J. ASTON.

METHOD OF MAKING WROUGHT IRON.

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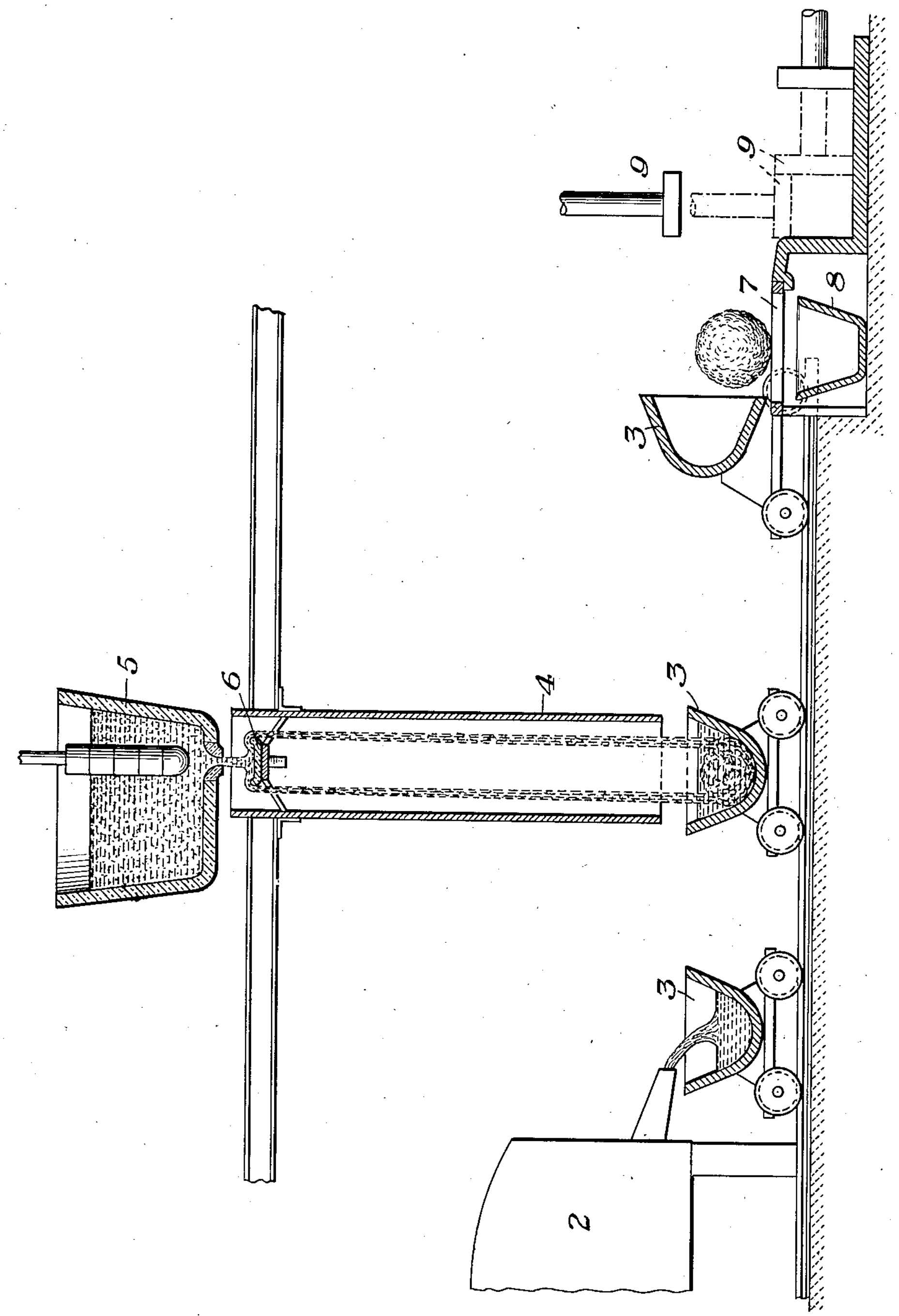
1,370,622. **Patented Mar. 8, 1921.**



WITNESS

R A Balderson

INVENTOR

James Aston

by Bakewell, Byrnes Parmelee

his Attys.

UNITED STATES PATENT OFFICE.

