

March 22, 1960

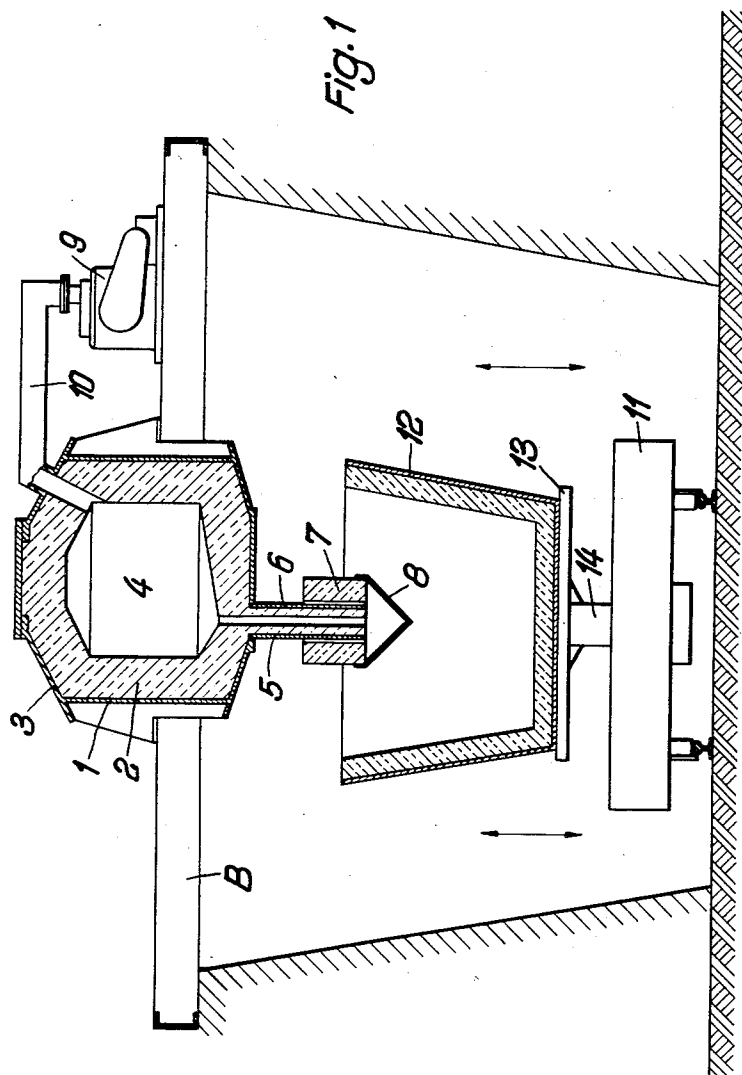
F. HARDERS

2,929,704

METHODS OF AND APPARATUS FOR DEGASIFYING METALS

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5 Sheets-Sheet 1



Inventor:

FRITZ HARDERS

BY

Thomas, Weisman & Russell
ATTORNEYS

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F. HARDERS

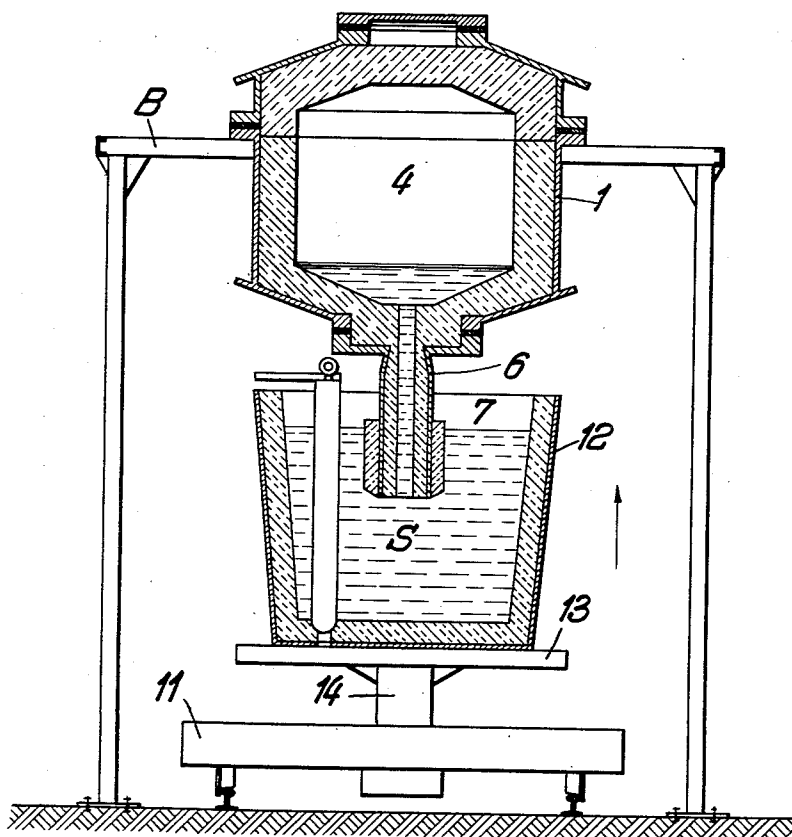
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METHODS OF AND APPARATUS FOR DEGASIFYING METALS

