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Meyers

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[54] **SLAG SKIMMING APPARATUS**

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[52] **U.S. Cl.** **266/37**, 266/38

[51] **Int. Cl.** **F27d 3/14**

[58] **Field of Search** ..... 266/37, 38, 39, 1 R

[56] **References Cited**

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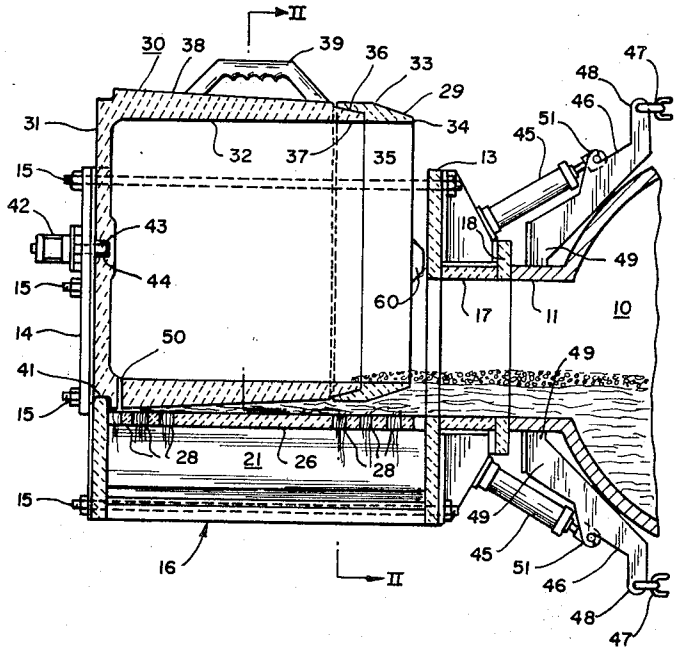
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Attorney, Agent, or Firm—Buell, Blenko & Ziesenheim

[57] **ABSTRACT**

Apparatus for skimming slag from molten iron poured from a submarine ladle or the like is comprehended in a frame attachable to a submarine ladle in communication with the port thereof. The frame holds a diversion trough, into an end of which the iron is poured when the ladle is tilted, the diversion trough having perforations in its bottom, a collecting trough positioned below the diversion trough so as to receive the iron therefrom and direct it to a transfer ladle, and an open-end slag collecting basket positioned in the diversion trough having a skimmer lip at its open end. The perforations in the diversion trough retard the flow of iron sufficiently to maintain a dynamic pool of iron therein, which buoys the open end of the slag collecting basket so as to maintain its skimmer lip at a skimming level.

