No. 864,719. PATENTED AUG. 27, 1907.

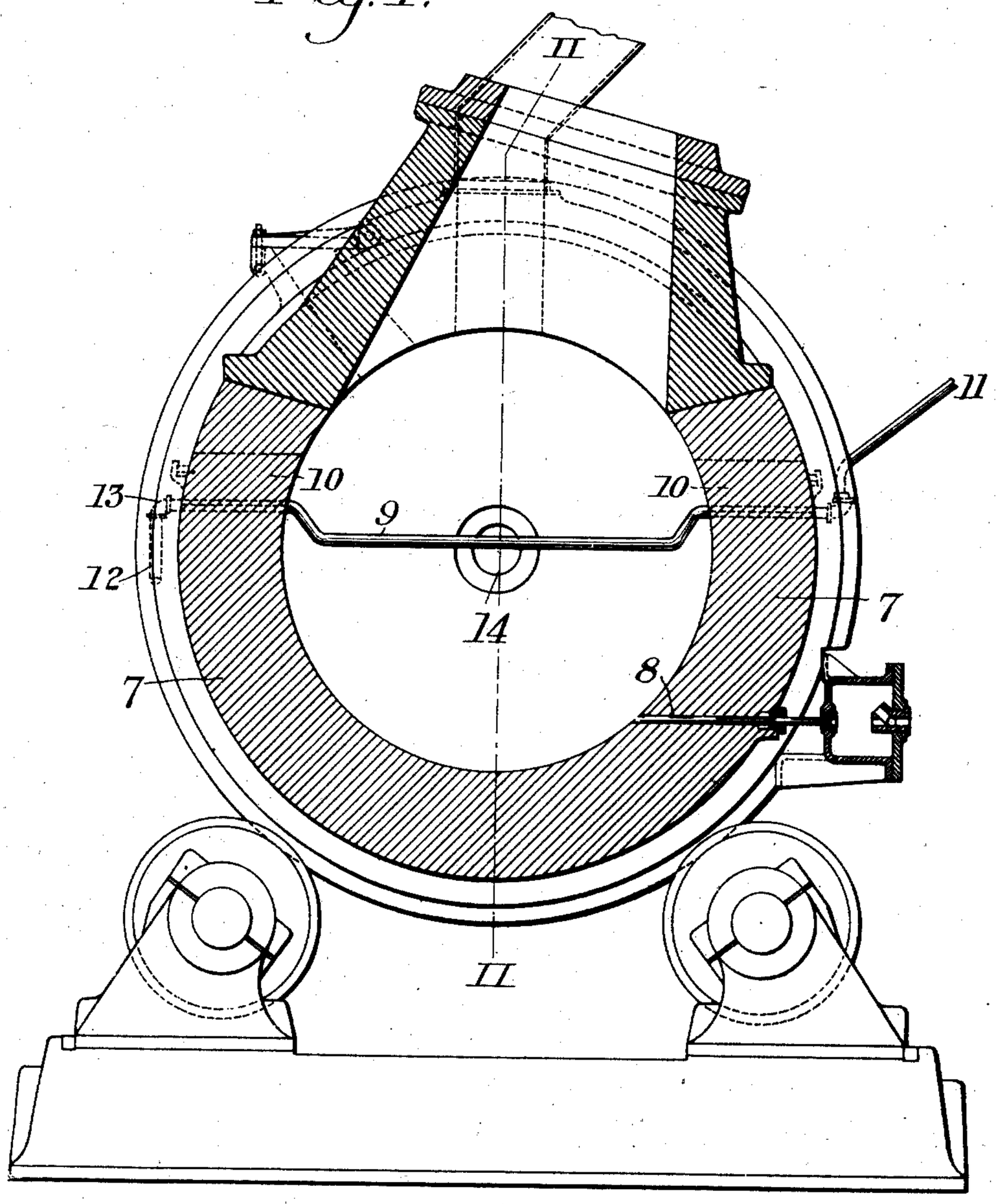
R. BAGGALEY, C. M. ALLEN & E. W. LINDQUIST.

MEANS FOR PREVENTING ESCAPE OF UNFUSED ORE FROM SMELTING CONVERTERS.

