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C. M. ALLEN.

METHOD OF SAVING METAL VALUES FROM SLAG.

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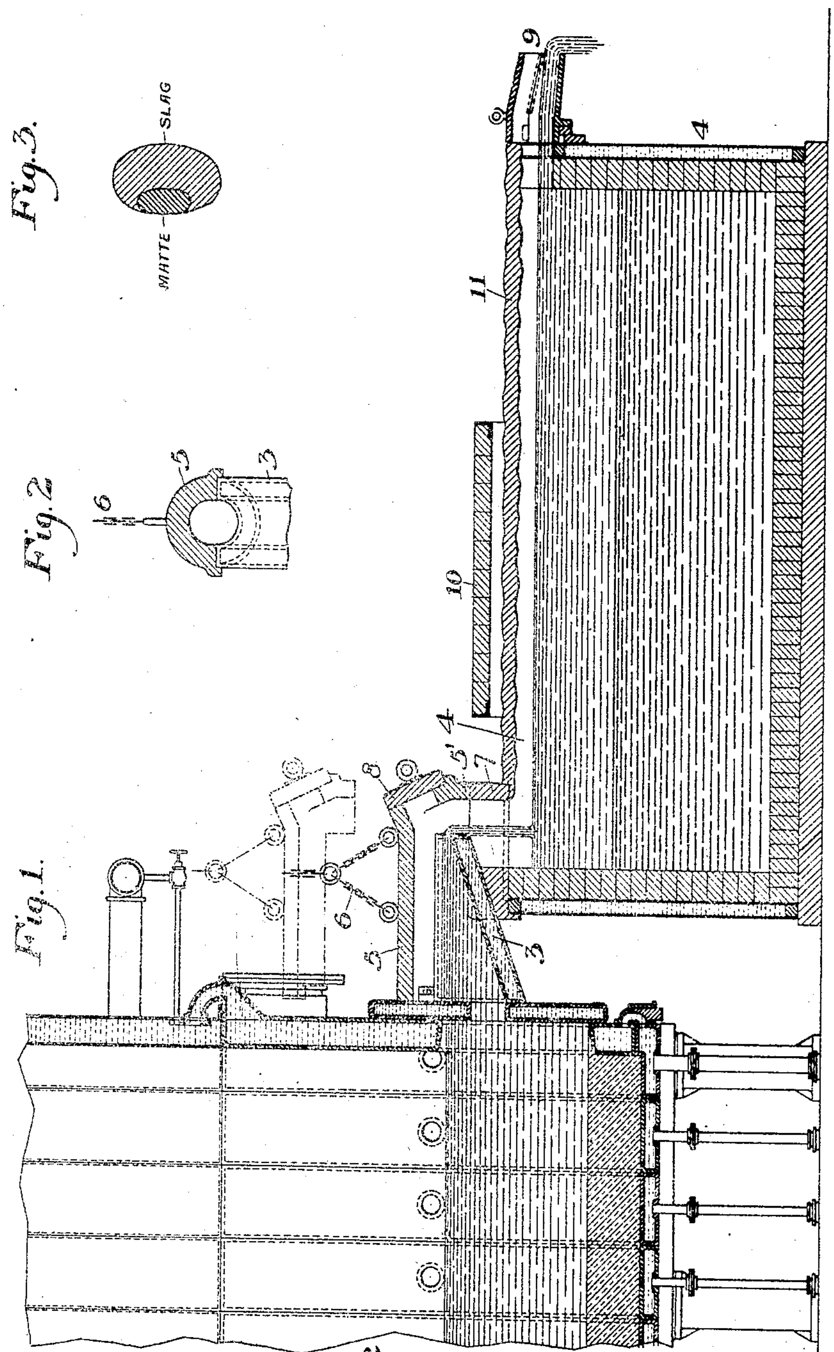

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METHOD OF SAVING METAL VALUES FROM SLAG.

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To all whom it may concern:

Be it known that I, CHARLES M. ALLEN, of Lolo, in the county of Missoula and State of Montana, have invented a new and useful Method of Saving Metal Values from Slag, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 shows a front view of a forehearth with part of a smelting-furnace arranged to conserve the initial heat in slag and matte, and thus to save values therefrom according to my invention, the dotted lines showing the cover while temporarily removed. Fig. 2 is a vertical section showing means for holding the heavy cover securely in its position by gravity. Fig. 3 is a cross-section of a falling stream of molten slag and matte, illustrating the knife-blade edges at each side where the heaviest losses in matte-prills occur.

