UNITED STATES PATENT OFFICE.

WILLIAM R. JONES, OF BRADDOCK, PENNSYLVANIA.

MANUFACTURE OF BESSEMER METAL.

SPECIFICATION forming part of Letters Patent No. 287,687, dated October 30, 1883.

Application filed May 21, 1883. (No specimens.)

To all whom it may concern:

Be it known that I, WILLIAM R. JONES, a citizen of the United States, residing at Braddock, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in the Manufacture of Bessemer Metal, of which the following is hereby declared to be a full, clear, and exact description, sufficient to enable any one skilled in the art to use the same.

In the early practice of the Bessemer method for reducing cast-iron to homogeneous malleable iron or steel, (ingot metal,) the charge of pig metal in the converter did not much exceed five tons in weight. Owing to the insufficient power of the blowing-engines and other causes, it was not feasible to work any greater weight of metal at one blow, and even then the conversion of the charge, which was obviously dependent upon the quantity of oxygen supplied, usually consumed twenty-five minutes, and frequently required much more time. In the interval between heats the crude pig metal tapped from the cupolas accumulated in the collecting-ladles and steadily fell in temperature. For this reason, but more especially because of the long duration of the treatment, it was necessary that the pig metal should contain a high per centum of silicon (usually about three per cent.) or of other heat-developing material—such, for example, as manganese—which would burn out in the course of the subsequent blow and keep the metal in condition best adapted to effect its satisfactory conversion. The "chilling" of the charge was the evil to be guarded against, and the presence of the silicon or its equivalent in high proportion was an essential precaution. If the metal should for any reason become overheated, as sometimes occurred, then a small amount of scrap—such as rail ends, butts, clippings, &c.—not to exceed five hundred pounds, and rarely that much, in weight, was added to the charge, either in the converter or in the casting-ladle, to reduce the temperature, and thus to save the ingot-molds from being "cut" by the hot metal. In the later stage of the art the improvements in blowing-engines and other machinery and the increased capacity of the converter and of the tuyeres have enabled the operator to work ten tons and upward of metal at a single heat and to effect its conversion in from eight to fourteen minutes, (rarely beyond the latter,) where some twenty-five minutes were necessary before to reduce five tons. This marked difference in the amount of the charge, the rapidity of conversion, and the frequency of the heats has been attended with other important changes. There is now but brief chance for the converter to cool or for the metal to accumulate in the collecting-ladles. The metal is oftentimes tapped directly from the blast-furnace, and hence the conditions are all such as tend to make the temperature higher and constantly increasing as successive charges are worked. The crude pig-iron is no longer high in silicon, but is preferably made to contain less than one per cent., though this may not be diminished too greatly in the working of the blast-furnaces without risk of introducing a hurtful per centum of sulphur into the metal. Despite all precautions, the energy and rapidity of the converter reactions frequently develop an overheated condition of the charge, which is attended by the emission of peculiar smoky vapors that obscure the flame so that the operator may not accurately determine when the blow should end. The overheated metal attacks the molds in casting and speedily destroys them. To add scrap or clippings of metal, either in the converter or casting-ladle, as may be necessary and as was practiced before, has become troublesome, expensive, irregular in its results, and not always effective. From two thousand to seven thousand pounds are now frequently added to the charge, which, quite aside from loss of time and uncertainty in determining what amount is requisite, involves the consumption of materials sometimes not conveniently obtained and having quite as high a market value as the finished metal itself. Besides, there is much risk of introducing objectionable or inferior grades of metal into the charge.

My invention is designed to obviate the use of this large quantity of clippings, &c., and to regulate the temperature of the charge at any stage of the conversion in a simple, expeditious, and inexpensive way, so that "over-

heating" is prevented. The flame is kept clear and free from obscuring vapors, so that the operator may determine with great nicety when the blow should end, and the ingot-molds are no longer subject to the destructive attacks of "hot" metal. This object I have accomplished by the use of steam, in conjunction with the air-blast, in the following manner:

