UNITED STATES PATENT OFFICE.

GEO. P. MILLER AND HUGH DOUGHERTY, OF LANCASTER, PENNSYLVANIA.

IMPROVEMENT IN MELTING AND REFINING IRON.

Specification forming part of Letters Patent No. **18,347**, dated October 6, 1857.

To all whom it may concern:

Be it known that we, GEORGE P. MILLER and HUGH DOUGHERTY, of Lancaster, in the State of Pennsylvania, have invented or discovered a new and useful Process of Melting, Refining, and Tempering Iron and other Metals, which we verily believe has not before been known or used; and we do hereby declare that the following is a full, clear, and exact description of the same.

The nature of our invention consists in the use and application of anthracite coke for the purpose of melting, refining, and softening iron, and the combining therewith due proportions of anthracite coal in the charging of the cupola for hardening the iron, and thus regulating the temper of the castings by the use of more or less coal, as the nature of the casting may require.

In order that others skilled in the arts may use our invention, we will proceed to give some practical examples of the manner of using the said material.

In an ordinary cupola of thirty-four inches in diameter, to run off a "heat" of forty-six hundred-weight of iron with a blast from a fan of thirty-six inches in diameter run at the rate of about fourteen hundred revolutions per minute, we proceed to run off a heat in from thirty to forty minutes, using said material in the following manner: In the first place we put or place in the cupola some light chips or kindlings to light off with. On this we put two hundred pounds weight of anthracite coal. On this we put one hundred and fifty pounds weight of bituminous coke. On this we place four hundred and seventy pounds weight of anthracite coke (commonly called "furnace-coke") for the bed. We then proceed to get the fire up. When the fire is up we place on this bed forty-six hundred-weight of iron of different qualities, all in one charge. On this we put a small sprinkle of anthracite coke for a finish. We then put the blast on and melt down or run off the whole heat of forty-six hundred-weight of iron in from thirty to forty minutes, if such speed is desired. In a heat of this kind, from the short duration which it lasts, there will be about three hundred and fifty pounds of anthracite coke which will pass through unconsumed, and which can be used with like advantage in the next heat. This, when the heat is run off and the bottom of the cupola dropped, we quickly extinguish by means of water to keep it from being consumed. Hence the whole amount of fuel consumed will be two hundred pounds of anthracite coal, one hundred and fifty pounds of bituminous coke, and about one hundred and forty pounds of anthracite coke—in all making only four hundred and ninety pounds of fuel consumed, whereas it will require more than twice that amount, under similar circumstances, by means of anthracite coal alone, and on an average more than twice the length of time that we take by this process for melting down the same quantity of iron.

In case circumstances require slower melting, we use the material in the following manner: In the first place we put into the cupola some light chips or kindlings to light off with. On this, to run off a heat of forty-six hundred-weight of iron, we put two hundred pounds weight of coal. On this we put three hundred and fifteen pounds weight of anthracite coke mixed with eighty pounds of bituminous or gas coke for the bed. We then proceed to get the fire up, and when up we place on this bed two thousand pounds weight of iron, constituting our first charge. Then on the first charge we put one hundred and thirty pounds of anthracite coke mixed with twenty-six pounds of gas-coke, and on this we put fourteen hundred pounds of iron for our second charge. On this we put one hundred pounds of anthracite coke mixed with twenty-five pounds of gas-coke, and on this we put twelve hundred pounds of iron for our third and last charge. We then turn on the blast and run off the heat as fast as circumstances may require.

The gas-coke used in our process is for speedy and perfect ignition of the anthracite coke.

These two examples are intended for making all the castings of one heat of the same temper, and that rather soft. When no proportion of anthracite coal is used in the heat the castings are rather too soft for ordinary use. Hence the necessity of using generally a proportion of raw coal.

In case the castings are required to be hard, we use about one-third as much anthracite coal in each of the charges as we do anthracite coke and bituminous coke together. This will make the entire heat of the same temper. But in case we wish to produce both hard and soft

castings from the same heat, we charge in the following manner: In our first and second charge we use the anthracite coal, as stated above for making hard castings, combined with two-thirds of its weight of bituminous and anthracite coke. This will make the casting of the first two charges hard. In our third and fourth charges we use the anthracite coke with the bituminous for igniting it, and the castings of these two charges are soft. Anthracite coal being introduced into any one of the charges will make that charge hard. The other charges of that heat will produce soft castings.

The following examples taken from two different shops where this process has been introduced show the following results: First, by our method a heat of heat of forty-eight hundred-weight of iron was run off in these proportions:

16	hundred-weight of scrap-iron at $18 per ton (2,000 pounds)	$14 40
32	hundred-weight of No. 2 anthracite pig at $27 per ton (2,240 pounds),	38 57
48		$52 97

This proportion is fifty pounds of scrap-iron to one hundred pounds of No. 2 anthracite pig-iron, whereas by the old method we used only twenty-five pounds of scrap to one hundred pounds of No. 1 anthracite pig-iron to make the same quality of castings, which would cost as follows:

12	hundred-weight of scrap-iron at $18 per ton	$10 80
36	hundred-weight of No. 1 anthracite pig at $29 per ton (2,240 pounds),	46 60
48		$57 40

From this deduct the cost of our method and we have a saving of $4.43 on each heat of forty-eight hundred-weight in iron alone. We estimate the saving of fuel at $1.25 on each heat of this size, which will make the net saving $5.68. Three heats of this size a week would make a saving of $17.04, saving in one year $886.08. This example shows the saving in expense to a shop of ordinary size. In a large shop, where as much business is done in one day as they do in this in a week, the saving would be $2,758.24. But we can do much better than this, as will be seen in the following example, taken from another shop. In a heat of fifty-three hundred-weight we used—