The object of my invention is to provide means for more perfectly separating matte-prills containing metal values from worthless slags than in present pratice; and to that end my invention consists in conserving the original heat that exists in the slag and matte while in a smelting-furnace during their passage from the smelting-furnace into the forehearth or separating-chamber and also during the time of separation by gravity while in the forehearth or separating-chamber and until the clean worthless slag has been discharged therefrom.

My invention provides an economical, convenient, and simple method of saving prills of matte that are lost unless a method such as I will now describe is used in connection with blast-furnaces provided with the large forehearths, such as have now been brought into general use for commercial reasons.

In present practice where matte-producing ores are smelted in blast-furnaces and where the matte and slag flow out into a forehearth as fast as formed and are there separated by gravity the molten material is conveyed into the forehearth by a spout which is always left open on its top side, so that the molten material while traveling through this space, being exposed to the open air, will be materially cooled, and as a consequence will be rendered less fluid. The less fluid the slag becomes the more matte will be mechanically confined within it, and, *per contra*, the higher the heat the more liquid will be the slag, and hence the more perfect will be the separation of matte-prills by gravity. The chilling effect on matte and slag during their travel through an open spout is evidenced by the constant formation of congealed accretions, which must be removed from the spout from time to time by hand as a means of maintaining a continuous flow. Blocks of wood are constantly placed upon the spout in a feeble effort to maintain the heat and to counteract in part the chilling effect of the air. In some instances brick arches have been constructed over the spout as a means of accomplishing the desired result; but the front end is always left open, and the result has not been satisfactory. Moreover, when the operator finds it necessary to work at the spout the entire brick structure above referred to must be destroyed. The general practice is to keep a stick or block of wood lying over the running stream of molten material. This is expensive, as it consumes a large amount of wood, and neither the wood nor the brick arches protect that portion of the stream that falls from the spout to the space below the congealed slag-cover of the forehearth. These expedients do not perfectly protect the stream while in the spout, nor do they protect it at all during its fall through the open air, where the greatest mischief is accomplished.

A furnace has been patented by J. B. F. Herreshoff in which the chilling of the slag or matte in their transit from a smelting-furnace into a separating-chamber is prevented by making the forehearth, in effect, a subdivision of the furnace itself. Herreshoff's device required the forehearth to be mounted on wheels; but when the large rectangular type of blast-furnace came into use and for commercial reasons largely superseded the smaller furnaces it was found necessary at the same time to enlarge the forehearth to a diameter of from eight to twenty feet, so that it became impracticable to mount the forehearth on wheels, and in order that the operator could get at the connection between the furnace and the forehearth it became necessary to construct the forehearth separate and distinct from the furnace and to trap the blast at the spout of the furnace. This enables the furnaceman to "rod" the furnace at any time. The Herreshoff forehearth therefore can only be used with small round or oval blast-furnaces of the German type, which have been generally superseded.

In the Herreshoff portable forehearth the trapping of the blast by the molten bath is accomplished by the water-jacketed wall of the forehearth itself, and when the matte separates from the worthless slag it is thereupon removed from the forehearth by an ordinary tap-hole. The slag alone passes from the overflow-spout after the separation has been accomplished. The molten matte and slag therefore do not flow through a spout or trough or drop through the open air at all. It is imperative in the Herreshoff apparatus that the forehearth shall be portable, because when any obstruction occurs at the junction-point between the furnace and the forehearth it becomes necessary that the forehearth should be removed in order that the operator may be able to rod the furnace and free the passage or orifice.

By my method an opening is provided in the front of the spout-cover which may be closed or opened at will and which permits the furnaceman to rod the furnace at any time. Provision is also made so that the entire spout-covering may be raised without tedious delay and without destroying the structure, and provision is made for the immediate replacement of the same when desired. The spout-cover is preferably made of heavy metal, or it may be made of brick held together by a metal frame, or it may be molded in the form of tiling. The connection from the spout to the top of the forehearth may also be made of metal, brick, or tile, as above indicated, and any of these are so arranged that they will not be destroyed or disarranged by the removal of the spout-cover.