APPLICATION FILED MAY 1, 1905.

4 SHEETS—SHEET 1.

Fig. 1.



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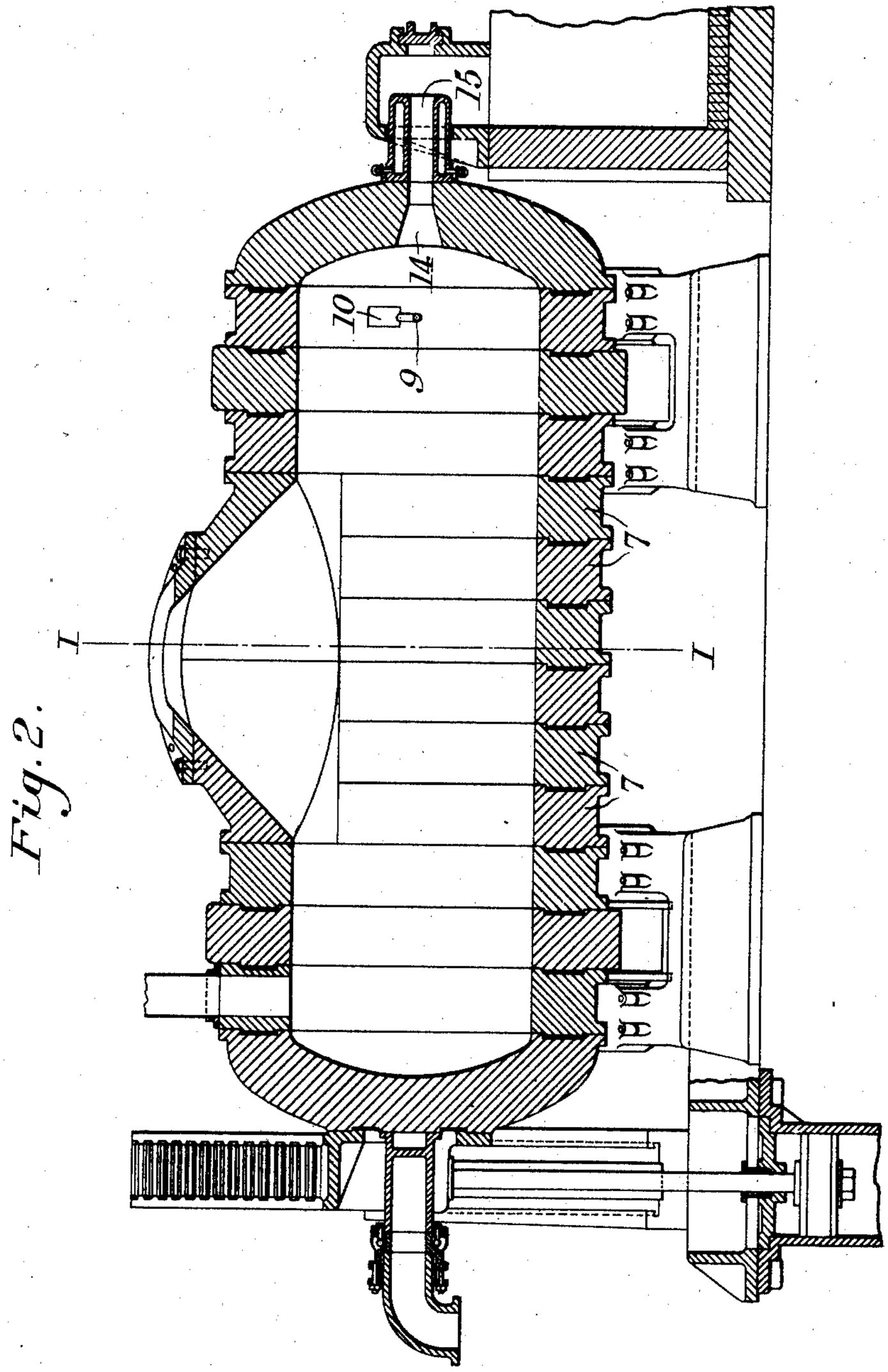

Fig. 2.

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Fig. 6.

