United States Patent

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[73] Assignee The British Iron and Steel Research Association
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[31] 42550/66

[54] **REFINING OF FERROUS METALS**
8 Claims, 6 Drawing Figs.

[52] U.S. Cl. 266/34, 75/46; 239/420, 239/422
[51] Int. Cl. C21c 7/00
[50] Field of Search 266/34, 35, 41, 34V, 34.1, 38, 34.2, 34PP, 34Pt, 34T, 37, 39; 75/51, 52, 54, 59, 60, 46, 93; 164/66, 133, 281; 239/420, 422, 291, 292

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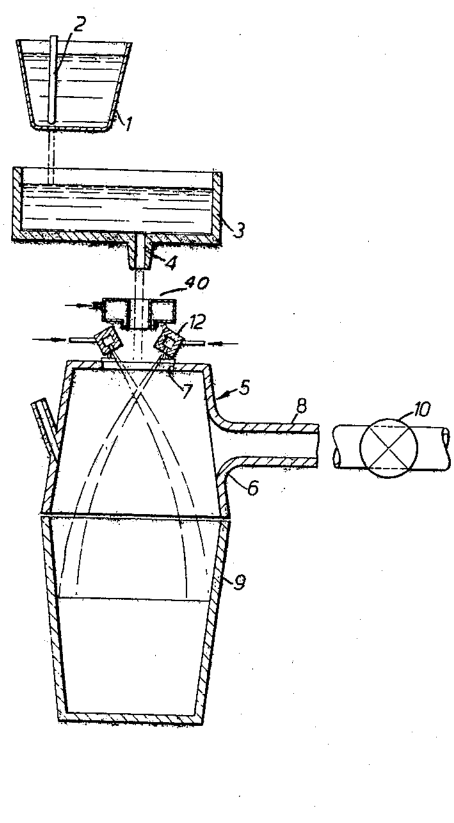
ABSTRACT: Apparatus for refining molten metal including angularly adjustable nozzles for oxidizing gas to shatter a stream of molten metal.



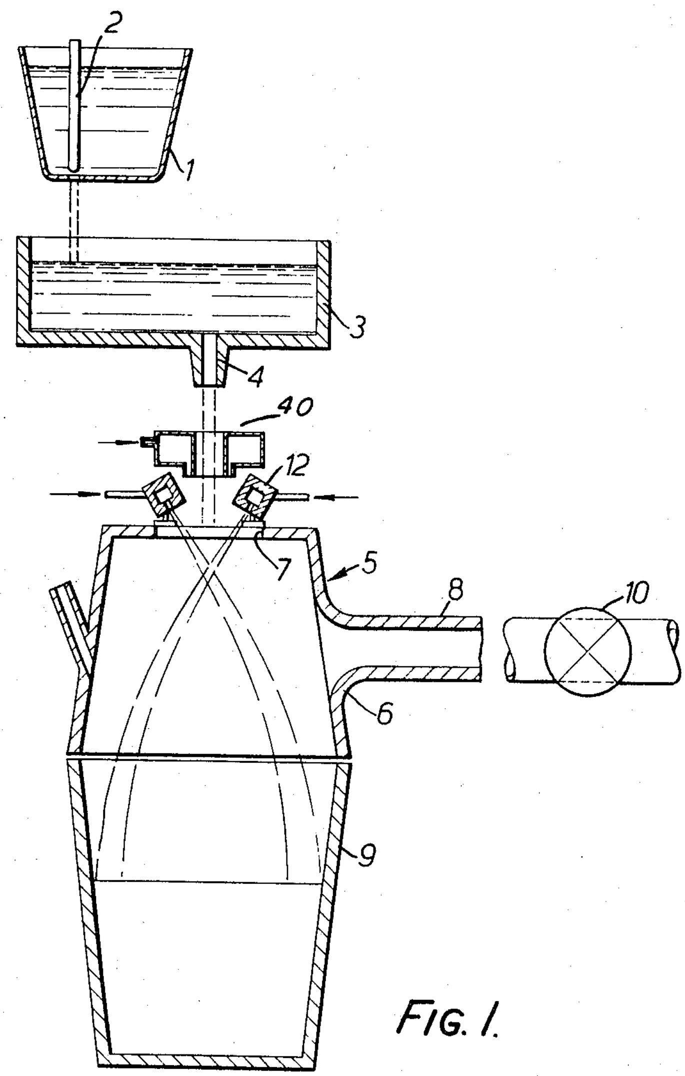


FIG. 1.