In the drawings, 2 is a water-jacketed copper-smelting furnace having a slag-spout 3, from which the molten slag overflows into a forehearth 4. The spout is covered by a cover 5, provided with a lifting device 6, by which it may be raised to expose the top of the slag-spout. The cover has an end piece 5′, which when the cover is in place rests upon a bridge 7 and in conjunction therewith shields the stream of molten slag from the atmosphere from the point where it leaves the furnace until it reaches the forehearth, and thus prevents the loss of heat and chilling of the slag by radiation. The cover has preferably an end opening closed by a cap 8, which can be removed when it is desired to get access to the spout without raising the cover.

9 is the overflow, from which the cleaned and worthless slag passes from the forehearth.

10 is a bridge which I place above the forehearth for the support of the workmen in rodding the furnace, for it will be found that when my spout-cover is used the chilled crust of slag 11 which is allowed to form over forehearths for the purpose of conserving the heat is apt to be thinner and unable to bear the weight of a man, because of the increased heat of the slag and matte, and bridges or supports are therefore needed for the workmen who have been accustomed to stand on such crust.

The device which I have described above will tend to preserve the heat of the slag and matte and to make them more fluid and will thus produce a much better separation in the forehearth. It will also prevent the formation of the customary accretions of chilled slag that accumulate in the spouts of present furnaces and that now require removal by hand, because the radiation of heat from the cover is so great that it effectually prevents such accretions.

It is found in present practice that "rod samples" taken of the slag do not show the full losses in matte-prills. Ladle samples of blast-furnace slag never show less than from .3 to .4 per cent of copper, and in many cases where poor work is done the slag carries as high as .7 per cent. of copper and a proportionate amount of precious metals. In the Butte district, Montana, in each pound of copper lost there is an additional loss of about four cents in precious metals. In other words, the precious-metal losses may approximate one-third of the value of the copper in addition to the loss of copper itself. About ten tons of slag is made for every ton of copper produced. Thus a loss of even .4 per cent. in the slag would be equivalent to a loss of about 4.4 per cent. of the copper in the ore, to which, of course, must be added the value of the precious metals. Hixon in his work on copper-smelting states that the smelting loss at the Anaconda works under his management was 7.38 per cent. of the copper in the ore, and the converter loss (which is also strictly a slag loss) was 2.238 per cent. of the copper in the ore. It will therefore be apparent that my invention is of great commercial value, for even a saving of .1 per cent. over present losses (even when considering the very best present practice) will amount to a saving of at least one-quarter of the great slag losses that are now being made. My present invention will easily accomplish this result, and I have done much better in every-day work, inasmuch as I have made slags by this process carrying only a trace of copper and precious metals too small to determine by assay. In this connection it is worthy of note that ordinary smelter practice is not at present conducted with average losses of only .4 per cent. I have tested by assay slags from the dump-piles of several prominent Butte smelters that ran from .9 per cent. to 1.5 per cent. in copper and with the usual percentages of precious metals.

Moreover, in present smelter practice it is customary to add fluxes to the ore charge, and where oxidized iron is difficult to procure, as is the case in the Butte district, the use of limestone flux is almost imperative, and the percentage of fluxes added to the ore charge is usually quite large. The addition of such fluxes adds proportionately to the tonnage of slag. Hence it adds proportionately to the prill losses of matte, and my present invention will make a proportionate saving in all such cases.

At many points ores of very low grade are treated for their copper contents. At Ducktown, Tennessee; Tilt Cove, Newfoundland; Rio Tinto, Spain, and in the Greenwood district in British Columbia ores are smelted that run two per cent. and less in copper. The smaller the copper, gold, and silver contents of the ore the greater will be the relative proportion of worthless slag. Hence in present practice the greater will be the proportion of loss relatively to the copper contents of the ore. It is not uncommon in present practice to thus lose one-third of the entire mineral values of the ores. In such cases my present invention in reducing these slag losses to a mere trace can easily transform a smelting plant that is a money-loser into a source of profit.

In the best smelter plants of to-day the slag from the converters and refinery is poured into pigs, and on being broken up into pieces of suitable size is returned to the blast-furnace, where it acts as a flux and where its contained mineral values are partially recovered prior to its ultimate discharge to the slag-dump. My process is therefore far-reaching in its effects, inasmuch as it operates on the last and final treatment of all slags as now made in copper-matte blast-smelters. Smelting and converting losses up to this point are subject to future recovery; but beyond this point they enter the waste-slag dump, and therefore are beyond recovery.