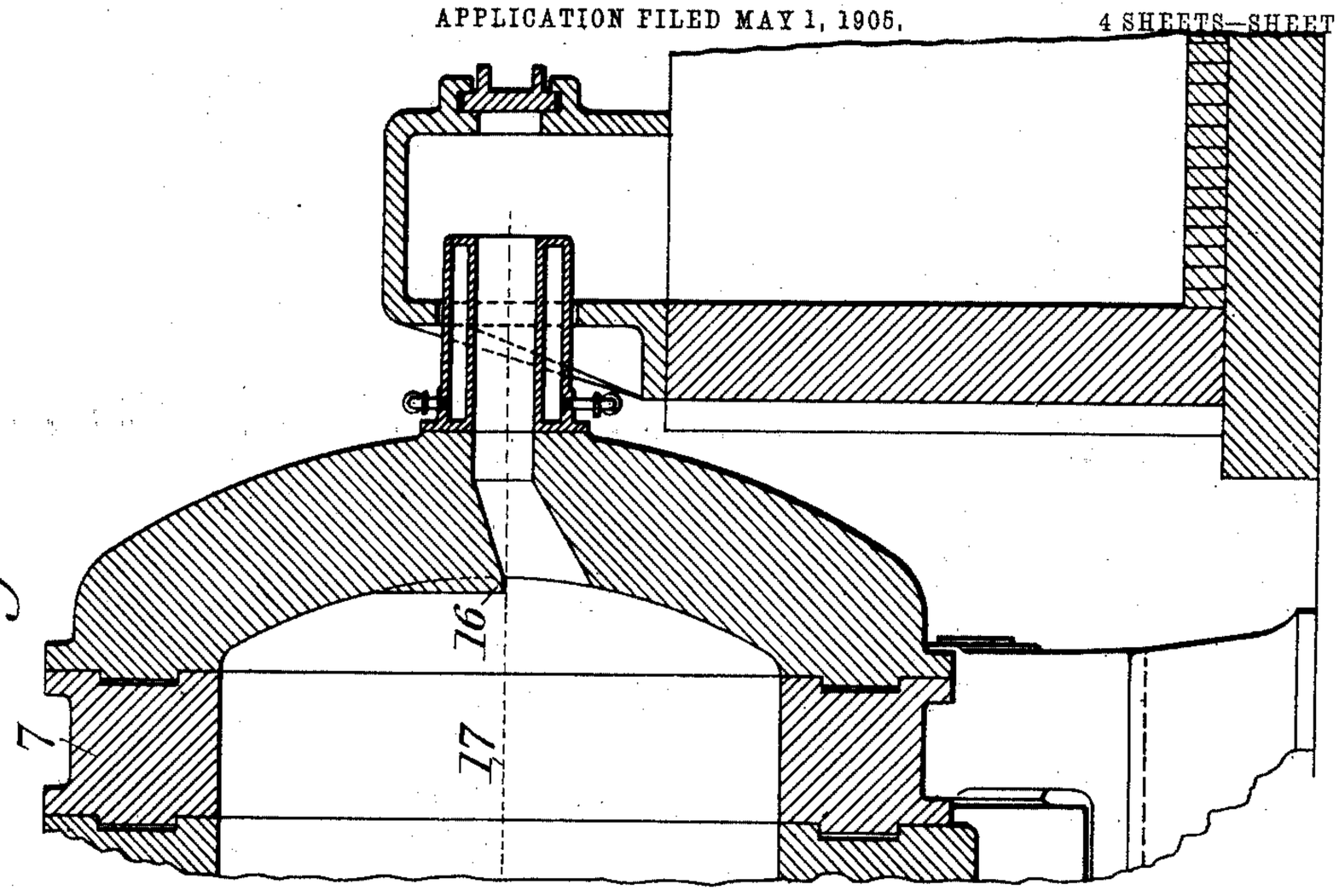

Fig. 3.

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APPLICATION FILED MAY 1, 1905. 4 SHEETS—SHEET 4.

Fig. 5.