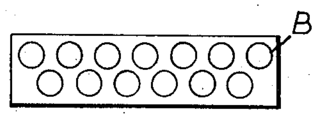


FIG. 2.

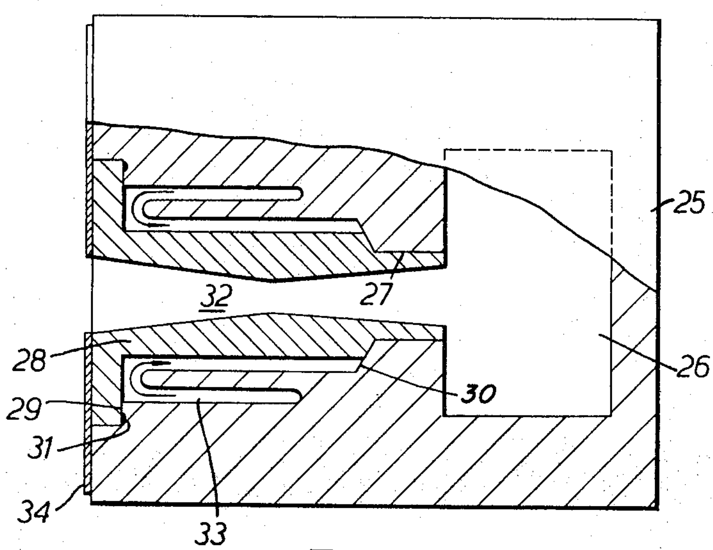


FIG. 4

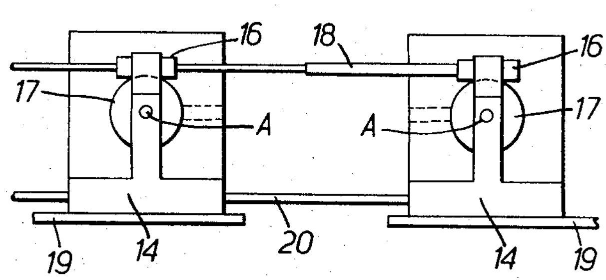


FIG. 3

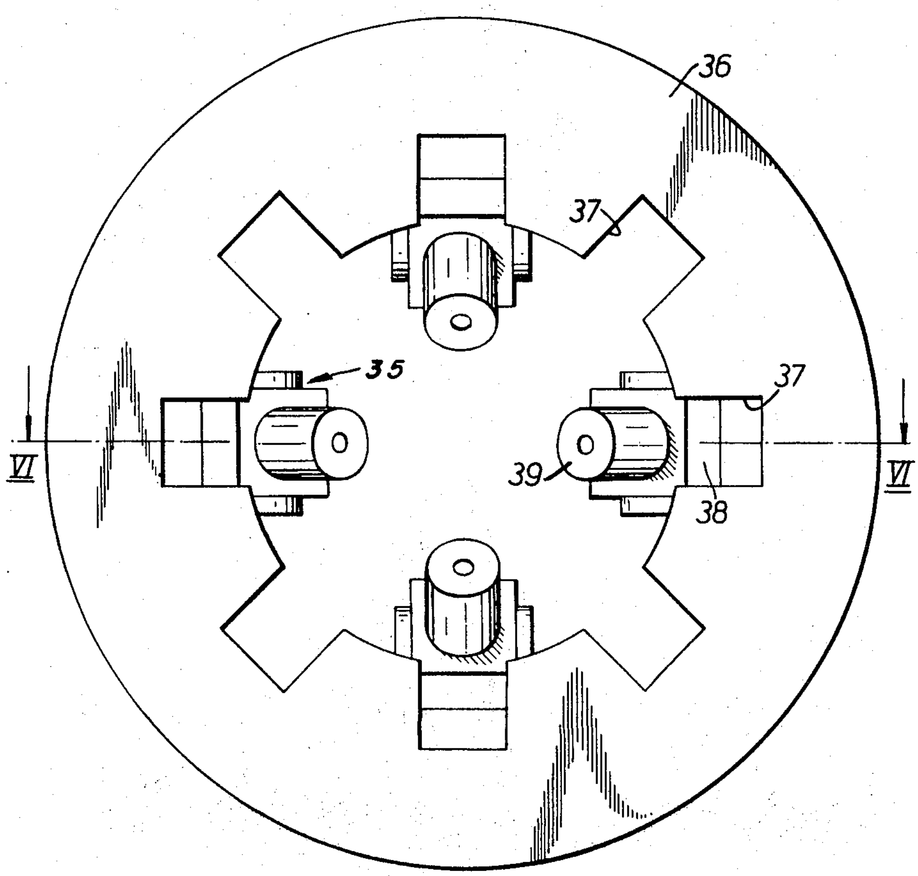


FIG. 5.

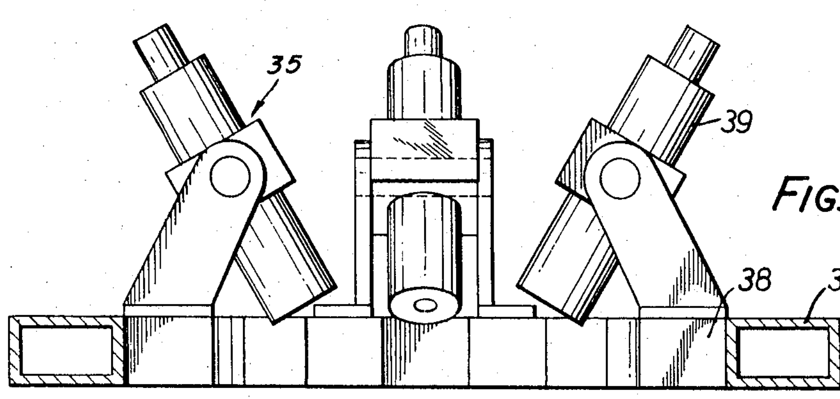


FIG. 6.

REFINING OF FERROUS METALS

This invention is concerned with improvements in and relating to apparatus for refining metal.

It has been proposed to remove certain impurities from iron by oxidation of such impurities and one form of apparatus for carrying out that process comprises a tundish from which a stream of molten metal falls into a refining vessel. The freely falling stream passes gas discharge nozzles from which jets of oxidizing gas are emitted, such jets shattering the molten metal stream, the resulting particulate metal reacting with the gas and the substantially refined metal collecting in the bottom of the vessel.

The flow of metal in such apparatus will be relatively constant as between successive pours, but the degree or kind of the impurities to be removed may vary from pour to pour. For example, it may be desired to remove carbon and silicon which would require a higher oxidizing gas flow rate for a given metal flow rate than would removal of the silicon alone. Different flow rates of oxidizing gas will result in varying degrees of shatter of the metal for a given metal flow rate and hence a varying exposure of metal to the action of the gas. Additionally it is desirable to keep the molten particulate metal away from the vessel wall since the particulate metal is highly erosive.

According to the present invention there is provided apparatus for refining molten metal comprising a container for the metal, a metal discharge device, communicating with the container and a vessel below the device, to discharge a freely falling flow of metal in the vessel, and a plurality of gas discharge nozzles adjacent the path of the freely falling flow, such gas discharge nozzles being directed at the said path and being angularly adjustable to vary the angle of intersection of the jets and the path.

By means of the angular adjustment of the nozzles, the angle of intersection can be selected to provide that degree of shatter to expose an adequate surface area of the metal to the gas whether the gas flow rate and hence gas momentum is at the lower end of the scale or at the upper end when wide scatter is undesirable since this would rapidly erode the vessel. If desired the distance of the nozzles from the flow path may also be varied.