When matte and slag flow through a spout, the matte, being the heavier of the two, necessarily flows on the bottom of the spout, and in this position it is covered on the top by the slag, and it is thus protected from the open air. The plastic lining of the trough itself soon becomes heated, and the matte stream is therefore at the same time protected against chilling on its under side. When the matte and the slag together are discharged from the front of the spout in their vertical fall into the forehearth, the matte may be seen on the rear side, or, in other words, on the under side of the stream, while the slag can be seen to envelop the front or top portion of the falling stream. Where the slag flows in contact with the matte stream on each side, it thins out into knife-blade edges, as indicated in Fig. 3, and as a consequence there is a portion of slag that thins out until it ceases altogether, while the rest of the stream consists of matte. The very thin edge at the junction-line between the matte and the slag on each side of the falling stream is a prolific matte-gatherer, for, being exposed to the open air, it chills more rapidly than the central and thicker portion of the stream, and the viscidity thus produced causes it to entangle and to carry away mechanically steady streams of matte-prills on each side. In extreme cases portions of chilled slag that enter the forehearth often accumulate on the congealed slag-cover and build up the surface with matte and matte-prills through the partially-chilled and viscid condition of the slag. This is also the cause of much loss in mineral values. The flow from all copper-blast furnaces is necessarily intermittent and irregular. It will vary with the rapidity of the smelting process. It also seems to pulsate and to throb, possibly through the generation of gases. When a salamander or a scaffold drops into the molten charge, a wave in the spout usually follows its drop into the bath. For the reasons stated the stream of molten material is greater at times than at others, and it constantly swells and subsides in its passage through the spout and through the outer circulating air. This has the effect of building chilled accretions on the spout, which require constant attention from the furnaceman and must be removed by hand in order to keep the molten stream in motion. By withdrawing the slag and matte from beneath the surface of the molten bath in the furnace the blast is trapped at all times and the spout may be rodded at will without uncovering the forehearth and without uncovering the spout. When the spout is thoroughly covered and protected against the outer air, as in my present invention, all of these difficulties and expenses are avoided, inasmuch as the radiated heat from the cover maintains the molten stream without regard to its volume or its pulsations at practically the same temperature from the time it issues from the furnace until it is ultimately discharged at the opposite side of the forehearth as a thoroughly settled and cleaned slag for removal to the slag-dump.

The description above given will make it clear that my apparatus as shown in the drawings is merely illustrative of my method and that it may be variously modified in order to suit the requirements of varied conditions, since

What I claim is—

1. The method of saving metal values from slags, which consists in withdrawing the slag and matte from beneath the surface of the molten bath, thereby trapping the blast, and permitting them to overflow from a furnace-spout into a forehearth or separating-chamber, and conserving the original heat of the matte and slag by protecting them from the

chilling effect of air during their flow into the forehearth or separating-chamber; substantially as described.

2. The method of saving metal values from slags, which consists in withdrawing the slag and matte from beneath the surface of the molten bath, thereby trapping the blast, and permitting them to overflow from a furnace-spout into a forehearth or separating-chamber, and conserving the original heat of the matte and slag by covering them throughout their entire transit into the forehearth; substantially as described.

3. The method of saving metal values from slags, which consists in withdrawing the slag and matte from beneath the surface of the molten bath, thereby trapping the blast, and permitting them to overflow from a furnace-spout into a forehearth or separating-chamber, and conserving the original heat of the matte and slag by covering them with heat-radiating surfaces throughout their entire transit into the forehearth; substantially as described.

4. The method of saving metal values from slags, which consists in withdrawing the slag and matte from beneath the surface of the molten bath, thereby trapping the blast, and permitting them to overflow from a furnace-spout into a forehearth or separating-chamber, and conserving the original heat of the matte and slag by covering them with a practically air-tight conduit which extends around the course of the falling stream of slag, and into the slag-covering of the forehearth; substantially as described.

In testimony whereof I have hereunto set my hand.

CHARLES M. ALLEN.

Witnesses:

THOMAS H. BURKE,

THOMAS C. MARSHALL.