JAMES ASTON, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO A. M. BYERS COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

METHOD OF MAKING WROUGHT-IRON.

1,370,622. Specification of Letters Patent. Patented Mar. 8, 1921.

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To all whom it may concern:

Be it known that I, JAMES ASTON, a resident of Pittsburgh, Allegheny county, Pennsylvania, have invented a new and useful Improvement in Methods of Making Wrought-Iron, of which the following is a full, clear, and exact description, reference being had to the accompanying drawing, forming part of this specification, in which the figure is a diagrammatic view showing one form of apparatus for carrying out my invention.

My invention relates to a method of making wrought iron from a molten refined product such as that produced by the Bessemer or open hearth process of making steel from pig iron.

In my Reissue Letters Patent No. 14,457, granted April 2, 1918, I describe a process for this purpose. My present invention is designed to improve this process and make it cheaper, as well as more rapid and economical; and it consists essentially in granulating or comminuting the molten refined product of a steel making process, mixing the hot granulated product with a proper slag, preferably immediately after granulating, and then compressing the hot mass. It also consists in feeding the heated metal granules, formed from the product of a steel making process into a bath of proper slag, in such a manner that they will contact with each other below the surface of the slag bath while at a welding temperature, so that a coherent mass or sponge of mixed metal or slag is formed under the surface of the slag, which may be handled in the manner of a puddle ball and is made without any mechanical working or agitation, such as hand manipulation or the use of a mechanical puddling apparatus.

In carrying out my improved process the refined molten substantially slagless metal from the steel making furnace may be disintegrated, granulated or comminuted in any desirable manner; preferably by pouring it upon a splash-plate and allowing the hot granulated product to drop into a receiver containing the proper slag.

This slag may be made separately from the refining or steel making operation; or in the case of refining in an open hearth, it may be formed during the refining of the metal in the open hearth, as hereinafter described. The proper slag is substantially an iron silicate, such as that formed in ordinary hand puddling operations. It may be obtained directly from existing metallurgical operations with or without modifications or additions, or it may be prepared from its several constituents or ingredients. It should have the proper fusibility, viscosity and other physical characteristics to adapt it for making wrought iron. The melting point of the slag may vary considerably in accordance with its composition, but will generally be about 2200 degrees F., and should be below 2600 to 2700 degrees F.

The molten refined metal, which will have a melting point of approximately 2750 degrees F., may be comminuted by the natural action accompanying a falling stream or by the aid of splashing baffles or centrifugal action. The hot granulated metal, preferably just below its melting point of 2750 degrees F., may drop into a receptacle containing molten slag so that the granules or particles of metal become coated with a layer of slag and settle to the bottom of the receptacle. These granules are preferably at a welding heat (2400 to 2600 degrees F.) so that they form a fairly coherent mass or ball at the bottom of the receptacle and within the slag. This coherent mass is practically a sponge of solidified or plastic iron mixed with liquid slag.

The coherent mass, which resembles a puddle ball, is then removed and compressed to eject the surplus slag and form it into a fairly compact welded bloom of a size and shape suitable for rolling into bars or billets in accordance with existing practice.

In the drawing 2 represents a slag-forming furnace in which the iron silicate slag of the proper chemical and physical characteristics is prepared. The slag from this furnace is tapped into a removable receptacle 3 shown as mounted on wheels. A series of these receptacles is preferably provided so that while one receptacle is being charged with slag from the slag furnace, another one is receiving the hot granulated refined metal, as shown at the next station in the drawing. At this station 4 represents a shield surrounding the dropping metal, 5 a ladle for the refined metal which may be of the usual bottom pour type, and 6 a splash plate of refractory material on which the metal drops from the ladle. As the streams of molten metal fall from this splash plate,

the metal will become comminuted in its descent within the shield and will drop into the receptacle and pass through the slag and lie underneath it. The slag should entirely cover the mass; for if the mass projected above the slag, part of it would be crystalline or of poor quality.

At the right hand of the figure one of the receptacles 3 is shown at another station where the mass resembling a puddle ball is dumped upon a screen or grating 7, the slag residue dropping through this grating into a receptacle 8. From this grating the mass is dumped into a squeezing apparatus 9 which is shown as of the "press" form, although it may be of the rotary squeezer type or any other desired type. In fact any means for compressing may be used.