In order that the present invention may be well understood there will now be described an embodiment thereof, given by way of example only, reference being had to the accompanying drawings in which:

FIG. 1 is a diagrammatic elevation of apparatus for refining iron;

FIG. 2 is a plan view of a metal discharge device;

FIG. 3 is a side elevation of a pair of gas discharge nozzle blocks for a metal flow produced by the discharge device of FIG. 2;

FIG. 4 is a cross section of a gas discharge nozzle block;

FIG. 5 is an underneath view of gas discharge devices for shattering a cylindrical stream, and

FIG. 6 is a sectional elevation of the device on the line VI–VI of FIG. 5 shown upright

Referring to FIG. 1 the refining apparatus shown is particularly intended for refining crude iron and comprises a transfer ladle 1 having a flow control stopper 2 to control molten metal flow to a tundish 3 having a refractory outlet nozzle 4.

Beneath the tundish is a reaction vessel 5 which comprises a cover or hood portion 6, having a central aperture 7 and a gas takeoff 8, and a receptacle portion 9 beneath the hood. An extractor fan 10 is located in the gas takeoff, which may have a plurality of inlets symmetrically placed about the hood portion, only one being shown.

The outlet nozzle 4 may have a rectangular cross section normal to flow to provide a wide thin metal flow having a high surface to volume ratio per unit length of flow. Alternatively the nozzle cross section may be scallop edged, formed for example by a plurality of bores on centers spaced by less than the diameter of the bores, to give the same flow characteristics. In another arrangement the thin wide metal flow may

be achieved by a plurality of individual cylindrical bores B set close together as shown in FIG. 2 to give a total flow which has a high surface to volume ratio.

For such forms of metal flow a gas discharge device is provided on the hood of the vessel comprising a pair of distributor blocks 12 each having one or more gas discharge nozzles to give a gas jet or jets which span substantially a wide face of the metal flow. Each block is angularly adjustable to vary the angle of intersection of the gas discharged from it with the path of metal flow.

A particular embodiment of mounting a pair of distributor blocks is shown in FIG. 4 and a cross section through one embodiment of block is shown in FIG. 3. Each block in FIG. 4 is mounted in bearings in a pair of supports 14 so as to be angularly adjustable about axis A, for which purpose a worm 16 is provided on two of the supports engaging a wormwheel 17 fast with the associated block, a drive shaft 18 being provided to both worms to effect simultaneous equal angular adjustment. Additionally the supports are slidably mounted on guides 19, a support of each block including a threaded bore engaged by a suitably threaded drive shaft 20 rotation of which will adjust the spacing of the blocks. To cater for the relative movements of the supports, the drive shaft 18 is telescopic.

The block shown in FIG. 3 comprises a mild steel body 25 defining a distributor chamber 26 communicating with one face of the block by way of one or more passages 27. A suitable coupling is provided to couple the chamber to a source of oxidizing gas. The passage 27 (or each passage 27, as the case may be) receives an insert 28, which abuts the shoulders 29, 30. These shoulders may have recesses for seals and such a seal in shoulder 29 is referenced 31. The insert is secured by means (not shown), and defines one or more ducts 32 having a convergent/divergent cross section as shown. Since the blocks will be adjacent the high temperature metal, a coolant liquid flow path 33 is provided, defined by the insert and the block. Furthermore the insert face directed toward the metal path may be covered by a plate 34 to protect the insert from splash.

When refining is to be carried out the oxygen nozzle inserts 28 and the angular setting of the oxygen nozzle blocks will be selected to give, for the particular molten stream flow rate, the necessary momentum to that oxygen flow required to refine the molten stream so that the molten stream is shattered and an included prism angle is obtained suited to the vessel which is to receive the refined molten material. Thus, for a given molten stream a higher oxygen flow rate is required to remove carbon and silicon together than to remove silicon alone and, therefore, the velocity of the oxygen to achieve the momentum to break up that molten stream will be less, for a given angle of intersection, than that required for the lower oxygen flow rate.