20 Claims, 5 Drawing Figures



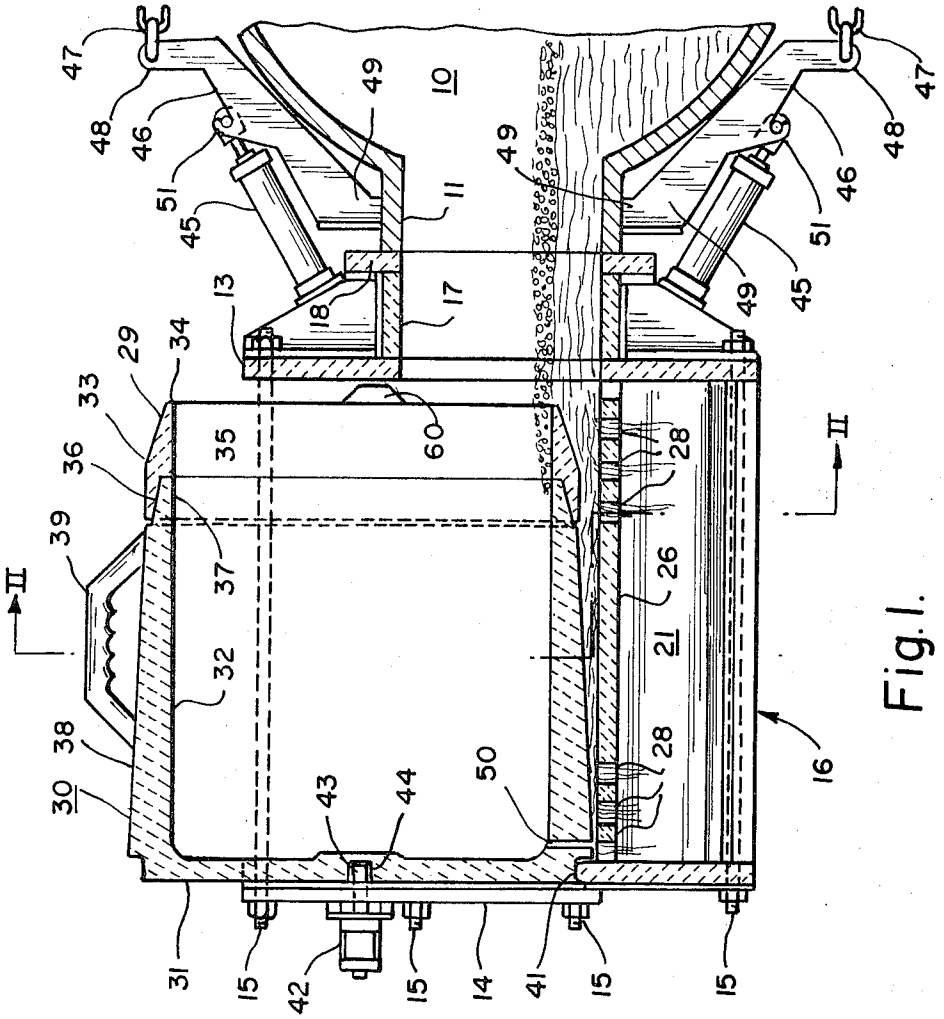

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Fig. 1.

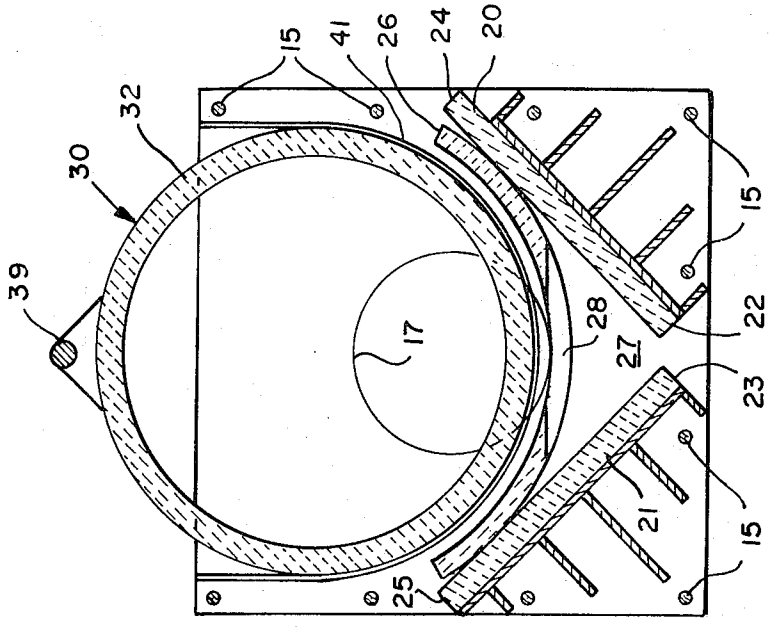

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Fig. 2.

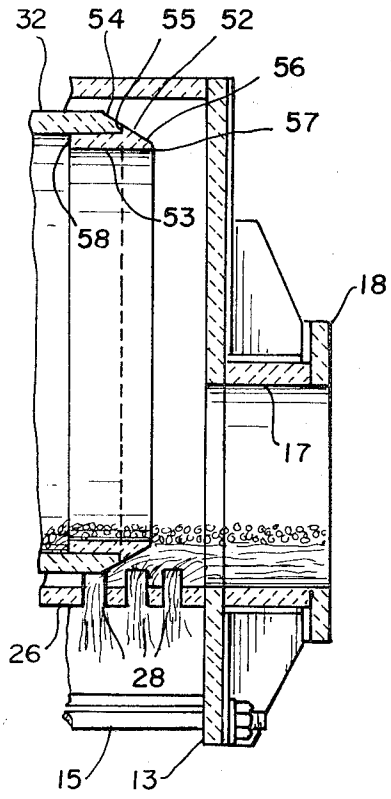


Fig. 3.