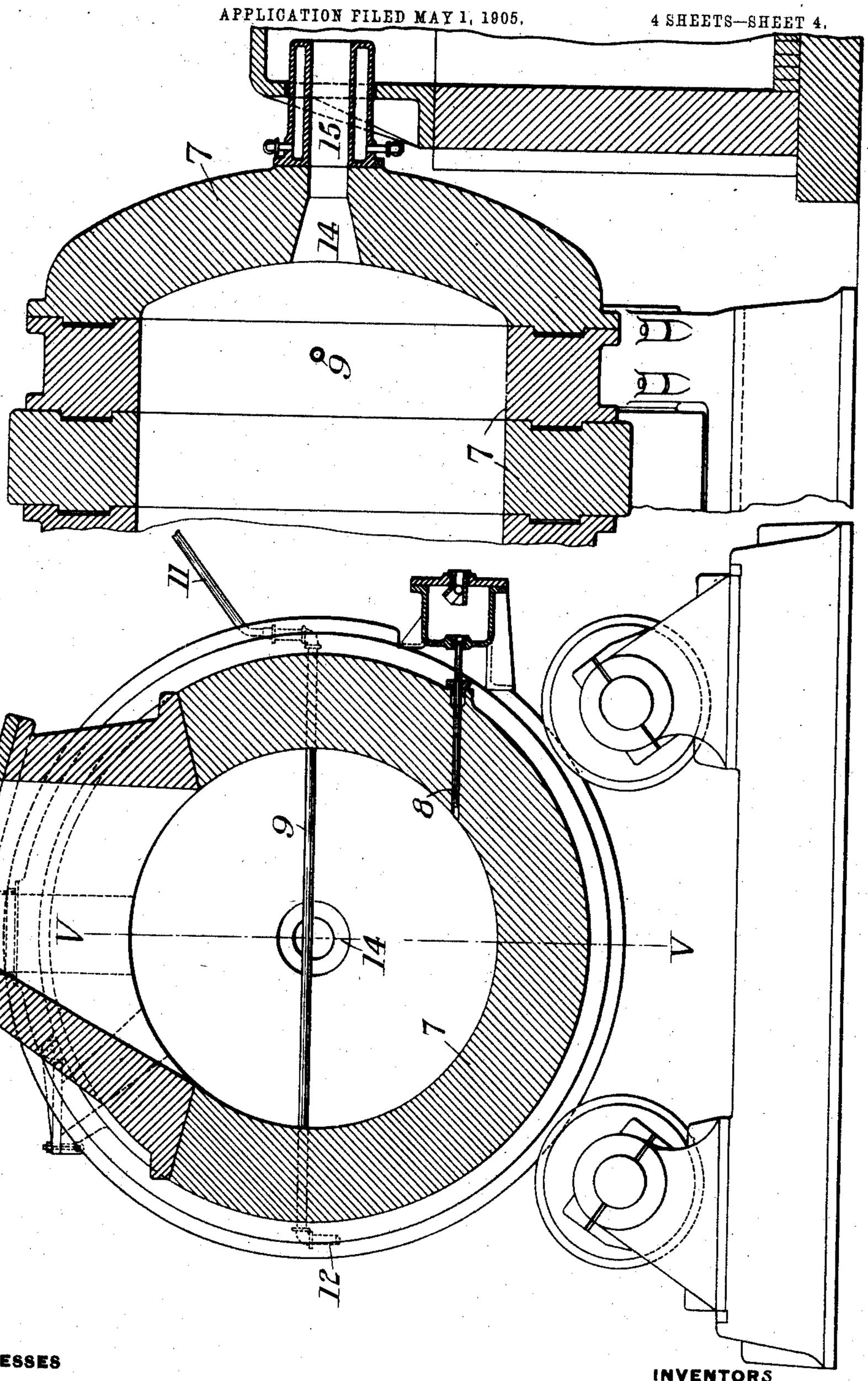

Fig. 4.

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UNITED STATES PATENT OFFICE.

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MEANS FOR PREVENTING ESCAPE OF UNFUSED ORE FROM SMELTING-CONVERTERS.

No. 864,719. Specification of Letters Patent. Patented Aug. 27, 1907.

Application filed May 1, 1905. Serial No. 258,426.