44	hundred-weight of scrap-iron at $18,	$39 50
9	hundred-weight of No. 1 anthracite pig-iron at $29 per ton	11 65
53		$51 15

The castings turned out from this heat were very soft and good. Every piece, large and small, was fit for use, whereas, if the same proportion of scrap and pig had been used, by means of coal by the old method the castings would have been so hard and full of "pin-heads" that they could not have been worked or used, as the following example will show, the same kind of iron being used, only in different proportions, the castings were rather too hard for ordinary use:

1,766	pounds of scrap at $18 per ton (2,000 pounds)	$15 89
3,534	pounds of No. 1 anthracite pig at $29 per ton (2,240 pounds),	45 84
5,300		$61 73

From this subtract the amount for cost of iron by our process in the previous example will show $10.58 in our favor. To which add the saving of fuel, $1.25, and we have $11.83. Three heats of this kind a week will show a saving of $35.49; one year will show $1,845.48, and a shop three times as large as this will save in one year, as will be seen by making the estimate, $5,536.44.

These examples are taken from a shop where our method is now in operation, and we give these results as positive and drawn from practice. We attribute the effects resulting from (as herein illustrated) our method to the following: All experience in the use of anthracite coke proves that it is more easily kindled than the raw coal, and when used with the gas-coke makes a much quicker fire. Now we will show the advantages of our method, and thus show why it is to be preferred:

First. The iron is melted in less time by our method than can be done in the old way, because the coke being more porous the fire penetrates more readily and ignites the mass more speedily. When raw coal is put into the cupola alone and the blast then turned on the entire mass is about double the time in becoming heated. If the coal is heated in pits separately, as is practiced by Crane, and then introduced into the cupola, the same time (or more) is lost, besides there is a loss of labor and of fuel, and the deleterious properties of the coal still have their action on the iron in melting.

Second. Softer, purer, stronger, finer-grained castings, and castings susceptible of a higher polish are produced by our method than by the old. In melting iron by the use of anthracite coal it is always hardened by the process. The coal is slow in heating, but when hot makes too intense a heat for the iron, and thus burns it before melting, or while melting. The sulphur of the coal, as the coal heats, is driven out and penetrates the iron, and is deleterious to the iron in its effects, and then it assists in creating a more intense and burning heat in the iron, and thus acting on it serves to harden it and make it more brittle. In addition to this, the iron being heated to such a degree, the transition from this heat to the chill of the molds produces a corresponding degree of hardness and brittleness. On the same principle, then, any piece of metal when very highly heated will become much harder when

plunged into water or is suddenly cooled than the same piece of metal would if not heated to such a temperature and cooled in the same way. The action of the heat and the influence of the sulphur produces hard spots in the castings—"pin-heads," so called—and being hard, like flint or glass, makes it almost impossible to work them, being too hard for the file in polishing. They also destroy the strength and utility, in a measure, of the casting. Now let us see what the uses of the coke are. It will be understood that when coal is submitted to the heat in the common furnace the sulphur escapes and passes off by the time the coke is cooled. The coke is then more porous and more accessible to fire and ignites more readily and produces almost instantly a mild but sufficiently intense heat—a heat that does not tend to burn the iron, but melts it readily, and the sulphurous properties of the coal being gone its evil effects do not injure the iron. Thus the iron not being burned or injured by excessive heat, and not being so intensely hot when poured into the molds, and the transition not being so great from hot to cold, the consequence will be that by this method the iron will be softer, finer-grained, stronger, more easily worked, and susceptible of a higher polish, while it will be free from hard spots and pin-heads.

Third. Cheaper castings are produced to the public, because a greater proportion of scrap-iron (which is always cheaper in price) can be used than by any other method to produce a good quality of soft castings. In one example which we have given we used two hundred and fifty pounds of scrap-iron to fifty pounds of No. 1 anthracite pig-iron, and made as good castings as could be made and as were made in another example given, in which were used fifty pounds of scrap to one hundred pounds of No. 1 anthracite iron melted by coal alone. The rule in the old method is that the more No. 1 anthracite pig-iron is used the softer and better the castings. We do not adhere to this rule, but make as good castings by our method of inferior and cheap iron as can be made by the old process of superior and high-priced iron.

Fourth. The castings may be tempered with precision, because the iron being softened by the use of the coke and hardened by the use of the coal, by varying the proportions of the two combined there will be made a corresponding variation in the temper of the castings, and this may be done at pleasure.

Fifth. Hard and soft castings may be made from the same heat in any desired proportion, because coke may be used in the first two or any desired number of charges of the cupola, and the castings will be soft, or coal may be used in any desired number of the charges in combined proportions with the coke, and the casting will be from those charges hard.

Sixth. A saving of fuel is effected by not using as much new fuel as is used in the old method, and in using fuel which has generally been either in part or wholly thrown away as worthless.

We do not claim having discovered the coking of anthracite coal, nor the admixture of such coke with other coal or coke; but

We claim—

Adjusting the proper proportions of these fuels for use in melting and refining iron, substantially as herein set forth, by which we are enabled to use more scrap-iron and inferior pig-iron than is now known to be used, and to temper the metal in the manner described with economy of fuel and of time.

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Witnesses:
ISAAC FELLENBAUM,
ZURIEL SWOPE.