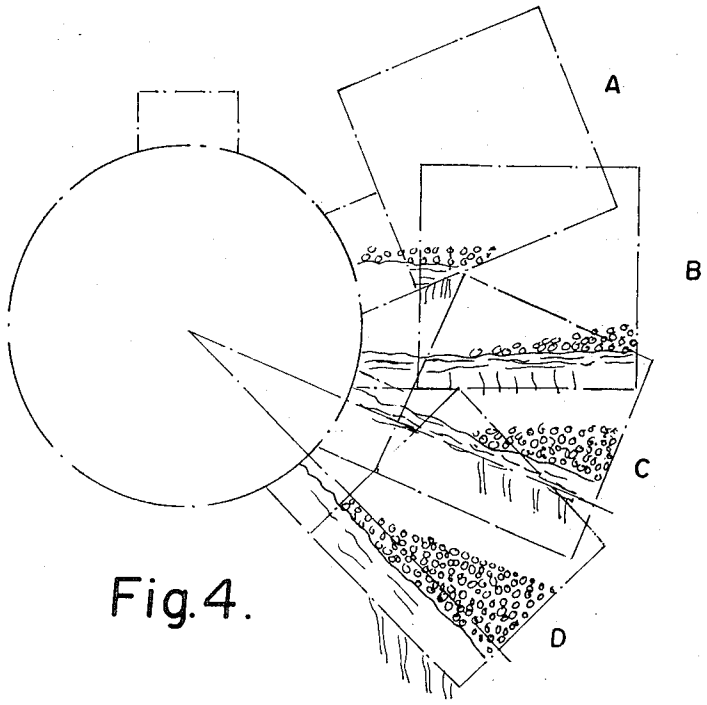


Fig. 4.

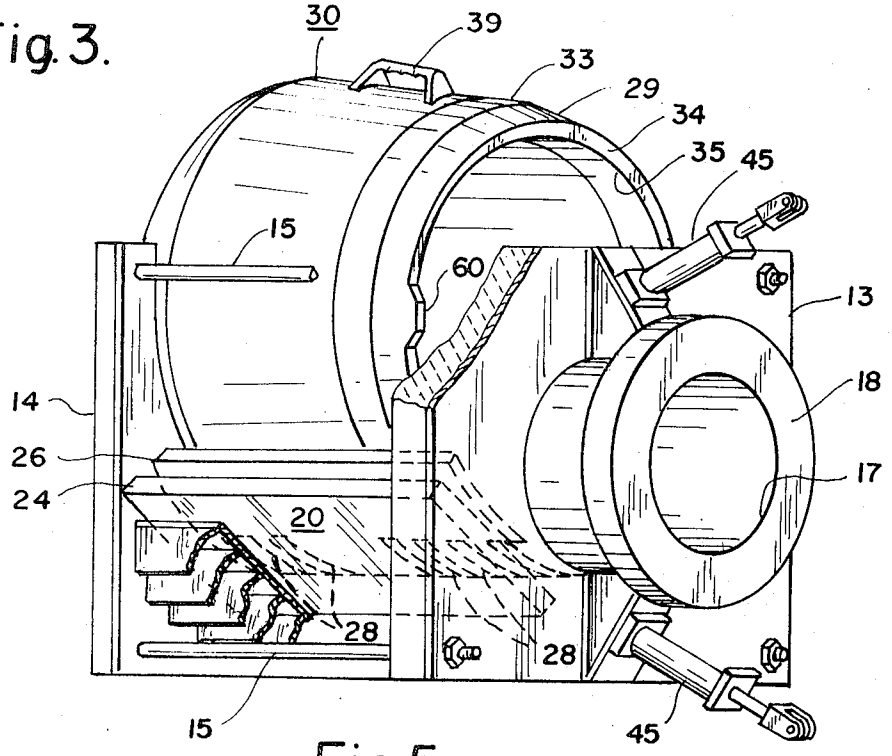


Fig. 5.

SLAG SKIMMING APPARATUS

This invention relates to apparatus for skimming slag from a stream of molten metal. It is more particularly concerned with apparatus of this type adapted for use with a submarine or torpedo ladle, so-called.

My invention is particularly adapted to the skimming of slag from the surface of a stream of molten blast furnace iron and will be described hereinafter in that context. My apparatus is suitable, however, for skimming slag from other metals, or for skimming any lighter weight liquid from a stream of a heavier liquid.

Iron for steel making is smelted from its ores in blast furnaces, which now are built in capacities approaching 5,000 tons per 24 hour day. These furnaces are continuously charged, but are tapped at intervals of a few hours so that each tap represents several hundred tons of iron. The slag resulting from this smelting is lighter than the iron and floats thereon. Although it is flushed off from the blast furnace before each tap, some slag always remains on the iron and is tapped out with the iron into the iron runner. These runners are provided with slag skimming devices which divert most of this slag but some of it is carried into the iron ladle.