To all whom it may concern:

Be it known that we, RALPH BAGGALEY, of Pittsburg, Allegheny county, Pennsylvania, CHARLES M. ALLEN, of Lo Lo, Missoula county, Montana, and EDWARD W. LINDQUIST, of Chicago, Cook county, Illinois, have invented a new and useful Means for Preventing Escape of Unfused Ore from Smelting-Converters, 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 in cross-section, a smelting converter provided with our preferred form of apparatus, the section being on the line I—I of Fig. 2; Fig. 2 shows in vertical longitudinal section on the line II—II of Fig. 1, a smelting converter equipped with our preferred form of apparatus. It also illustrates the removable block whereby the bridge may be removed from the converter, if desired. Fig. 3 illustrates a partial side elevation of a smelting converter equipped with our preferred form of apparatus; Fig. 4 illustrates in cross-section, a smelting converter equipped with an alternate form of our apparatus; Fig. 5 is a longitudinal cross-section partly broken away on the line V—V of Fig. 4; and Fig. 6 illustrates in longitudinal section, the discharge end of a smelting converter, together with the water-jacketed overflow-spout, the practically air-tight drop-tube and a portion of the forehearth, the design of the discharge orifice being such as to prevent the exit of unfused floating ore without trapping the blast.

Our invention is especially designed for use in connection with the method and the apparatus more fully described in other applications filed by us, to wit: Serial No. 243,677, filed February 1, 1905, method of smelting ores and separating mattes, and Serial No. 253,548, filed April 3rd, 1905, smelting converter and forehearth. Its object is to prevent the escape from the converter, of lumps or particles of ore in an unfused condition.

The smelting converter described in the cases referred to is preferably six feet in diameter and twenty feet in length. Its area is equivalent to the cross-sectional area of an ordinary copper blast furnace large enough to smelt six hundred tons of ore in twenty-four hours. The blast provided in this vessel is ample to smelt the tonnage referred to. For every one hundred pounds of ore fed into this smelting converter, one hundred pounds of molten material, either matte or slag, less the volatile portion such as that portion of the sulfur which is oxidized to SO_2, must be discharged through the overflow-spout, in a corresponding space of time. If the vessel be therefore smelting ore at the rate of 600 tons in 24 hours, it will reduce to the molten state 25 tons of ore per hour or more than 800 pounds per minute. This explanation will make the fact clear that the movement of slag and matte from the vessel into the forehearth will be extremely rapid.

In regular blast furnace smelting with a trapped overflow-spout and with a column of ore, flux and fuel, as used on the lines of universal practice, we have found that the column of charge so obstructs the blast escape through it, as to cause considerable air-pressure on the top of the molten material which is constantly in the crucible of the furnace, intimately mingled with the material of the charge. This pressure is sufficient to force down the top surface of the molten slag a distance within the crucible of the furnace of from one and one-half to two inches. Such top pressure seems to have the effect of expelling the molten matte from the crucible of the furnace, and the top layer of molten slag seems to constantly increase. In this way a floating layer of molten slag may accumulate to a depth of from eight to twelve inches, and anyone conversant with converter practice and especially with the dissolving of ores on a molten bath will be familiar with the troubles that would be experienced if this accumulation were allowed to occur. It is because of these things that we are careful to avoid the trapping of any blast in the smelting converter above referred to; because this would cause a top layer of molten slag on which unfused ore would float hopelessly separated from the molten matte that alone could dissolve the ore. This separation of the unfused ore from the body of molten matte would be fatal to the successful practice of this new method of smelting. It is also known to those conversant with the converting of mattes, that the rotary motion given to the charge by the entering blast causes the slag to be mixed more or less with the matte. If the relative proportion of slag to matte be small enough, no serious results will fullow; but when the slag increases beyond a certain amount, then it chills at the twyers and forms noses and thus creates difficulties which, if the cause be not speedily removed, will result in a stoppage of the entire operation. It is of paramount importance that the slag should be freely and quickly and thoroughly discharged through the overflow, in order that the entering, unfused ore may always come into immediate contact with and thereafter float in a comparatively clean bath of molten matte, towards the overflow-spout, approximately a distance of twenty feet, while subjected to the heat produced by the converting blast. If this overflow-spout be trapped against the escape of the blast, a top layer of slag will quickly accumulate and it will exert a certain amount of downward pressure on the molten matte because of the choked escape of the enormous volumes of gas at all times burning in the upper portion of the vessel, and which continuously produce smelting temperatures in its upper portion above the

level of the molten bath. This downward pressure on the top layer of molten slag will force the escape through the overflow-spout of an undue proportion of the molten matte, exactly as it now does from the crucible of the common copper blast furnace, and while this is a desirable condition in the blast furnace it is just the reverse in an ore-dissolving converter.

