Dec. 19, 1961 P. L. SAYRE ET AL 3,013,789

MOBILE APPARATUS FOR OXYGEN REFINING OF METAL

Filed Dec. 17, 1959 3 Sheets-Sheet 1

Fig. 1.

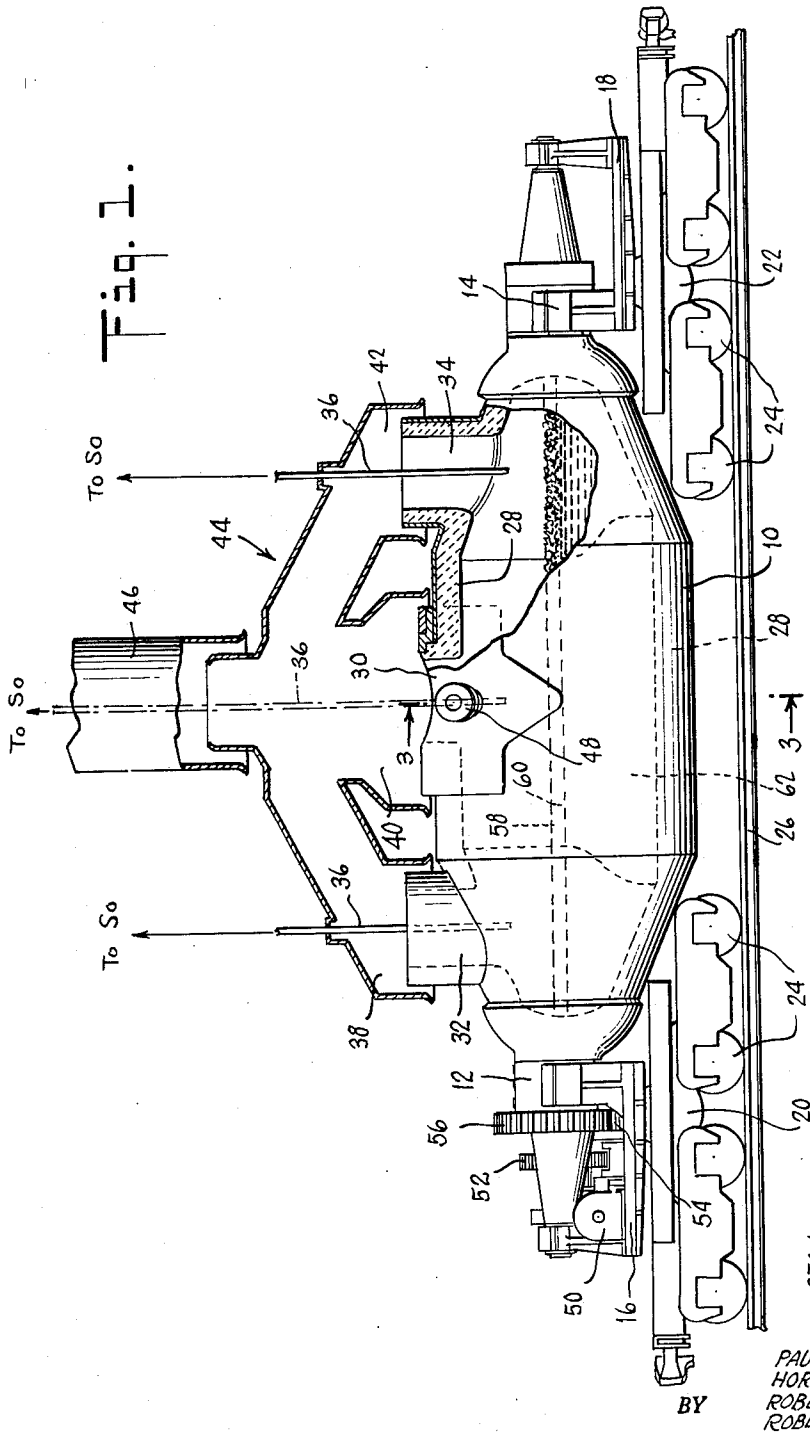
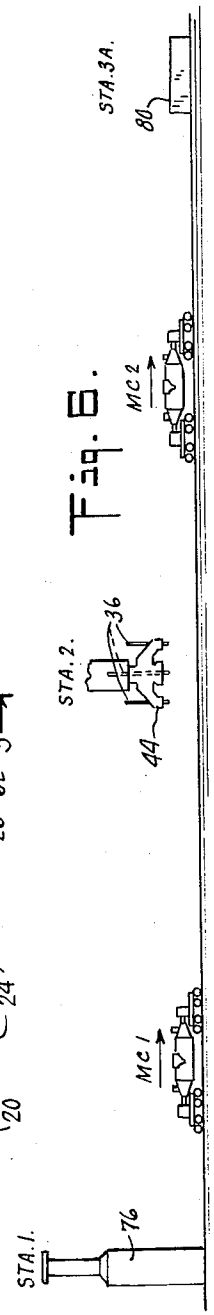


Fig. 6.