The iron ladles transport iron to the steelmaking furnaces. It is quite common to use submarine or torpedo ladles, so-called, for this purpose, as they are made in large capacities and retain the heat of the iron better than open-top ladles. A submarine ladle, as the name implies, is an elongated cylindrical structure carried on railroad trucks, rotatable about its axis. It has a covered port through which it is charged and through which, when it is rotated, it pours out its contents. Submarine ladles normally pour their contents into transfer ladles which charge the furnace with the iron and any slag which floats thereon. Iron ladles are conventionally lip-pouring ladles which do not separate slag from iron.

It is not desirable to charge blast furnace slag into steelmaking furnaces. Blast furnace slag is very effective in desulfurizing iron in the blast furnace, and is therefore high in sulfur. Under some furnace operating conditions, blast furnace slag is acid and is therefor detrimental to the basic linings of all tonnage steelmaking furnaces. Teapot spout ladles are sometimes used to separate iron from blast furnace slag, but the slag remaining in such a ladle must be cleaned out. Prior to my invention to be described, no apparatus was known which was fully satisfactory in separating slag from iron poured from a ladle.

It is an object of my invention to provide apparatus auxiliary to a submarine ladle adapted to skim slag from the stream of metal poured from the ladle. It is another object to provide such apparatus which segregates the slag in a separate removable container. It is another object to provide such apparatus which is detachably affixed to the ladle. It is still another object to provide such apparatus which utilizes the buoyancy forces of the flowing stream of metal to facilitate the skimming of slag therefrom. Other objects of my invention will appear in the course of the description thereof which follows.

My apparatus comprises a frame which is rigidly attached to a submarine ladle by a chain or other flexible means passed around the ladle and held tight. The frame supports an intermediate trough into which the iron is poured when the ladle is tilted and from which the iron escapes through openings in the trough bottom, sized so that a dynamic pool of iron is maintained in the trough. In this pool is positioned an open-ended slag-collecting basket having a skimmer lip at its open end which skims the slag from the metal into the basket. The metal flows below the basket and buoys or partially floats it so that the skimmer is positioned at the proper skimming level. The slag-collecting basket is detachable and removable.

An embodiment of my invention presently preferred by me is illustrated in the attached figures, to which reference is now made.

FIG. 1 is an elevation in cross-section through apparatus of my invention attached to a submarine ladle;

FIG. 2 is a cross-section through the apparatus of FIG. 1 taken on the plane II—II thereof;

FIG. 3 is a detail showing a modification of a portion of my apparatus;

FIG. 4 is a schematic showing the various positions assumed by my apparatus as the submarine ladle is rotated to pour out its contents; and

FIG. 5 is a perspective of my apparatus.

A submarine ladle **10** of circular cross-section has a loading and pouring port surrounded by an upstanding circular collar **11.** My apparatus is comprehended in a frame **16** which comprises a front end piece **13** and rear end piece **14** which are parallel to each other and are spaced apart by tie rods **15—15.** Front end piece **13** is formed with a port matching that of ladle **10,** which port is surrounded by a circular collar **17** terminating in a flanged open end **18.** This flanged opening **18** is adapted to fit against collar **11** of submarine ladle **10.**

Between end pieces **13** and **14** near their lower portions are positioned refractory surfaced partitions **20** and **21,** oppositely inclined so that their lower edges **22** and **23,** respectively, define a narrow opening extending from end piece **13** to end piece **14.** Upper edges **24** and **25,** respectively, of partitions **20** and **21** are spaced apart the full width of end pieces **13** and **14** so that those partitions form an open bottom V-shaped trough **27,** which I denominate a collecting trough. Supported by upper portions **24** and **25** of partitions **20** and **21,** respectively, and extending from end piece **13** to end piece **14** is a refractory surfaced arcuate concave-up trough **26** which I denominate a diversion trough. The lowermost portion of diversion trough **26** is flush with or slightly below the lowermost point of collar **17.** This diversion trough is perforated through its bottom portion with slots **28—28** so that molten metal poured into diversion trough **26** through collar **17** flows out through slots **28—28** into collecting trough **27** and through the open bottom thereof.

Within diversion trough **26** is positioned a refractory lined slag receptacle or basket **30.** This basket has a circular closed end **31** adjacent frame end piece **14** and a wall **32** which extends to a region short of end piece **13.** The inside surface of wall **32** is cylindrical but the outside surface **38** is a section of a cone having a greater diameter at its closed end **31** than at its other end. Basket **30** is open at this end and is there fitted with a ring-shaped skimmer **33** which around its outer surface **29** tapers to a relatively sharp lip **34** adjacent end piece **13.** The inside surface **35** of skimmer **33** is cylindrical and is of the same diameter as the cylindrical inside surface of wall **32.** The back end **36** of skimmer **33** is formed as a tapered socket into which fits a

tapered nose 37 formed on the front end of cylindrical wall 32.