When, at the beginning of the operation, the metal has been run into the converter and the air-blast has been turned on in the usual manner, steam is admitted from a pipe connected to the blast-pipe, and passes with the air through the tuyeres until the temperature of the metal is sufficiently reduced to insure a clear flame, when the steam will be shut off and the air-blast continued alone until the completion of the blow. The length of time during which steam will thus be admitted to the converter will depend upon the size of the pipe delivering the steam, as well as upon other conditions, such as the nature of the metal, the pressure and volume of the air-blast, &c.; but I have found in practice that in working a ten-ton converter with steam delivered at about fifty pounds pressure through a pipe of one and one-half inch in diameter the steam may be forced with the air about six minutes, or about one-third to one-half the length of the blow. It will also be found of advantage in some cases to inject steam with the air-blast for a short time just before the completion of the blow, if the heat of the metal is shown by the flame to be excessive, and, in fact, the steam may be introduced at any time when the appearance of smoky vapors or other indications in the flame familiar to the operator show that the metal is becoming too hot. The skilled operator will readily understand, however, at what stage and for how long a time the steam may be advantageously employed, depending, as it must, somewhat upon the varying conditions under which the work is performed.-

Instead of using the steam at the commencement of the blow, it may be introduced first at some later stage, or, again, may be used continuously throughout the entire period of conversion in connection with the air-blast. Again, in lieu of steam, it may be expedient to introduce a spray of water in finely-divided (atomized) condition, together with the air-blast, though, as the chilling effect is much greater than where the steam is employed, the more equable action of the latter makes its use preferable in practice, as heretofore indicated.

When scrap is used to chill the charge, the tendency is, as before stated, to reduce the per centum of silicon in the pig metal to the lowest working limit, because thereby less heat is developed in the converter and the amount of scrap to be added is correspondingly diminished; but in so far as the silicon is reduced there is danger of more and more sulphur passing into the iron while it is being smelted in the blast-furnace; hence it is an obvious and important advantage of the present invention that it allows for the use of a grade of pig metal which shall be high enough in silicon to uniformly avoid the presence of an objectionable per centum of sulphur, and yet which, despite its greater heating capacity, is under the easy control of the operator, who may quickly and cheaply counteract any harmful increase in temperature that may develop during the blow.

The skulls from the ladles, butts from the ingots, and the like, which ordinarily accumulate about the mill, may be utilized by remelting with subsequent charges in the converter, as heretofore, for while the present invention enables the scrap metal to be entirely dispensed with, there is nothing detrimental in such additions. Besides, the scrap metal of a single mill is but a minor percentage of the additions which the invention is designed to save.

I am well aware that it has been proposed to inject steam into molten iron in smelting-furnaces, puddling-furnaces, and crucibles. The object was to eliminate sulphur and other impurities by aid of the hydrogen and oxygen liberated by decomposition of steam; and the cooling influence of the steam, if ever practically observed, was regarded as a positive detriment and was applied to no useful purpose. The suggestion has also been made to inject steam, either alone or in conjunction with the air-blast, into the molten iron of a Bessemer converter; but in one instance the notion prevailed that the steam, by decomposition and reburning, would actually increase the temperature, which is not true in fact, and in the other instance the steam was employed to reduce a small quantity of an inferior grade of iron to a pasty or solid condition, after which the main charge of molten iron of superior grade was poured into the converter and the entire mass treated to the action of an air-blast alone to accomplish its conversion into homogeneous metal. Aside from any question of practicability, it is plain that in said process the steam was not designed to temper the heat during conversion of the charge, but was used exclusively at a preliminary stage to bring about a pasty or granular condition of the metal similar to what results in working upon a puddle-hearth, and that subsequently, while actual conversion proceeded, no steam whatever was added, nor could be in the form of converter used.

In so far as my invention dispenses with the use of a large amount of valuable scrap metal and places the temperature of the charge during conversion under the easy and efficacious control of the operator, the invention plainly distinguishes itself from all analogy to any of the preceding real or suggested uses of steam in metallurgic arts.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

In the Bessemer process of converting cast-iron by injecting blasts of air through the molten charge of metal without extraneous heat applied thereto, the prescribed method of regulating the temperature of the charge during conversion to prevent overheating, which method consists in injecting steam simultaneously with the air-blast in quantity substantially as described, whereby the desired cooling is effected without permanently impairing the molten condition of the metal, substantially as set forth.

In testimony whereof I have hereunto set my hand.

WILLIAM R. JONES.

Witnesses:

JULIAN KENNEDY,

WILLIAM WHITE, Jr.