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Filed Dec. 17, 1959 3 Sheets-Sheet 2

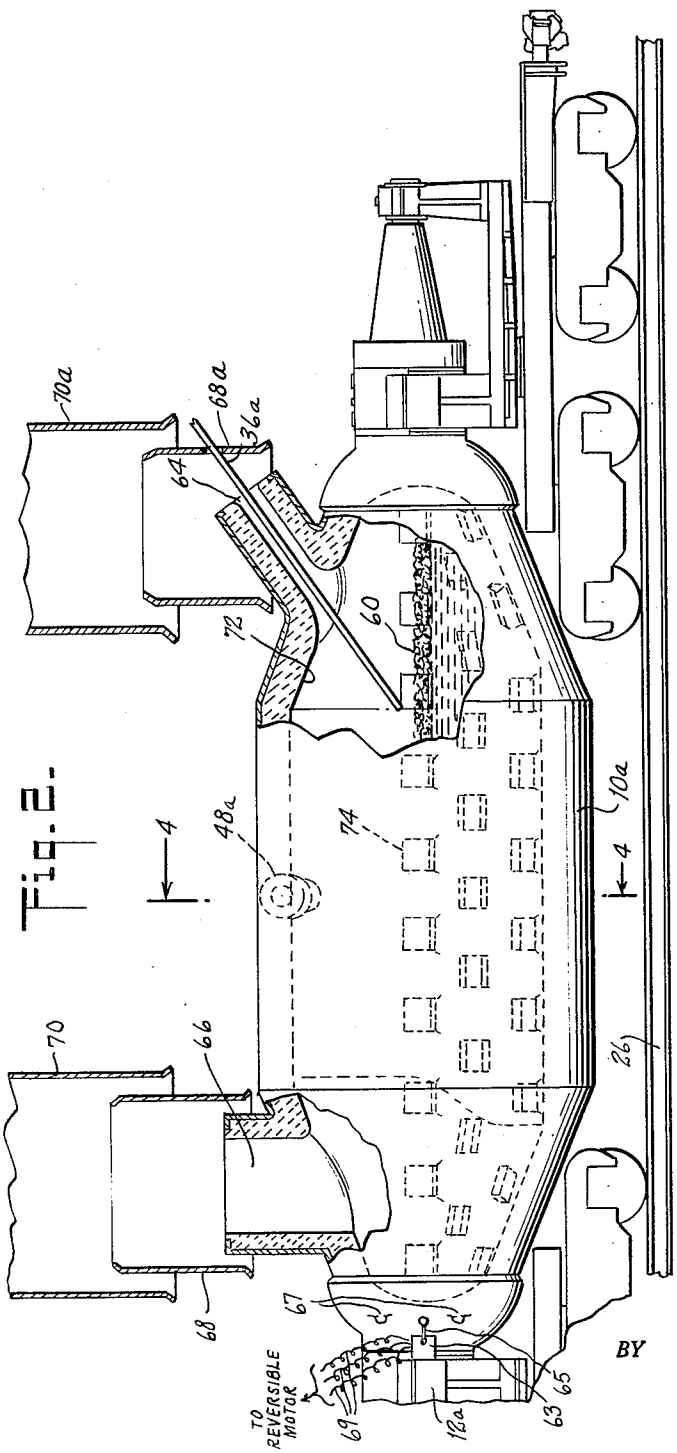

Fig. 2.