Wall 32 of basket 30 is provided with a bail 39 adapted to receive a crane hook. Circular end 31 is supported for tilting movement therein by a semi-circular ledge or shoulder 41 formed in end wall 14. That wall also supports an air cylinder 42 on its rear face which is adapted to move a pin 43 through wall 14 in and out of a recess 44 with clearance, formed at the center of circular end 31 of basket 30. A drain opening 50 is provided in wall 32 adjacent end 31 and opposite bail 39. A stop 60 projects from skimmer lip 34 90° from bail 39, and a like stop 90° in the other direction, for a purpose to be described.

At the front end of frame 16 adjacent flange 18 are mounted like upper and lower fluid-operated cylinders 45—45 which are detachably connected to like upper and lower saddles 46—46. The outside ends 48—48 of those saddles are connected to the two ends of chain 47 which encircles the shell of submarine ladle 10. The inside ends 49—49 bear against collar 11. Each cylinder 45 is detachably connected to a saddle 46 by a hook 51 intermediate ends 48 and 49.

In the embodiment of FIG. 3, a ring-shaped skimmer 52 is fitted to the open end of cylindrical wall 32 of basket 30. Skimmer 52 is formed with a cylindrical sleeve 53 which extends inside wall 32. The open end of wall 32 is bevelled at 54 to fit against a shoulder 55 of skimmer 52 positioned intermediate its ends. The outside surface of skimmer 52 between shoulder 55 and its lip 57 is also bevelled to form a prolongation of bevel 54. The inside end 58 of skimmer 52 thus forms a ring-shaped dam at the open end of wall 32.

The operation of my apparatus will be explained with reference to the foregoing description and the figures above mentioned.

My apparatus is positioned against a submarine ladle so that flange 18 abuts the collar 11 surrounding the port of the ladle. My apparatus is held in place by passing chain 47 around the shell of the ladle 10 and pulling it tight by admitting fluid under pressure to cylinders 45—45. The pull exerted by these cylinders on the outer ends 48—48 of the saddles 46—46 also causes their inner ends 49—49 to exert pressure on the collar 11, thus aligning it with collar 17 and flange 18. This attachment is effected with the ladle rotated so that its port and surrounding collar 11 are upright, and my apparatus may be suspended from a crane or otherwise supported to facilitate attachment.

The submarine ladle is then rotated about its axis a few degrees to permit iron to flow into my apparatus through the port surrounded by collar 17. The relative positions of my apparatus and the ladle at this stage are those marked A of FIG. 4. Initially, the front end of basket 30 rests in diversion trough 26 and most of the iron coming from the ladle flows out of diversion trough 26 through the slots 28 near the front end piece 13. This flow of iron passing largely beneath the outer surface 29 of skimmer 33 tends to lift the skimmer and basket 30 at that end so that the lip 34 of the skimmer 33 is automatically positioned at the interface between the iron and the slag floating thereon. The closed end 31 of basket 30 tilts on shoulder 41 of end piece 14. The length of collar 17 is such that together with collar 11, it positions diversion trough 26 far enough from the ladle that iron flowing out of the open bottom of collecting trough 27 clears the shell of the submarine ladle 10. A transfer ladle, not shown, is positioned below my apparatus to receive this iron.

As the iron level in the submarine ladle falls the ladle is rotated further so as to move my apparatus into the position marked B in FIG. 4. More of the iron flows through the tapered gap between outer surface 38 of basket 30 and diversion trough 26 and out of the slots at the back end of diversion trough 26 exerting buoyant forces on basket 30 along a greater portion of its length. This tends to align inner surface 35 tangent to the slag-metal interface plane so that slag will flow toward the closed end 31 of basket 30. Continued rotation of the submarine ladle moves my apparatus into position C and then into position D of FIG. 4, in which the bulk of the iron flows out of diversion trough 26 through the slots 28 near the rear end piece 14. However, the rear end 31 of basket 30 is restrained by pin 43 from rising, which limits any tendency for lip 34 of skimmer 33 to be moved below the slag-metal interface. The stops 60 prevent basket 30 from sliding out of place. In its lower position, above mentioned, basket 30 of my apparatus holds larger amounts of slag. Some iron, of course, flows into the basket with the slag but it, being heavier than the slag, escapes through drain 50 adjacent end wall 31.