In the apparatus illustrated in the cases above referred to, the level of the top layer of molten bath can never exceed that of the central line of the overflow-spout as shown in Fig. 2. For this reason the upper half of the overflow-spout is constantly open, so that no trapping of the blast can possibly occur.

From the thirty-two $1\frac{1}{4}$ inch converting twyers on the side of the vessel, an enormous volume of converting blast constantly enters. The thin layer of floating slag that is constantly forming through the action of the intense heat may be silicious, and for this reason it may be more or less pasty. The entrance of this enormous volume of blast, throughout the entire length of the vessel, will have a constant aerating or lightening effect on the molten material and particularly on the thin layer of floating silicious slag, the tendency of which will be to prevent in a measure its mixture with the matte and to assist constantly and continuously the escape of this top layer of slag through the overflow-spout.

The foregoing explanation will make clear the fact that the movement of unfused ore, from the point of entrance at one end of the smelting converter to the point of escape at the overflow-spout, located at the other end of the vessel, will be rapid. Where the entering ore is delivered into the vessel in a fine state or in highly silicious lumps, this movement may be rapid enough to carry such material and discharge it in an unfused state through the overflow-spout. If such material escapes from the smelting converter unfused into the forehearth, then the recovery of its contained mineral values becomes impossible.

An object of our present invention therefore is to provide a bridge or a check that will be practically indestructible and that will catch and hold any floating particles or lumps on the surface of the molten bath, before the same can escape through the overflow-spout.

Another object of our invention is to accomplish this result without the possibility of trapping the blast, for the reasons hereinbefore described.

The violent action of the converting blast, as well as the very rapid movement of molten slag and matte from the ore entrance to the overflow-spout and thence into the forehearth, may be sufficient to cause floating particles or lumps of ore or silicate to pass under the bridge, as illustrated in the drawings. Should this occur, it constitutes exactly the result that we wish to be produced; because in this way each separate particle or lump will become submerged in the molten matte during its passage under the bridge, and this will have the effect of immediately dissolving the then red hot ore and of compelling it to join the bath in molten form, in which form it becomes possible to recover all contained mineral values.

When the ore charge is melted the matte, being of greater specific gravity than the slag, fills the lower portion of the vesssel up to the level of the overflow-spout, and the slag-layer on top may thus be forced to occupy a position above the level of the overflow-spout. In the case of the ordinary blast furnace equipped with a trapped overflow, the air pressure of the blast, obstructed by the unfused charge in the furnace, exerts a top pressure upon the slag and this causes it to be discharged through the overflow-spout with the matte. A floating layer of slag, however, is maintained constantly in a blast furnace, that may be from eight to twelve inches in thickness owing to the depth of the trap. No such assistance as the considerable top pressure herein described, is available in our process of dissolving ores. For this reason it is essential that our overflow-spout shall at all times be free and open, so that the upper floating layer of slag may at all times find a free and a ready exit. Any considerable thickness of floating slag would have the effect of separating the floating ore from the body of low-grade corrosive matte, where alone it can be dissolved. In order to explain this matter in clear terms, we quote the following table of specific gravities of materials ordinarily dealt with in smelting.:

Pure silica, (SiO_2)	2.60
Pure alumina, (Al_2O_3)	2.55
Pyrrhotite, (Fe_7S_8)	4.50 to 4.65
Iron pyrites, (FeS_2)	4.90
Copper pyrites, ($CuFeS_2$)	4.30
Copper mattes	4.60 to 5.1
Bornite, (Cu_3FeS_2)	5.00
Chalcocite, (Cu_2S)	5.5
Enargite, (Cu_3AsS_4)	4.34 to 4.45
Slags	3.21 to 3.90

It will be noted that the specific gravity of silica or quartz and of alumina or clay are such that these will float on slags. It will also be noted that the slags resulting from this smelting process will float on copper mattes. The silicious portions of many ores as described above are almost as light as silica itself, and these will also float upon slags. Such silicious ores are the most difficult to dissolve or render liquid by heat.