The apparatus is preferably so arranged and the steps so carried out that the granulated or comminuted refined metal will enter the slag while the metal is still at or above a welding heat, with the slag at substantially the same temperature.

The metal may, however, enter the slag at a temperature somewhat above the melting point of the metal, in which case the molten slag is preferably at a temperature sufficiently below the finally desired temperature of the mass, so that in the adjustment of the equilibrium of temperature between the slag and metal, the granulated iron will solidify; but be at the welding heat needed for forming the coherent ball or mass.

Again the metal may enter the slag at a temperature below the welding temperature of the metal. In such case, if the slag is at the proper higher temperature, it will in the adjustment of the equilibrium of temperature between the slag and metal, raise the comminuted metal to the welding temperature, so that the mass will properly form. But even if the temperature conditions between the slag and metal are such that the welding temperature is not reached, external heat may, in such cases, be supplied to bring the metal granules to welding temperature, and the advantages of my invention will be present, though to a lesser degree, since some of the heat of the original melt will be saved and utilized.

Instead of dropping the hot granulated metal into a bath of slag I may feed the granulated metal (either in molten or in hot solidified drops or granules) and also the molten slag, into a receiver or mold; although I prefer to drop the metal into the slag bath immediately after granulating or comminuting.

Instead of refining the pig iron in one set of furnaces and preparing the slag in another furnace, or set of furnaces, I can modify standard open hearth practice by using iron ore or roll scale to replace or partly replace lime additions for fluxing the silica and phosphate, and form a slag covering the molten refined metal in the furnace. In such case the refined metal and the slag would be drawn from the furnace separately and then mixed together as above described.

The advantages of my invention will be apparent to those skilled in the art since by granulating or comminuting the molten refined metal, mixing it with the proper slag and compressing, at one heat, the operating is made simple, rapid and economical. In the preferred form no reheating of the comminuted metal is necessary prior to mixing it with the slag, and the hot granules will weld together without necessity for manual or other operations such as are at present used in puddling.

But even if the metal granules are cooled down below the welding temperature, and therefore, require additional heat when mixed with the slag, the advantages of my invention are secured to the degree that the heat remaining in the granules from the original melt is saved and utilized.

The apparatus employed may be widely varied and other changes may be made without departing from my invention.

I claim:

1. The method of producing wrought iron, consisting in granulating or comminuting the molten substantially slagless product of a steel making process, mixing this granulated product with a proper slag while the granulated product retains some of its original heat, and forming the mixture into a coherent mass.

2. The method of producing wrought iron consisting in comminuting the substantially slagless product of a steel-making process while the same is in molten condition, mixing the hot granulated product while it retains some of its original heat with a proper slag, and squeezing the mixture at the same heat.

3. The method of producing wrought iron consisting in granulating or comminuting the substantially slagless product of a steel making process while the same is in molten condition, feeding the hot comminuted or granulated product as it drops into contact with the proper slag to form a mixed mass and then compressing the mass.

4. The method of making wrought iron consisting in comminuting or granulating the substantially slagless product of a steel making process while the same is in molten condition, allowing the hot granulated product to drop into contact with the proper slag forming a coherent mass while at or above a welding temperature, and removing and compressing the mass.

5. The method of producing wrought iron consisting in comminuting or granulating the product of a steel making process

while the same is in molten condition, allowing the hot granules as they are formed to drop into a slag bath, forming a mass therein while the metal is at substantially welding temperature, and removing and squeezing the mass.

6. In the method of producing wrought iron, the steps consisting in forming an iron silicate slag of proper physical and chemical characteristics, comminuting or granulating the molten product of a steel making process, and mixing the hot granulated refined product with the slag.

7. The method of producing wrought iron consisting in granulating or comminuting the product of a steel-making process while the same is in molten condition, mixing this granulated product with an iron silicate slag of proper characteristics for making wrought iron while the granulated product retains some of its original heat, causing the granules to adhere or weld into a mass mixed with the slag, and squeezing the mass.