For lower metal flow rates a cylindrical metal stream can be adequately shattered by the oxygen required for refining purposes. To deal with a cylindrical flow a plurality of nozzle blocks 35 may be mounted round the flow path at less than 180° spacing as diagrammatically shown in FIGS. 5 and 6.

The device shown in those FIGS. comprises a support ring 36 defining eight recesses 37. Each is intended as a guideway for a carriage 38, only four being shown, to support its carriage for radial movement relative to a metal flow path extending coaxially through the ring. Each carriage pivotally supports a nozzle body 39 which will have an individual connection to a gas supply. The choice of number of nozzles will depend upon the circumstances, but with four or eight mounted equispaced, jets of gas will converge at a selected angle from a selected distance on to the metal flow. The ring may be hollow as shown for cooling purposes.

A flux discharge device 40 is mounted above the gas discharge nozzles, as shown in FIG. 1 to provide a curtain of flux falling between the metal stream and each gas nozzle. In the case of a wide thin stream a pair of curtains is provided while in the case of a cylindrical or like stream an annular flux manifold may dispense through an annular outlet a continuous curtain of flux surrounding the stream.

Operation of the refining process will be understood more fully by reference to copending applications Nos. 640,121, Pat. No. 3,542,351 and 640,122 filed May 22, 1967 by Malvern John Rhyddetch having an assignee common to the instant application.

I claim:

1. Apparatus for treating molten metal to remove certain impurities comprising a container for the metal, a metal discharge device communicating with the container for discharging therefrom a freely falling vertical stream, a vessel below the device for receiving said stream of molten metal, and gas discharge nozzle means having a plurality of discharge orifices for discharging streams of gas capable of reacting with said molten metal into said metal stream with a momentum sufficient to shatter said metal stream into particles, the gas discharge means being angularly adjustable in a vertical plane to vary the angle of intersection in that plan between the gas streams which will issue from said discharge orifices and the path of said metal stream to provide a desired degree of shatter.

2. Apparatus according to claim 1 in which said nozzle means comprises gas discharge nozzles mounted to give two streams of gas downwardly convergent on the path of said metal stream from opposite sides thereof.

3. Apparatus according to claim 1 in which said nozzle means comprise a plurality of gas discharge nozzles located at less than 180° angular displacement about the path of said metal stream, the gas discharge axes of the nozzle means being downwardly convergent.

4. Apparatus according to claim 1 in which the gas discharge nozzle means is adjustable toward and away from the path of said metal stream.

5. Apparatus for treating molten metal to remove certain impurities comprising a container for the metal, a metal discharge device communicating with the container for discharging therefrom a freely falling vertical stream, a vessel below the device for receiving said stream of molten metal, and gas discharge nozzle means having a plurality of discharge orifices for discharging streams of gas capable of reacting with said molten metal into said metal stream with a momentum sufficient to shatter said metal stream into particles, the gas discharge means being angularly adjustable in a vertical plane to vary the angle of intersection in that plane between the gas streams which will issue from said discharge orifices and the path of said metal stream to provide a desired degree of shatter, said gas discharge nozzle means comprising a block for each discharge orifice defining a passage communicating with a gas distribution chamber, and an insert removably received by each passage, each insert having a bore which terminates at a discharge orifice of said nozzle means.

6. Apparatus according to claim 5 in which each block is rotatably mounted on support means, a drive coupling being provided between the blocks and a drive shaft to adjust each block about its axis of rotation which is parallel to the face of the block to which the passage extends.

7. Apparatus according to claim 5 in which each block is rotatably mounted on support means, and comprising a drive coupling between the blocks and a drive shaft to adjust each block about its axis of rotation which is parallel to the face of the block to which the passage extends, and a shaft which is threadedly received by the support means of each block, the threaded engagement of the shaft and the support means of the blocks being such that on rotation of the shaft the spacing of the support means of the blocks is adjusted.

8. Apparatus according to claim 5 in which each block is mounted for horizontal movement relative to the path of said metal stream.