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ORE-BRIQUET.

SPECIFICATION forming part of Letters Patent No. 791,799, dated June 6, 1905.

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To all whom it may concern:

Be it known that I, WILLIAM A. KÖNEMAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Ore-Briquets, of which the following is a specification.

It is a well-known fact that the smelting of fine ores in blast-furnaces has always been a matter of much difficulty, the difficulty increasing in the ratio of the depth of the smelting charge or burden. In iron-ore smelting the charge has a depth which often exceeds eighty-five feet, and under such conditions the presence of an undue amount of "fines" tends not only to create irregularities in the operation of the furnace, but renders danger of explosion imminent. In the smelting of magnetic-oxid concentrates and other fines it has been found as a rule that no more than twenty per cent. thereof in briqueted form (usually agglomerated with lime) can be safely carried with a charge of coarse hematite ore, and when such a mixture is made it causes serious reduction in the smelting capacity of the furnace, as well as a notable reduction in the entire carbon contents of the pig product. This difficulty is due to the fact that the briquets as provided decrepitate while in the upper section of the furnace and the granular fines work downward into the smelting zone before their oxygen constituent has been sufficiently eliminated.

Attempts have been made to overcome the above difficulties by mixing the fines with coking coal, then bricking the mass, and subjecting the bricks to a coking action in coke-ovens. The resultant briquets consist of coke and ore particles held in place by the entangling action of the coke. Although this procedure has been more or less successful in overcoming difficulties attendant upon the use of fine ores in a blast-furnace, it is expensive, and therefore objectionable from an economic standpoint. The ore and coal briquets or lumps in such case must undergo a separate and independent coking action, which, as stated, is not only expensive, but iron fines under such conditions also take up a material percentage of sulfur from the pyrites in the coking coal. Furthermore, there is a loss of weight in the coal constituent of the briquets amounting to from thirty to forty per cent., according to the percentage of its volatile constituents. In the case of magnetic-iron concentrates the same are produced by a series of operations to which ordinary hematite ores are not subjected, and it is therefore essential that such concentrates shall not be burdened with further operations, which would add still greater expense and make their utilization uncommercial.

I have found that certain very cheap and almost waste carbons may be successfully utilized for the purpose of smelting finely-divided ores.

The principles upon which my invention is based are, first, that a non-coking carbon—such as coke dust or fines, anthracite dust or fines, Rhode Island graphitic anthracite, &c.—may during combustion be readily and substantially perfectly consumed when such non-coking carbons are in a finely-divided state and mixed with not less than approximately fifteen per cent. of finely-divided coking coal; second, that such a mixture when suitably agglomerated will form a solid coke during combustion without preliminary coking.

In carrying out my invention I provide a mass consisting in proper proportions of ore-fines and finely-divided non-coking and coking coals all intimately mixed together with an agglutinant and molded into briquets. During the initial subjection of such briquets to heat in a furnace the agglutinant holds the constituent particles together until the particles of coking coal during initial combustion entangle and hold the particles of non-coking coal and ore, so that no disintegration or rupture of the briquets takes place, and the fuel is fully consumed under conditions which assure when fine ores are mixed with such briquets the perfect and simultaneous reduction of the values to the metallic state.

In connection with my present invention I believe that all the particles of coal and ore should be capable of passing through a sixteenth-mesh screen to produce what I would consider satisfactory results. The percentage of coking coal may vary as desired; but

as a rule it should not exceed forty per cent. of the coal's constituent, especially if it carries any material quantity of pyrites.

My invention is more especially adapted for the reducing and smelting of iron-fines or iron found in a granular or pulverulent condition to put it in a condition for economical use in blast-furnaces; but as the invention may be found desirable in connection with other ores I do not wish to be limited to iron ores.

In providing iron-ore briquets in accordance with this invention the degree of purity of the iron and the average mesh or size of particles will, to a large extent at least, govern the proportions and character of the carbonaceous material and binding agent which I employ. For example, in some cases I would mix a volume of about twenty-five per cent. of iron-fines (finely-divided iron ore) with about fifty per cent. of non-coking (anthracite) coal and about twenty-five per cent. of coking (bituminous) coal. I do not wish to be understood as in any way limiting my invention to exact proportions, because, as before stated, they would necessarily vary materially to produce the best results when employing different characters of ore or carbon. To the mixture of iron and coals I add an ingredient or binding agent, which may be one material alone or a plurality of materials mixed together in suitable proportion. In some cases the binding agent may be in whole or in part lime or a lime mixture or other material to aid in fluxing refractory ingredients of the ore. Other binding substances, such as gelatinous matter or clay, may be employed with or without a fluxing material in the briquet. In certain cases, especially where immediate handling of the briquet is desired, it may be treated with a slight addition of ammonium borate.