8. In the method of producing wrought iron, the steps consisting of gradually feeding heated metal granules formed from the product of a steel-making process into a bath of proper molten slag in such a way that they will contact with each other beneath the surface of the slag bath while at a welding temperature; whereby a coherent mass or sponge of mixed metal and slag is formed without mechanical agitation or working.

9. In the method of producing wrought iron, the steps consisting of gradually feeding into a bath of proper molten slag heated metal granules formed from the product of a steel making process, the metal granules being hotter than the slag, in such a manner that the granules will contact with each other beneath the surface of a slag bath while at a welding temperature, whereby a coherent mass or sponge of mixed metal and slag is formed without mechanical agitation or working.

10. In the manufacture of wrought iron, the steps consisting of gradually feeding a succession of hot metal granules formed from the product of a steel making process into a bath of molten slag of the proper puddling characteristics, and forming under the surface of the bath a mass of mixed metal and slag.

11. In the method of producing wrought iron, the steps consisting of maintaining a molten bath of iron silicate slag, feeding successive portions of the molten slag into a series of receptacles, feeding heated metal granules formed from the product of the steel-making process into the receptacles, and causing them to contact with each other beneath the surface of the slag in the receptacles at welding temperature, whereby a coherent mass or sponge of mixed metal and slag is formed beneath the surface of the slag in the receptacles without mechanical agitation or work.

12. In the method of producing wrought iron, the steps consisting of maintaining a molten bath of iron silicate slag of the proper chemical and physical characteristics for making wrought iron, feeding successive portions of the slag into shaping receptacles, feeding heated metal granules formed from the product of a steel-making process into the slag in the receptacles, and bringing them in contact with each other at welding temperature below the surface of the slag to form a coherent balled mass, whose lower portion takes the shape of the shaping receptacle, whereby a coherent partly shaped mass of mixed metal and slag is formed beneath the surface of the slag in the receptacles.

13. In the method of producing wrought iron, the steps consisting of bringing heated metal granules formed from the product of a steel-making process into contact with each other at a welding temperature beneath the surface of a bath of molten puddling slag in a shaping receptacle, permitting the metal to settle to the bottom of said receptacle and thereby forming a coherent sponge or mass of mixed metal and slag below the surface of the slag bath in the receptacle, and then removing the mass from the receptacle and compressing it.

14. In the method of forming wrought iron, the steps consisting of gradually feeding heated metal granules formed from the product of a steel-making process into a bath of puddling slag of the proper chemical and physical characteristics for wrought iron, allowing them to contact with each other at welding temperature below the surface of the bath to form a coherent mass or sponge of mixed metal and slag, freeing the said mass from the surplus slag of the bath, and removing and compressing it.

15. In the method of producing wrought iron, the steps consisting of maintaining a large bath of iron silicate slag of the proper chemical characteristics for forming wrought iron, feeding successive portions of the molten slag into a series of receptacles, successively comminuting the molten metal product of a steel-making process and allowing the said comminuted metal to drop into the receptacles containing the slag, allowing the heated metal granules to contact with each other below the surface of the slag bath to form a coherent mass or sponge of mixed metal and slag, removing the coherent mass from the receptacle and freeing it from the surplus slag, and then compressing the same.

16. In the method of producing wrought iron, the steps consisting of maintaining

within the furnace a bath of molten iron silicate slag having the proper characteristics for making wrought iron, feeding successive portions of the bath into a series of receptacles, feeding the molten product of a steel-making process successively into the receptacles and comminuting the same as it is fed, allowing the heated metal granules to contact with each other below the surface of the slag bath, whereby a coherent mass or sponge of mixed metal and slag is formed without the need of mechanical agitation or working beneath the surface of the slag bath in the receptacles, and removing the masses from the receptacles, freeing them from surplus slag and compressing them.

17. In the method of producing wrought iron, the steps consisting of comminuting or granulating the product of a steel-making process while the same is in molten condition, causing the hot granules as they are formed to drop into a bath of iron silicate slag within a shaping receptacle, and allowing the granules to contact with each other at a welding temperature below the surface of the slag bath in the receptacle, and thereby forming a coherent mass or sponge of mixed metal and slag below the level of the slag bath, whose lower portion is shaped by the shaping receptacle.

In testimony whereof I have hereunto set my hand.

JAMES ASTON.