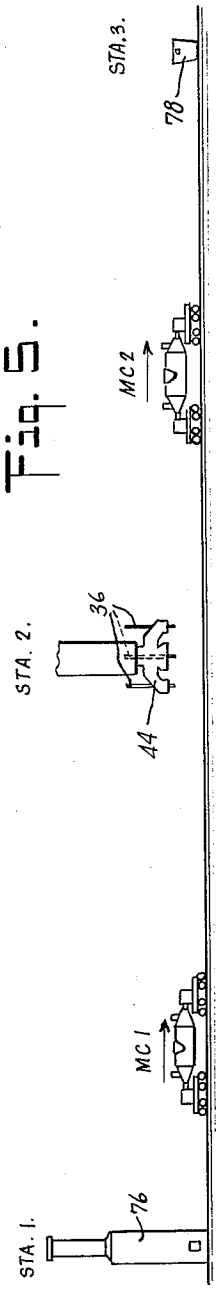

Fig. 5.

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MOBILE APPARATUS FOR OXYGEN REFINING OF METAL

Filed Dec. 17, 1959 3 Sheets-Sheet 3

Fig. 3.

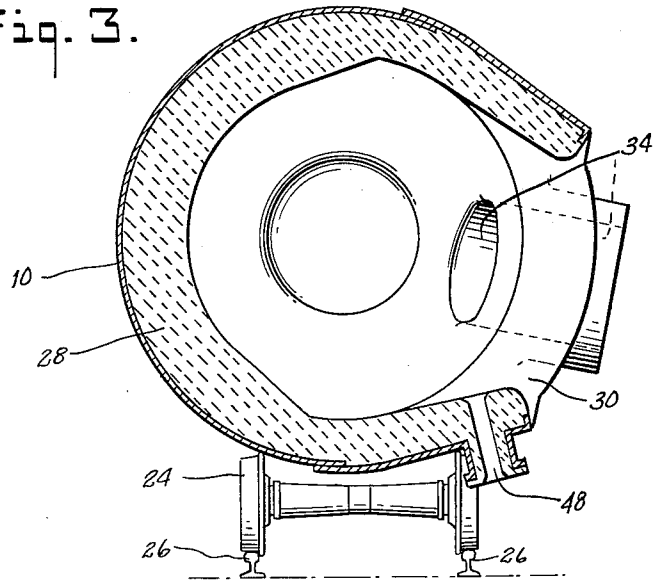
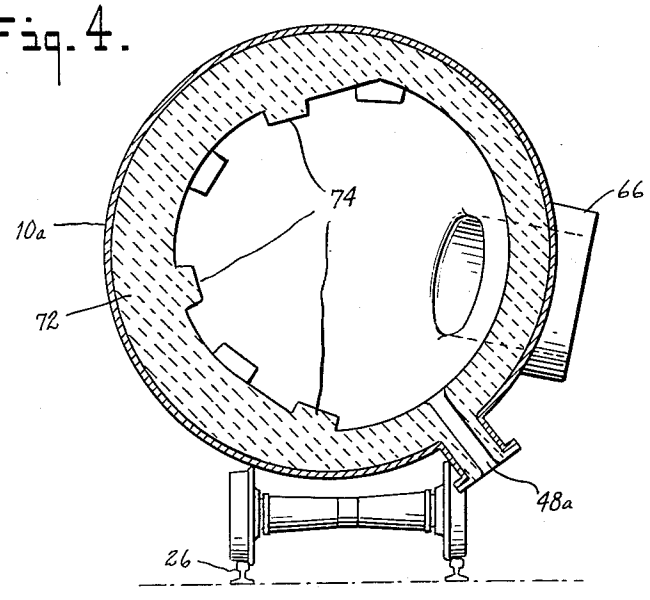


Fig. 4.



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3,013,789
MOBILE APPARATUS FOR OXYGEN REFINING OF METAL

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9 Claims. (Cl. 266—36)

This invention relates to improvements in converters such as are employed in oxygen processes for refining molten iron to produce steel therefrom, and relates also to improvements in methods of treating such molten iron in the production of steel therefrom. More particularly, this invention relates to such treatment of molten iron (hereinafter referred to, for convenience, merely as "hot metal") wherein a blast of oxygen is introduced into the surface of a hot-metal bath for refining purposes.

This invention stems partly from the discovery or realization that hot-metal cars such as are employed in steel plants for limited purposes may be used advantageously with little or no change both for the same purposes for which they have heretofore been employed and for additional, complemental purposes; to wit, for complemental purposes for which separate furnaces or converters have hitherto been employed. Among numerous advantages are reduced equipment costs and greater facility in the handling and treatment of hot metal to produce steel.