Our present invention relates especially to the recovery of any contained mineral values in such highly silicious floating particles. By placing the bridge or dam as herein described at or near the surface of the molten bath, the travel of the floating particles can either be checked until they have had time to dissolve, which result can be accomplished in a few moments through the medium of the intense heat of the converting blast as well as the intense heat of the ore, at this stage of the work when operating on low grade corrosive mattes, or they will be compelled to pass under the bridge or dam and will thus be submerged in the corrosive matte during their travel towards the overflow-spout, which will also have the effect of dissolving them.

In the drawings, 7 illustrates the heavy walls of the converting vessel, which may be made of solid metal blocks of such thickness that their bulk will bear such a relative proportion to the body of molten bath that they will not be injured and that they will successfully resist the heat and the corrosive action of the matte and thus be practically indestructible, ordinary wear and tear excepted. It is preferable that they should be

supplemented with an interior refractory lining. The use of these blocks however does not constitute part of our present invention, which relates to other parts of the converting apparatus.

8 illustrates the converting twyers.

9 in Figs. 1, 2, 3, 4 and 5 illustrates the location and the design of our preferred and alternate means for practicing our invention.

10 in Figs. 1, 2 and 3 illustrates removable blocks, so that the water-cooled pipe or bridge 9 may be removed from the vessel, if desired, even when incrusted with congealed slag or matte. Our preferred form of apparatus, as illustrated in Figs. 1 and 2, shows this bridge or water-cooled pipe so curved that the lower portion of it will skim the surface of the molten bath while at its normal level at the center line of the vessel. The advantage of this construction lies in the fact that the orifices through the converter wall are thus considerably higher than the level of the molten bath, hence none of the matte or slag can escape around the blocks that fill these orifices, nor can the slag or matte congeal injuriously upon the inside surfaces of the block and thus prevent or obstruct its removal when desired. Our alternate construction, which consists of a straight water-cooled pipe or bridge, is illustrated in Figs. 4 and 5 and it is objectionable to the extent above described, although with this apparatus successful skimming of the bath may be accomplished.

It is intended that the water or other cooling medium shall enter at one side of the vessel preferably as shown at 11 in Figs. 1 and 4, and that it shall escape as illustrated at 12 in the same figures. In this way a continuous stream may be forced through the pipe, which will at all times maintain upon its exterior surface, by reason of this cooling action, a sufficient layer of congealed matte and slag, to protect it against the heat and the corrosive slags and mattes that are inseparable from this work. In lieu of a continuous stream of water or other cooling medium passing entirely through the bridge or pipe 9, this pipe may be constituted of two separate pieces of different diameters, the one being located within the other. In such event, the cooling stream may enter through one of them and thereafter return at the point 13 in Fig. 1, and thus find its exit at or near the point of entrance.

It will be noted in Figs. 2 and 5 that the bridge is purposely located a short distance in front of the orifice or overflow 14, the object being to check the travel of any unfused ore while borne upon the surface of the molten matte sometime before its escape from the vessel. Should the particles or the lumps be submerged in the molten matte, through the action of the bridge and through the rapid motion of the molten bath in its travel towards the orifice 14 and thereafter in its exit from the overflow-spout 15, sufficient travel is thus secured for such unfused particles or lumps while immersed in the molten matte and while heated red hot to accomplish their successful dissolving before they are dropped from the overflow-spout 15.

Very pure silica or a very pure lime constitute almost perfect oxids and for this reason, they become practically infusible, excepting only in the presence of such intense heat for instance as is produced in the electric furnace. As soon however as even these perfect oxids come into contact with iron, their affinity for this will quickly produce either silicate of iron or silicate of lime, and this fact renders them amenable to and capable of being melted by comparatively moderate heat, such for instance as that produced in the method of smelting herein described.

