

# United States Patent Office.

JAMES PALMER BUDD, OF YSTALYFERA, NEAR SWANSEA, WALES.

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## IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL.

The Schedule referred to in these Letters Patent and making part of the same.

### To all whom it may concern:

Be it known that I, JAMES PALMER BUDD, of Ystalyfera, near Swansea, in the county of Glamorgan, Wales, a subject of the Queen of Great Britain, have invented or discovered new and useful Improvements in the Manufacture of Iron and Steel; and I, the said JAMES PALMER BUDD, do hereby declare the nature of the said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof, that is to say:

This invention has for its object the production of plate-iron, or refined metal, as it is sometimes called, suitable for puddling or steel-making, without the necessity of remelting the pig-iron and blowing air into it.

The invention consists in refining the metal in the plate-mold by running the molten pig-metal into shallow pans, which have previously been coated with a paste of soft hematite iron ore, or other oxide of iron, with or without nitrate of soda. The pans should be similar to the mold used for receiving the iron from the ordinary refiner's fire, and capable of holding from three to five inches in depth of the molten metal.

When the fluid metal is poured into the pans, a violent ebullition takes place, and a large proportion of the silica, together with some of the carbon, phosphorus, and sulphur, contained in the iron is carried off in the slag, so that, when the slabs of purified metal are subsequently worked in the puddling-furnace, the puddling operations are effected much more rapidly than with ordinary pig-iron, as, when puddling ordinary pig-iron in a puddling-furnace, but a very small proportion of carbon is separated from the iron before the greater proportion of the silica is eliminated.

Cast-iron, if of a suitable quality for steel-making, may advantageously be acted on by a paste containing nitrate of soda, or hematite ore, or both combined, in shallow pans, as above described, previous to being decarbonized to convert it into steel.

When my object is to produce bars of wrought iron, which are to be rolled into black plate or thin sheet-iron, to be afterwards converted into tin-plate, I line the shallow pans, into which the cast-iron is run previous to puddling, with a composition composed of hematite iron ore and nitrate of soda.

I mix together a quantity of hematite iron ore containing, if possible, no phosphorus or sulphur, and only a moderate quantity of silica, and mix therewith half by bulk, or two-fifths by weight, of nitrate of soda, or thirty pounds of hematite ore to twenty pounds of nitrate of soda. Having well mixed these together mechanically, I pass the mixture through a pair of clay rolls, by which the grit is reduced, and it becomes

more plastic. I then form a paste of the mixture, which requires about three-tenths of its weight of water to be added. It is then sufficiently liquid to be filled into a bucket. I place as near as convenient to the tapping-hole of the blast-furnace, from which the fluid cast-iron is to be obtained, a series of shallow molds of cast-iron.

Those I use, which I find convenient, are to the following dimensions: length, seven feet nine inches at top, tapering to seven feet four and one-half inches at bottom; width, two feet two inches at top, tapering to foot nine and one-half inches at bottom; depth, four inches.

The use of the beveling, or tapering, in the mold is that the plate of cast-iron shall be more easily removed from it.

These molds hold about thirteen hundred weight of cast-iron when filled about three and one-half inches deep. I run into those molds molten cast-iron every four hours, or oftener, taking care to fill them often enough that they shall retain their heat or drying power between the casts.

As the casts from the furnace must thus be frequent, I pot the iron from the furnace; that is I take out what iron I require from an opening in the furnace at the upper part of the tapping-hole, without emptying the whole of the iron in the hearth.

While the molds are hot from the previous cast I pour into each of them a bucket-full, or about sixty-four pounds, of the refining mixture before described, and spread it evenly over the bottom and sides. The water evaporates, and the mixture lies at the bottom as an adhering paste. I then proceed to run the molten iron from the furnace, or from the remelting cupola, or from the refinery or other furnace, as the case may be, until I have filled the molds about three and one-half inches. A great ebullition takes place; fumes in large quantity are evolved; jets of flame burn from the surface of the metal for a considerable time; a quantity of scoriæ is thrown up violently to the surface and separates from the plate of iron that fills the mold, and when cold can be stripped therefrom.

The weight of the scoriæ so thrown up is from thirty to forty pounds from each plate of metal weighing about thirteen hundred weight.

The iron contained in the hematite ore used in the paste is converted into cast-iron, and adheres to the bottom of the plate.

The refined iron, when broken, presents a honey-comb, or cellular, appearance throughout, and resembles over-blown refined metal, and a large proportion of the silica will have been removed from it.

The iron thus refined is ready for the puddling process as advanced refined metal. I find it advantageous to use some pig-iron with iron, refined as above de-

scribed, in puddling. About one-third of pig-iron I find to answer best, but a greater or lesser proportion may be used.

Cast-iron thus refined, even if it be what is commercially known as cinder-pig, which is produced when iron scoriæ are largely used as material in the blast-furnace, will make excellent puddled bars, and work to a good yield.

The process of puddling is shortened, and the sides and the bottom of the furnace are less acted on than with unrefined iron.

The quantities in proportion to the refining-paste, which I have given, are suitable for the quality of cast-iron known as white iron. When gray, or carburated iron is used, the quantity of nitrate of soda to be used with the hematite ore should be increased. I prefer to use thirty pounds of nitrate of soda, instead of twenty pounds, as in the composition first mentioned, with thirty pounds of hematite ore.

When the malleable iron sought to be made in the puddling-furnace is not to be of the quality suitable for tin-bars, and similar purposes, but is required to be a softer working quality, suitable for rails and merchant bars, I do not use nitrate of soda in the refining-paste, but make it of hematite ore alone. When used alone a great ebullition takes place when the molten iron runs over it. The oxide of iron in the hematite is reduced, jets of white flame burn on the surface for a considerable time, and a large proportion of the silica is separated from the iron. The refined iron in this state is much preferred by the puddlers, as it lessens and helps their work.

In place of hematite ore other oxide of iron, which can similarly be formed into a paste, may be employed as, for example, the refuse of iron pyrites, from which the sulphur has been abstracted for the manufacture

of sulphuric acid, and from which the copper and other metals contained in it have been extracted. Oxide of manganese, iron scale, or other substances capable of yielding oxygen when exposed to heat, may be incorporated with the paste.

Having thus described the nature of my invention and the manner of performing the same, I declare that I am aware that powdered oxide of iron and iron ore have heretofore been employed to improve the quality and decarbonize pig-iron in several modes, as, for example, by mixing it with the molten metal in the puddling-furnace, by charging it into the puddling-furnace, running the molten pig-iron over it, and mixing the two together, and by sprinkling it upon molten pig-iron and running molten metal over it. I am also aware that nitrite of soda has been used in like manner. I, therefore, do not claim, broadly, the employment of iron ore and nitrate of soda in the manufacture of iron, but

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

The process of manufacturing plate-iron by running the molten pig metal into pans which have previously been coated with a paste of iron ore, and permitting the metal to harden into a plate, as before described.

Also, the process of manufacturing plate-iron by running the molten pig metal into pans, which have previously been coated with a paste of iron ore and nitrate of soda, and permitting the metal to harden into a plate, as described.

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Witnesses:

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