An important object of this invention is the provision of a hot-metal car which, in addition to being usable as such, is usable also as a furnace or converter wherein refining of hot metal to produce steel therefrom is accomplished by a process in which a blast of oxygen is directed into or upon the surface of the hot metal (such process being hereinafter referred to, for convenience, merely as an "oxygen process").

Another important object is the provision of an improved method of handling hot metal incidental to oxygen refining thereof wherein handling steps, hitherto considered inescapable, are avoided.

Another important object is the provision of a hot-metal car in which means for dumping the car function additionally to rock a hot-metal container of the car to agitate molten metal therein during oxygen processing thereof.

Another important object is the provision of means within a hot-metal container of a hot-metal car which enhance agitation of molten metal therein when said container is rocked.

Another important object is the elimination of certain apparatus which, hitherto, has been considered essential in oxygen refining of steel.

Another important object is the reduction of equipment maintenance costs in steel plants by merging the separate costs of maintaining both hot-metal cars and separate converters into a single, lower, cost of maintaining a hot-metal car which serves also as a converter.

Another important object is a simplification of controls and the operation of controls for operating metal-refining equipment, leading to substantially minimized costs both of control equipment and of the expense of labor involved in operating such equipment.

Another important object is the reduction of the passage of time between the discharge of metal from a blast furnace and its oxygen treatment for conversion to steel.

The foregoing and other objects, which will be more or less obvious to those familiar with steel processing, are accomplished by use of the present invention, of which several embodiments are disclosed herein and illustrated in the accompanying drawings, without, however, limiting the invention to those particular embodiments.

In the drawings,

FIGURE 1 is a side elevational view of a hot-metal car, according to this invention, which is adapted to function, not only as a hot-metal car, but also as a metal-refining converter; this view being partly broken away to show details, and including also a sectional view of an elevatable hood for carrying off gases from the car-converter. As such a car is movable horizontally to and from a location where refining of metal therein takes place, it is sometimes hereinafter referred to as a "mobile converter" and at other times it is referred to as a "car-converter."

FIG. 2 is a side elevational view, partly broken away, of the metal-containing portion and one end of a modified form of car-converter according to this invention.

FIG. 3 is a vertical cross-sectional view on the line 3—3 of FIG. 1, showing a hot-metal container of the mobile converter of the latter figure rotated to a tapping position.

FIG. 4 is a vertical cross-sectional view on the line 4—4 of FIG. 2, showing a hot-metal container of the mobile converter of the latter figure rotated to a tapping position.

FIG. 5 is a more or less diagrammatic view illustrating a manner of using a mobile converter in relation to other equipment in practising a method according to this invention.

FIG. 6 is a diagrammatic view of the same general character as FIG. 5 but illustrating one of numerous possible variations in the manner of utilizing a mobile converter according to this invention.

The mobile converter illustrated in FIGS. 1 and 3 comprises an elongate container **10**, supported for rotation about a horizontal axis in suitable opposite end bearings **12** and **14** mounted respectively upon plates or frames **16** and **18** which, in turn, are mounted pivotally upon trucks **20** and **22** having wheels **24** by means of which the converter may be moved from place to place on track **26**.

The container **10** is supported on the trucks **20**, **22** in a substantially horizontal position, it is lined with suitable refractory material **28**, and, in the embodiment illustrated in FIG. 1, it is provided, at what is normally its top, with three openings, to wit, a central opening **30** serving as a charging mouth and also functioning otherwise as hereinafter explained, and openings **32** and **34** located toward opposite ends of the container. Some or all of said three openings may be utilized for the introduction of oxygen into molten metal in the container under substantial pressure, by means of lances **36**, and all three of said openings serve also to permit the escape of gaseous products of the chemical reactions from the container into branches **38**, **40** and **42** of a hood **44** through which the escaping gases ascend and are carried away to a remote point by a duct **46**. The container **10** also is provided with a tap hole **48** which may be closed or opened in any suitable manner as, for example, by plugging or unplugging refractor material therein.

The container **10** may be rotated by any suitable means, which, as illustrated, comprises a reversible motor **50** which drives reduction gearing including a spur gear **52** and a pinion **54**. The pinion **54** drives a ring gear **56** which is fixed upon one end of a journal of the container concentrically with respect to the latter's axis of rotation. These container-rotating means may be located at either end of the mobile converter, and in the drawings are shown as mounted upon plate **16**.