Fig. 6 illustrates a possible method of accomplishing the successful skimming and checking of the exit of unfused ore particles or lumps from the vessel. We do not recommend this method of accomplishing the result, for the reason that if carelessly used it might result either temporarily or continuously in trapping the blast and should this occur, it would be fatal to the successful practice of this art. The device as illustrated in Fig. 6 is intended to skim or to check the travel of any floating ore particles or lumps, by means of the overhanging projection in the converter-wall as shown at 16, the level of the molten bath being at 17. It is intended, in using this device, that the upper level of the molten bath shall never extend above the line 17 shown in the drawing. In other words, it is the intention that the travel of the ore shall be checked at 16, or if it be carried forward, the projection 16 will automatically cause its submersion in the molten bath and this will have the effect of dissolving it. At the same time, the level of the molten bath being at or about the line 17, the blast will still be permitted to escape past the projection 16 and the possible trapping of the blast or obstruction to the flow of the molten bath will be prevented.

Doubtless many modifications in the details of this means for preventing the escape of unfused ore from smelting converters will suggest themselves to those skilled in the art. Insofar as we know, this means for accomplishing the desired result is broadly new and as such we intend to claim it.

We claim:—

1. A smelting converter in which the smelting is effected by the heat of oxidation of the ore charge having twyers, a constantly open overflow at one end, and a bridge or barrier placed near said opening and arranged to check floating particles of ore and submerge them in the molten bath in their movement towards said opening; substantially as described.

2. Means for preventing the escape of unfused ore from smelting converters which consists in the combination of a converter having a discharge opening, a barrier or bridge adapted to check floating particles or lumps, and an orifice through which the barrier or bridge is inserted, said orifice being above the level of the barrier or bridge; substantially as described.

3. In a smelting converter having twyers and in which the smelting is effected solely by the heat of oxidation of the ore charge, and which has a constantly open discharge, means for preventing the escape of unfused ore, consisting of a barrier or bridge located near the discharge opening and extending somewhat below the same so that the blast will not be trapped and floating unfused ore particles or lumps will, in passing under the bridge or barrier, be submerged in the molten matte; substantially as described.

4. Means for preventing the escape of unfused ore from smelting converters which consists in the combination of a converter having twyers, and a constantly open discharge-opening, a barrier or bridge adapted to check floating particles or lumps, said barrier or bridge being in the converting chamber, and a forehearth to which the discharge-opening leads; substantially as described.

5. Means for preventing the escape of unfused ore from smelting converters in which the smelting is effected solely by the heat of oxidation of the ore charge which consists in the combination of a converter of oblong form having

twyers, an end discharge-opening, and a removable barrier or bridge adapted to check floating particles or lumps said barrier or bridge being in the converting chamber; substantially as described.

6. Means for preventing the escape of unfused ore from smelting converters in which the smelting is effected solely by the heat of oxidation of the ore charge which consists in the combination of a converter having twyers, a discharge-opening and a fluid-cooled barrier or bridge adapted to check floating particles or lumps said barrier or bridge being in the converting chamber; substantially as described.

7. Means for preventing the escape of unfused ore from smelting converters which consists in the combination of a converter having a discharge-opening, a barrier or bridge adapted to check floating particles or lumps, and an orifice through which the barrier or bridge is inserted, said orifice being above the level of the barrier or bridge and provided with a removable block; substantially as described.

8. The combination with a converter for smelting ores solely by the heat of their oxidation, said converter having twyers and a normally open overflow or discharge opening, of means for preventing the discharge of unfused ore at such opening, consisting of a bridge or barrier in the converter chamber behind and in transverse relation to the opening and arranged to check floating particles of ore and cause them to be submerged in their forward passage; substantially as described.

9. In a smelting converter having twyers, and a constantly open overflow, means for preventing the escape of unfused ore, comprising a bridge or barrier placed transversely of the said opening adjacent thereto, and extending somewhat below the same, and acting to cause the pieces of unfused ore which impinge against it to be submerged in the molten matte in the converter; substantially as described.

10. A smelting converter of the character described, having a single constantly open overflow opening at one end portion for both slag and matte, and a barrier or bridge placed transversely of said opening in position to catch and submerge floating pieces of ore; substantially as described.

In testimony whereof, we have hereunto set our hands.

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Witnesses:
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