In its broad sense my invention may be stated to consist in mixing together in suitable proportions and forming into briquets finely-divided ore, finely-divided non-coking carbon, sufficient finely-divided coking coal to accomplish the agglomeration of all the constituents when subjected to initial combustion, and a suitable binding agent, whereby the briquets will not disintegrate in the furnace and whereby the coal constituent will contribute by its combustion to the reduction and fusion of the ore constituent. The binding agent may itself be a flux, or fluxing material may be incorporated with the binding agent. My invention also consists in the article of manufacture, as set forth in the claims.

When bituminous coal is made into a briquet or when bituminous coal is present in the mixture of coals in a preponderating quantity and such briquet is then subjected to combustion, it will swell, lose its briquet form, and the resulting coke will be of a very open and weak structure, unable to bear the pressure of the furnace burden—in fact, producing a coke during combustion which is much weaker than gas-house coke, and therefore unfit for blast-furnace practice. It is on this account that bituminous-coal dust when mixed with ore-fines has hitherto been subjected to a preliminary coking action by slow distillation in coking apparatus. I have discovered that when a non-coking carbon, such as pulverized anthracite, is mixed with a coking carbon, such as pulverized bituminous coal, and such non-coking carbon is present in quantity of one-half or more a briquet made of such a mixture and ore-fines in suitable quantity will form a hard and solidly-coked cake during direct combustion as soon as it becomes incandescent and that such a briquet will not swell and lose its form during initial combustion. It is fully as strong and able to support the necessary blast-furnace burden as any coke which has been produced by preliminary coking from bituminous coal entirely. Thus the expense is merely that of the anthracite and bituminous culms plus the binding agent and cost of briqueting. On the other hand, where bituminous culm alone is employed, or where it preponderates materially over the non-coking or anthracite coal in the mixture, a preliminary coking is necessary, whereby the expense is that of the soft-coal culm (which is far greater than anthracite culm) plus that of the anthracite, if any is employed, plus the binding agent, cost of briqueting, the placing of the briquets into coking-ovens, the coking, and discharging from the ovens, which total expense amounts in practice to fully fifty per cent. more than the cost of my product. The principal economic features of my invention are, therefore, the utilization of large quantities of anthracite culm, which has heretofore been considered practically worthless and is obtainable in vast quantities, and the production by means of such anthracite culm or coke-dust of a fuel which produces a solid coke during direct combustion and does not require preliminary coking to fit it for the blast-furnace.

As before stated, the mixture to be employed in forming an ore-briquet according to my invention would depend to a large extent upon the character of the ingredients. One way of determining upon the character of the mixture is to mix the ore-fines and coking and non-coking culms together in various arbitrary proportions, adding a binding agent, forming the mixtures into briquets, and drying the same. The briquets may then be burned in an ordinary open stove and left undisturbed until completely incandescent. If any of the briquets show material swelling or blossoming, they are rejected and only that mixture adopted which produces a briquet which maintains its shape without swelling when incandescent, showing a coking action of desired hardness.

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

1. The method of making ore-briquets for blast-furnace smelting, which consists in mixing together in suitable proportions ore-fines and finely-divided uncoked bituminous coals and anthracite coals, adding to the mixture a binding agent, forming the mass into briquets and drying the same without coking, whereby to provide briquets of mixed ore and fuel for subsequent coking by the direct heat of the blast-furnace.

2. The method of making ore-briquets for blast-furnace smelting, which consists in mixing together in suitable proportions ore-fines and finely-divided uncoked bituminous coals and anthracite coals, adding to the mixture a fluxing binding agent, forming the mass into briquets and drying the same without coking, whereby to provide briquets of mixed ore and fuel for subsequent coking by the direct heat of the blast-furnace.

3. As a new article of manufacture, uncoked ore-briquets for blast-furnace treatment, composed of properly-proportioned ore-fines, finely-divided uncoked bituminous coal and finely-divided anthracite coal intimately mixed together, and a binding agent mechanically uniting the mixed particles of ore and coking and non-coking carbons and holding the ore-fines and non-coking particles until said fines and particles are held by the particles coked in the initial combustion in the blast-furnace.

4. As a new article of manufacture, uncoked ore-briquets for blast-furnace treatment, composed of properly-proportioned ore-fines, finely-divided uncoked bituminous coal and finely-divided anthracite coal intimately mixed together, and a fluxing binding agent mechanically uniting the mixed particles of ore and coking and non-coking carbons and holding the ore-fines and non-coking particles until said fines and particles are held by the particles coked in the initial combustion in the blast-furnace.

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In presence of—
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