The container-rotating means preferably should be such as to enable rotation of the container either through a complete turn of 360° or only partially. Complete turning is desirable to permit complete evacuation of the container and cleaning thereof. The container may be par-

tially turned to permit tapping-off of treated metal through the tap hole **48**.

The hood **44** may be so mounted or suspended that it may be moved vertically down into close association with the converter as shown in FIG. 1, or elevated sufficiently that lower extremities of the hood may be above and clear of the converter so that the latter may be moved on track **26** into and from its indicated position directly beneath the hood. If desired, however, the principal parts of the hood **44** may be stationary and certain lower parts thereof may be shiftable upwardly relatively to the remainder of the hood to permit the converter to be rotated or to be moved, on its tracks, to or from a position under the hood, without material interference from the latter. If desired or necessary, the duct **46**, or at least a lower end portion thereof, may also be vertically movable by suitable means.

The lances **36** are of a character quite commonly used in refining steel by an oxygen process. They are in the form of water-cooled pipes (the water-cooling means not being shown) which at their upper ends are connected to a suitable source SO of oxygen under pressure. All three lances are suspended by suitable manually controllable means (not shown) which enable operators to control the introduction of the lances downwardly into the container, to a suitably determined distance above the upper surface **58**, of a molten bath, the upper portion of which is in the form of a layer of floating slag **60**, and the portion underlying the slag is a body of molten iron **62**. The center one of three lances **36** shown in FIG. 1 is shown in chain lines in a position which it occupies when introduced downwardly through at least a portion of duct **46** and through branch **40** of the hood into center opening **30**; while the other two lances are shown as introduced downwardly through suitable openings in branches **38** and **42** of the hood and thence through the openings **32** and **34** of the container. The lower ends or nozzles of the lances **36** may be specially designed to enable oxygen directed downwardly under pressure upon the slag layer **60**, to spread or open up a spot in that layer as, for example, by a swirling action, to enable the oxygen to blow down upon or into the underlying body **62** of molten iron.

FIG. 3 illustrates the effect of tilting the mobile converter after completion of a refining step therein, to draw off the floating slag and underlying metal separately. After completion of the refining step, the converter is first tilted somewhat less than shown in FIG. 3 to cause the slag, alone, to run out through mouth **30**. Thereafter, the converter is rotated toward an upright attitude and the previously plugged tap hole **48** is unplugged. Then, the converter is somewhat gradually tilted downwardly to or slightly beyond its attitude shown in FIG. 3 to cause the refined metal to run out through the tap hole **48** into a suitable receptacle such as a ladle or a mold. Such rotation or tilting, of course, is brought about by properly controlled operation of the motor **50**. The described drawing-off of the slag may be effected at the refining station or at some other point, depending upon the arrangement of the plant's facilities.

The mobile converter shown in FIG. 2 differs from that shown in FIG. 1, chiefly in being provided with a different arrangement of openings in the top of a container **10***a*, in the provision in the latter of lining projections which aid in agitating metal being treated when the container is rocked or oscillated to a limited extent about its horizontal axis, and the provision of suitable means for reversing the rotation of the container to rock or oscillate the latter.

Assuming that the means for rotating the container **10***a* includes a reversible motor such as is indicated at **50** in FIG. 1, it is obvious that an operator could manually operate the switch controls of the motor to rock or oscillate the container **10***a* to the extent desired during oxygen treatment of metal in the container. Such control of the rocking, however, would be rather crude and probably hazardous; therefore, suitable means preferably are employed for automatically operating a reversing switch controlling such a motor or for otherwise automatically rocking the container. One of many possible arrangements for the latter purpose is illustrated in FIG. 2 wherein a snap-type reversing switch **63** is fixed upon a bearing **12***a* with the free end of its switch arm **65** in interfering relation to lugs **67** on an adjacent end portion of the container **10***a*. Wires **69** serve to connect the switch to such a motor.

During operation of a reversible motor such as **50**, the lugs **67** alternately engage and operate switch arm **65** in opposite directions, thereby alternately reversing the operation of the motor to rock the container. The lugs **67** may be fixed upon the container or they may be adjustable thereon to permit adjustment of the degree of rocking movement to be given to the container.

