached, somewhat as indicated by the temperature-scale shown on Fig. 1. It will be understood that a zone of intense heat is produced in the vicinity of the inner ends of the lower twyers and that the carbon dioxid produced in that zone changes to carbon monoxid as the gases ascend in the chamber A^2. Owing to the high temperature maintained in the chamber A^2, a rapid interchange of oxygen occurs, and the metal ores are rapidly robbed of their oxygen, and as the metallizing operation proceeds, the metals are fused, or partially fused, and agglomerated or run together, thus producing metal bodies of tangible size, ranging from small meshes to large chunks. Inasmuch as the ore-clusters are substantially isolated in the solid fuel, the production of a bath is avoided, and the metal freezes as it descends to the chamber A′. Isolated pools of metal may be produced, and likewise isolated pools of gangue, especially where the ore contains a natural flux, may be produced, which will congeal as the ore descends. No lime or other flux need be introduced with the charge, however, as general fusing of the charge is to be avoided.

It will be understood that somewhat intense zones of heat will be produced at the inner ends of the several series of twyers, the heat in these zones becoming of less and less intensity as the upper end of the furnace is approached. Thus, it will be understood that the solid fuel is attacked less and less as the upper end of the furnace is approached, and finally the combustible gases produced below are burned with the air introduced through the upper twyers, in contact with the entering fuel and ore, and thus serving to preheat these materials, without attacking the solid fuel, the products of complete combustion finally escaping through the chimney A^5.

The proportions of the fuel and ore will vary, of course, but a preponderance of solid fuel, serving to space and isolate the ore-portions, will be carried wholly through the furnace; and the operation of the furnace will be so balanced that the solid fuel at the upper portion of the furnace will be preserved, while the gases produced below will be burned to a state of complete combustion, under ideal conditions. As an illustration,

in dealing with a high-grade iron ore, the materials may be used in the proportion of 400 pounds of coke, 100 pounds of bituminous coal, and 250 pounds of ore, the fuel having approximately twice the weight of the ore and being approximately five times as large in volume as the ore. If wood and charcoal be used in place of coke and coal, the disparity in volume is much greater. For illustration, with 2240 pounds of ore one may use 96 cubic feet of charcoal and 32 cubic feet of wood. The proportions may be varied to gain the best and most economical results. In any case, it is preferred to use the fuel mainly in large block or lump form, although this is not indispensable. The coke (or charcoal) is used over and over again, being gradually reduced in size but being constantly replenished by freshly formed coke (or charcoal) when the process is carried on in the preferred manner.

The separation of the metals, gangue and distilled solid fuel, after removal from the bottom of the furnace, may be effected in any desired manner.

In practice, the method of feeding materials to the furnace may be varied, according to conditions. If green or wet wood be used for fuel, it may be fed in at a higher level, so that the water will be driven off before the wood reaches a lower and hotter zone. In such case, the wood will be thoroughly dried and somewhat charred during the pre-heating, the volatile hydro-carbons being mainly liberated at a lower level where they can be utilized most effectively. In some cases, it may be desirable to feed all or a large portion of the fuel in at a lower level than that at which the ore is fed. Much will depend upon the character of the ore and the solid fuel used. In any event, it will be necessary to maintain sufficient interstitial passages for the air and gases through the burden; and it will be necessary to maintain a large preponderance of solid fuel in the lower, hotter zone.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitation should be understood therefrom, but the appended claims should be construed as broadly as permissible in view of the prior art.

What I regard as new and desire to secure by Letters Patent is—

1. An ore-reducing furnace having walls forming a tortuous upright passage adapted to contain a stack of solid fuel and ore-portions isolated therein and afford supports at intervals for the burden-sections, and twyers disposed at a plurality of levels and adapted to supply air in such limited quantities to the burden-sections as to produce a deoxidizing atmosphere.

2. An ore-reducing furnace comprising walls having internal projections at a plurality of planes, arranged in staggered relation, said furnace adapted to contain a stack of solid fuel and ore-portions mixed therein and give independent support to the burden-sections comprising said stack, and a plurality of series of twyers disposed at a plurality of levels and adapted to supply air in such limited quantities to said burden-sections as to produce a deoxidizing atmosphere.

3. An ore-reducing furnace comprising a soaking-pit equipped at its lower portion with means for removing unconsumed solid fuel, gangue and metal in solid form, a superposed de-oxidizing chamber, means for charging fresh solid fuel into the de-oxidizing chamber, superposed pre-heating chambers having walls provided with staggered internal projections, twyers disposed at a plurality of levels and serving to furnish limited air-supplies to the pre-heating chambers, and means for charging distilled solid fuel and ore-portions mixed therein into the upper portion of the furnace.

4. An ore-reducing furnace comprising a soaking-pit provided with discharge means, a superposed de-oxidizing chamber with a contracted passage between said chambers, means for supplying air to the de-oxidizing chamber, a series of pre-heating chambers above the de-oxidizing chamber, the walls thereof having internal projections arranged in staggered relation, a plurality of series of twyers arranged at a plurality of levels for supplying air to the pre-heating chambers, and means for charging solid fuel and ore into the upper portion of the furnace.

5. In an ore-reducing furnace, the combination of a shaft provided with a series of internal staggered burden-section supports, adjustable twyers disposed at a plurality of levels and associated with said internal supports, means for supplying air in limited quantities to said twyers, and means for charging solid fuel and ore mixed therein into the upper end of the furnace.

6. In an ore-reducing furnace, the combination of a shaft provided with side walls spaced a few feet apart and provided with end walls, internal projections carried by the side walls and arranged in staggered relation, a series of horizontally arranged adjustable twyers associated with the internal projections at different levels, means for supplying air in regulable quantities to said twyers, and means for charging solid fuel and ore into the upper portion of the furnace.

7. The bathless process of metallizing ores, which consists in supporting burden-sections composed of solid fuel and ore-portions substantially isolated therein, in superposed relation in such manner as to

afford substantially independent support to the burden-sections and effect turning and mixing of the materials as the stack settles slowly, introducing and burning in the lower portion of the stack air in such quantity as to produce a high temperature metal-fixing zone and a high temperature de-oxidizing medium above said zone, and introducing and burning air in limited quantities at a plurality of higher levels in such manner as to attack the solid fuel less and less as the upper portion of the stack is approached, finally burning the combustible gases to a state of practically complete combustion without attacking the solid fuel at the upper portion of the stack.

JOHN T. JONES.

In the presence of—
ALBERT G. JONES,
E. W. JONES.