Slag basket 30 need not be large enough to hold all the slag in the submarine ladle. A basket full of slag is easily removed from my apparatus by tilting the ladle back far enough to cut off the flow of iron therefrom, withdrawing pin 43 from its socket 44 in end wall 31 of basket 30, and lifting basket 30 out of frame 16 by a crane hook through bail 39. An empty basket is then dropped into place, and the submarine ladle again tilted down to pouring position.

My apparatus is easily disconnected from the ladle after it has been emptied. Pressure fluid is cut off from cylinders 45—45, allowing chain 47 to slacken and relieving the pressure of the saddles 46—46 on collar 11. One or both of cylinders 45—45 is disconnected from its saddle 46 and hook 51 and chain 47 pulled clear of ladle 10.

It is not essential that my apparatus be provided with fluid operated cylinders 45 to attach it to a submarine ladle. The chain 47 may be fitted with a turnbuckle or other known form of take-up for this purpose. If permissible, the saddles 46 or similar devices may be welded or otherwise permanently attached to the submarine ladle and if this is done no chain is needed.

Although I find it convenient to make basket 30 circular in cross-section and diversion trough 26 an arc of a circle in cross-section, it is not necessary that these elements take those shapes, nor is it essential that other elements of my apparatus have the precise configuration of my preferred embodiment.

In the foregoing specification I have described a presently preferred embodiment of this invention, however, it will be understood that this invention can be otherwise embodied within the scope of the following claims.

I claim:

1. Apparatus for separating floating slag from a stream of molten metal comprising means for forming a dynamic pool of the metal, a slag receptacle having an upstream open end and a downstream closed end, and means positioning the receptacle so that its open end is buoyed by the dynamic pool and so that it retains slag which flows into it.

2. Apparatus of claim 1 in which the bottom of the slag receptacle is arcuate in cross-section.

3. Apparatus of claim 1 in which the slag receptacle is an open ended cylinder.

4. Apparatus of claim 1 in which the inner wall surface of the slag receptacle is cylindrical and the wall is thicker at the closed end of the receptacle than at its open end.

5. Apparatus of claim 1 including a relatively sharp lipped skimmer affixed to the open end of the slag receptacle arranged to skim floating slag off the molten iron into the slag receptacle.

6. Apparatus of claim 5 in which the underside of the skimmer is inclined away and downstream from its lip so as to direct molten metal beneath the slag receptacle.

7. Apparatus of claim 5 in which the skimmer is detachably affixed to the slag receptacle.

8. Apparatus of claim 5 in which the face of the skimmer adjacent the inside surface of the slag receptacle is flush therewith.

9. Apparatus of claim 5 in which the face of the skimmer adjacent the inside surface of the slag receptacle is higher than that inside surface so as to form a dam for slag within the slag receptacle.

10. Apparatus of claim 1 in which the means for forming a dynamic pool comprise a diversion trough into an end of which metal is poured and openings of restricted area extending through the bottom of the diversion trough so as to retard the flow of metal therethrough.

11. Apparatus of claim 10 in which the bottom of the diversion trough is arcuate in cross-section.

12. Apparatus of claim 10 including a collecting trough positioned below the diversion trough to receive metal which flows through the openings therein.

13. Apparatus of claim 12 including a frame in which the diversion trough and the collecting trough are fixed and means movably positioning the slag receptacle in the frame.

14. Apparatus of claim 13 in which the means movably positioning the slag receptacle in the frame comprise a ledge which supports the closed end of the slag receptacle so as to permit the slag receptacle to tilt on the ledge.

15. Apparatus of claim 13 including means affixed to the frame for releasably retaining the closed end of the slag receptacle therein.

16. Apparatus of claim 13 including means for releasably clamping the frame to a ladle so that when the ladle is tilted iron poured therefrom flows into the diversion trough.

17. Apparatus of claim 16 in which the means for releasably clamping the frame to a ladle include a chain surrounding the ladle connected at its ends to the frame.

18. Apparatus of claim 16 in which the means for releasably clamping the frame to a ladle include means for drawing the frame against the ladle.

19. Apparatus of claim 18 in which the means for drawing the frame against the ladle comprise fluid cylinder means.

20. Apparatus of claim 18 including saddle means attached to the means for drawing the frame against the ladle and disposed to bear on the ladle so that the operation of the means for drawing the frame against the ladle increases the bearing pressure of the ladle means on the ladle.

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