In the embodiment illustrated in FIG. 2, the tank **10***a* is provided with a tap hole **48***a* which is utilized in the manner already described with reference to FIG. 1. The tank **10***a* is provided at its top and toward one end with an oblique lance opening **64**, and toward its other end with an approximately vertical opening **66** for charging, gas-exhausting and evacuating the container. As one of at least several possible variations of this embodiment, oblique lance openings may be provided at opposite ends of the container with a vertical opening, corresponding to opening **66**, located toward the center of the container. During a refining operation, openings **64** and **66** are directly beneath and open respectively into hoods **68** and **68***a*, which lead upwardly respectively into ducts **70** and **70***a* by means of which exhaust gases are carried off to a remote point. The hoods **68** and **68***a* may be of such dimension and shape transversely of the mobile converter as to avoid interference between them and the structures defining the openings **66** and **64** during rocking of the container **10***a* or during movement of the converter on its tracks to and from its position beneath said hoods. Alternatively, and for the same purpose, said hoods may be elevatable, or portions thereof shiftable upwardly to clear said opening structures.

The opening **66** serves as a mouth through which the container **10***a* is charged with hot metal and other substances employed in the refining process, and also for drawing off slag upon suitable tilting of the container and for carrying off gases during processing of the metal in the container. The lance opening **64**, preferably, is only large enough to permit easy introduction of an oxygen injecting lance thereinto. It may be understood that a lance **36***a* may be suspended by suitable positioning means (not shown) and that the upper end of the lance may be connected by flexible tubing (not shown) to a suitable source of oxygen under pressure; the flexible hose and the positioning means being such as to enable an operator to exert such control of the lance as may be necessary to permit the latter to be easily introduced into and removed from the opening **64**. Clamping means (not shown) may advantageously be provided to hold the lance in a desired proper position in the opening **64** during treatment of the metal in the tank.

It may be seen that, in the tank **10***a*, oxygen issuing in force from the lance **36***a* might penetrate the floating layer of slag **60**, although because of the oblique impingement of the oxygen on the slag such penetration might not occur and the oxygen might not find its way to direct contact with or entry into the molten metal underlying the slag. For that reason the tank **10***a*, during refining of metal therein, is rocked back and forth to a limited extent equidistantly from both sides of its upright position by rocking means already described herein, in order to agitate the metal in the container to bring some of the otherwise underlying metal to the surface and into intimacy with the oxygen. The degree of such

rocking is so limited that molten metal or slag may not spill out of the tank through either of the openings **64**, **66** during the refining process.

The mobile converter illustrated in FIG. 2 has a refractory lining **72** which includes projections **74** of refractory material, at least in the lower part or half of said lining. These projections may be formed during installation of the refractory lining by using refractory brick which is specially shaped for the purpose, or by so laying refractory brick used in the lining that a length or a dimension of the brick other than its smallest dimension will extend radially and project inwardly beyond adjacent lining portions. When the tank **10***a* is rocked as described, the projections **74** serve to enhance the agitation of the metal bath in the container. Thus, in utilizing the embodiment of FIG. 2, the oxygen, instead of necessarily being concentrated at one point in the bath, is distributed quite evenly to blanket the bath and achieve a substantial blanketing intimacy of the oxygen with the metal which is brought to the surface by the mentioned agitation.

The handling of the mobile converter of FIG. 2 after completion of the refining of a charge of metal therein, is substantially the same as described with reference to the embodiment of FIG. 1.

FIG. 5 shows three important stations between which hot metal is moved during handling and processing thereof, according to this invention, in either of the two types of converters disclosed herein. At station **1** is a conventional blast furnace **76** from which molten metal is discharged directly into a mobile-car-converter indicated as moving at MC1 to carry the molten metal to a refining station **2** where a hood **44** and lances **36** are located. The metal is oxygen-treated at the latter station while still in the mobile converter, whereafter the same converter, moving as indicated at MC2, transports the treated metal to a teeming station **3** where the refined metal is tapped-off from the converter into a teeming ladle **78** from which, as in prior practice, the refined metal is poured into suitable ingot-molds. Pouring-off of slag may be done at a suitable station (not shown) between stations **2** and **3**.

FIG. 6 differs from FIG. 5 only in showing the mobile converter as transporting refined metal to an ingot-mold **80** into which it is directly discharged from the mobile converter.

The economies which may be realized from use of this invention in a steel plant are many. To mention only certain more important economies, this invention permits elimination of certain facilities hitherto employed, to wit, a charging ladle for receiving unrefined hot metal from a conventional hot-metal car, a charging-ladle crane for carrying the charging ladle to an oxygen furnace and discharging the ladle's contents into said furnace, and the oxygen furnace itself with related equipment which is used only in conjunction with the oxygen furnace. The elimination of such facilities not only saves their cost, but also saves on plant space, equipment maintenance costs and cost of labor ordinarily employed in handling such equipment.

This invention also effects saving in time, increases plant capacity, minimizes time which elapses between discharge of metal from a blast furnace to the commencement of oxygen-processing thereof, thereby assuring adequate retention of heat in the metal, and yields many other advantages which will be obvious to those familiar with steel plant operation.

It should be understood that, within this invention, mobile converters may be different in some respects from those disclosed herein, and that handling and refining of molten metals may be conducted somewhat differently than specified herein. Thus, for example, a greater or lesser number of lances and openings in the container may be provided for the stated purposes; the tap hole and other apparatus may be so designed and arranged as to permit metal to be charged directly from the container into ingot-molds; and suitable safety means (not shown) may be provided for readily stopping rotary and/or rocking motion of the container. For these reasons, this invention should not be limited to the precise embodiments and variations disclosed herein, but should be considered as broad as may be permitted by the language of the following claims.

We claim:

1. Apparatus for oxygen refining of metal comprising in combination, a track, a metal-refining station at an intermediate point of said track, and a hot-metal car carried by said track and movable therealong between said station and other stations at distal points of said track in opposite directions from said metal-refining station; said car including a horizontal, elongate container, rockable about a horizontal, longitudinal axis and having a first top opening adapted for the insertion of an oxygen-conveying lance thereinto and a second top opening adapted for the exhaustion of gases from said container, and said metal-refining station including an oxygen-conveying lance adapted for insertion into said first top opening.

2. A combination according to claim 1, further including a hood having a portion shiftable between a lowered position in close association with said second top opening and a raised position sufficiently clear of upper portions of the container to enable the container to be rotated about said axis and to enable the car to be moved on said track to and from the location of said hood without material interference from the latter.

3. A combination according to claim 1, wherein said car includes mechanical means for rocking said container automatically to agitate molten metal therein during injection of oxygen into the container through said lance.

4. A combination according to claim 3, said container having inside projections enhancing such agitation of the molten metal.

5. A combination according to claim 1, one of said openings being of sufficient size to permit introduction of metal therethrough into said container and discharge of metal therethrough from said container, and the latter being rotatable about said axis to bring said opening to a lowered position to cause molten metal to flow therethrough from the container.

6. A combination according to claim 1, said first top opening being located toward one end of the container and extending obliquely into the latter to receive said lance thereinto in position to inject oxygen into the container obliquely upon molten metal therein and toward the opposite end of the container; and said second top opening being located toward the opposite end of the container.

7. A hot-metal car comprising a horizontal, elongate container, rockable about a horizontal, longitudinal axis, trucks at opposite ends of the container adapting the latter for movement along a track, said container being provided with a lance-receiving top opening toward one end thereof and a gas-exhausting, top opening at the opposite end thereof, means carried on one of said trucks and coacting with said container to rock the latter automatically about said axis, and said container having a lining of refractory material including radially inwardly extending rigid projections adapted to agitate molten metal in said container when the latter is rocked.

8. Apparatus for oxygen refining of metal comprising in combination, a length of track, a vehicle adapted to move along and under the guidance of said track, said vehicle including a container for holding a charge of molten metal therein and the container being provided with a top opening, charging means at a charging station at said track adapted for the charging of molten metal into said container, a processing station at said track, distal from said charging station and including a movable oxygen-emitting lance which is insertable into said top opening when said vehicle is at said processing station to inject oxygen into a charge of molten metal in the vehicle's

container and is removable from said opening to permit free movement of said vehicle from the processing station, and a discharging station at said track, distal from both said charging station and said processing station, and including means adapted for the reception of molten metal discharged from said container.

9. Apparatus according to claim 8, including a plurality of said vehicles each of which is adapted to coact with said track and with said stations in the manner set forth in said claim.

References Cited in the file of this patent

UNITED STATES PATENTS

290,075	Leveque	Dec. 11, 1883
810,301	Philp	Jan. 16, 1906
2,290,961	Heuer	July 28, 1942
2,708,572	Hudson et al.	May 17, 1955
2,851,351	Cuscoleca et al.	Sept. 9, 1958
2,886,308	Boynton	May 12, 1959
2,900,249	Kerlie	Aug. 18, 1959