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Fig. 2



Inventor:

FRITZ HARDERS

BY

Thomas, Weisman & Russell
ATTORNEYS

March 22, 1960

F. HARDERS

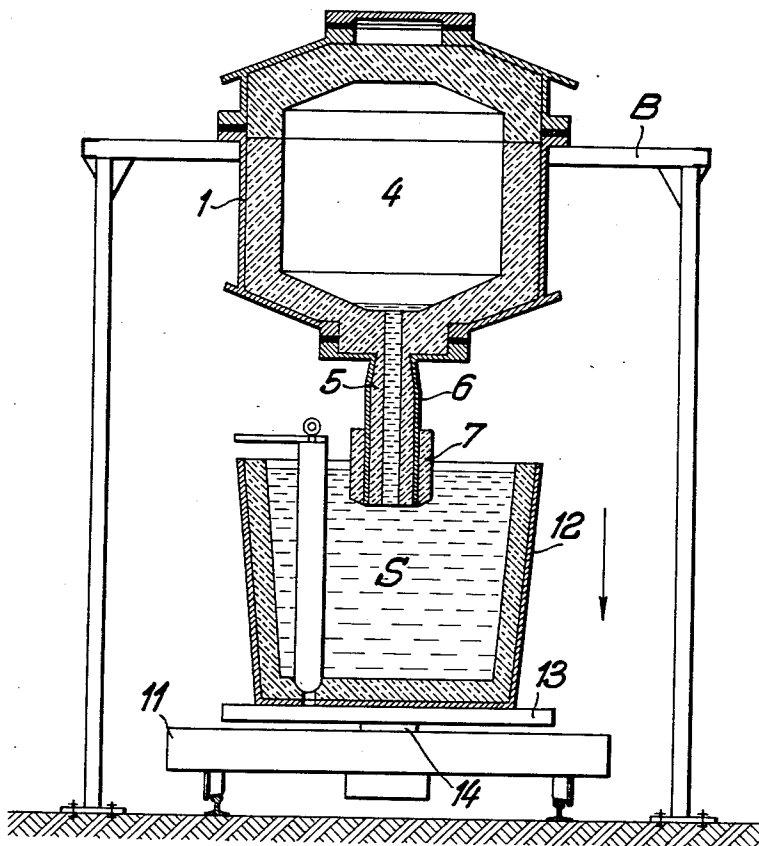
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Fig. 3



Inventor:

FRITZ HARDERS

BY *Thomas, Weisman & Russell*
ATTORNEYS

March 22, 1960

F. HARDERS

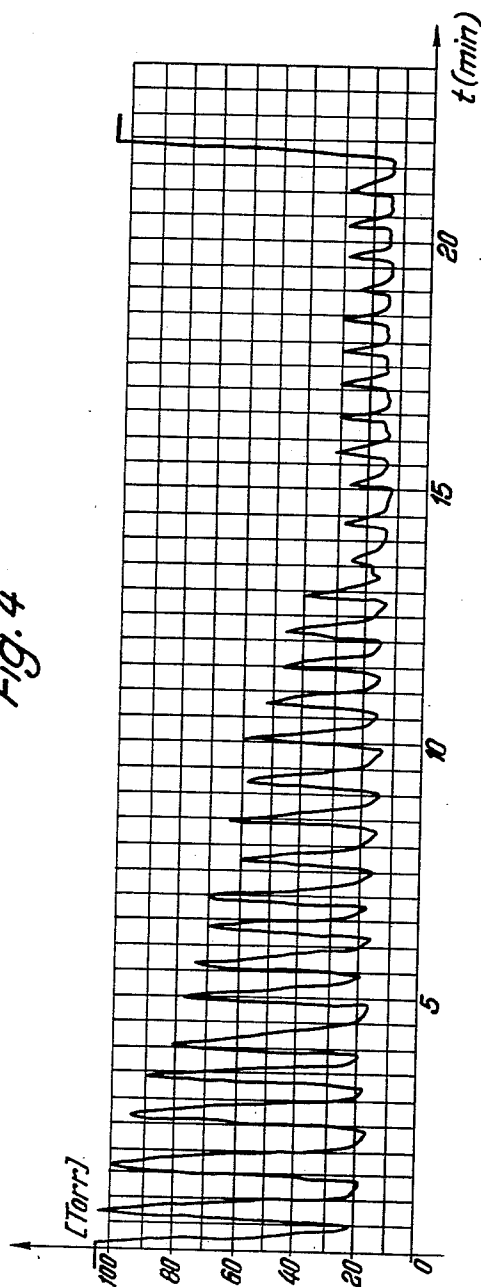
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Fig. 4



Inventor:

FRITZ HARDERS

BY

Thomas, Weisman & Russell
ATTORNEYS

March 22, 1960

F. HARDERS

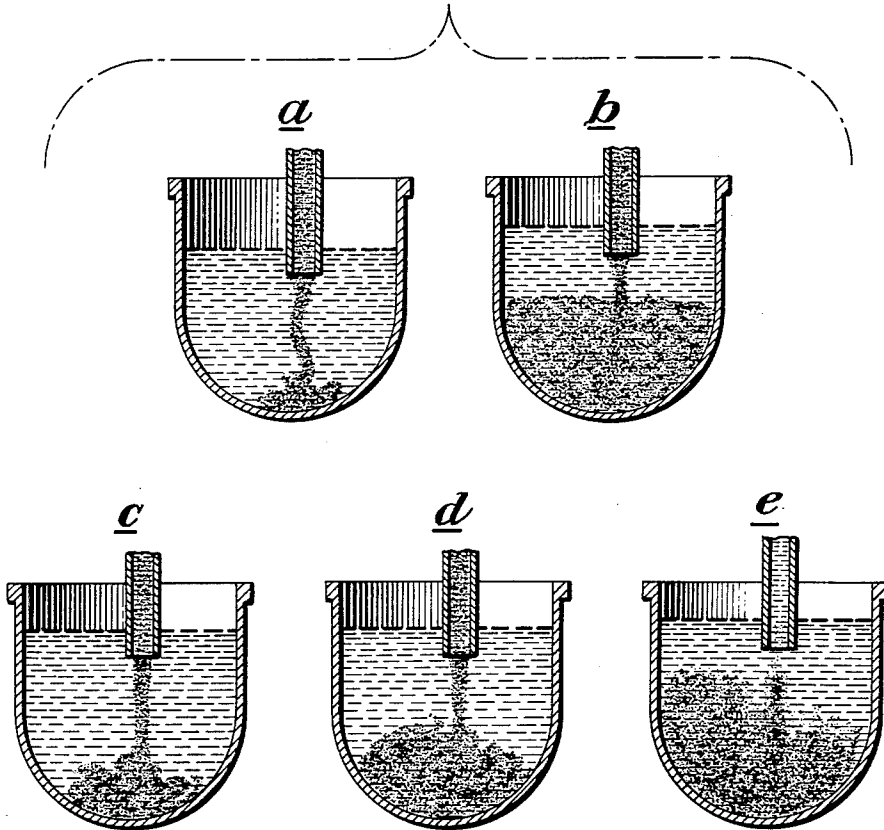
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Fig. 5.



INVENTOR

Fritz Harders

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2,929,704

METHODS OF AND APPARATUS FOR DEGASIFYING METALS

Fritz Harders, Post Ergste Uber Schwerte (Ruhr), Germany, assignor to Dortmund-Hörder Hüttenunion Aktiengesellschaft, Dortmund, Germany

Application January 14, 1957, Serial No. 633,971

Claims priority, application Germany February 27, 1956

4 Claims. (Cl. 75—49)

For degasifying iron and steel melts it is known to use large vacuum chambers which are generally arranged below the floor of the iron works and into which the metal is cast into ladles or moulds from an intermediate vessel communicating with the chamber. Such installations, however, cannot be incorporated in the ordinary steel works. The installations are complicated and their operation is time-consuming so that they interfere with continuous production.

A vacuum vessel provided with an inlet and an outlet pipe in which the metal is degasified in continuous or discontinuous flow is also known but is open to the same objections. For sealing the inlet and outlet pipes, two vessels, for example two steel-works ladles, are required of which one is filled with the metal to be degasified and the other must contain a smaller quantity of metal which is necessary for the air-tight sealing of the outlet pipe. The degasification of the metal in continuous flow has the disadvantage that in the delivery ladle in which the steel gradually cools towards the end of the charge and tends to freeze, at least the amount of metal necessary for sealing must remain behind and, at the end of the charge, a steel which is not completely degasified and is mixed with the molten sealing metal is contained in the receiving ladle. When working in discontinuous flow the proportion of the melt used for sealing in the receiving ladle is particularly great, because the level of the metal in the ladle must be raised to the level of the metal in the delivery ladle in order to interrupt the flow through the vacuum vessel, so that the end of the outlet pipe which has to be sealed can not at the beginning of the process be arranged so as to be near the bottom of the receiving ladle. These difficulties could only be overcome by constructing the receiving ladle as an intermediate vessel from which the metal is tapped either continuously or periodically into a steel-works ladle. The vacuum vessels which operate either with continuous or discontinuous flow, therefore, require a considerable amount of time and energy to operate them which impairs all the output of the steel works. Further, the dimensions of the vacuum vessel are determined by the distance apart of the inlet and outlet pipes opening into it which must be relatively great owing to the work on the ladles and pipes which takes place below the vessel.

The invention overcomes the disadvantages of the known apparatus for degasifying molten metal, especially iron and steel melts, in a surprisingly simple manner which is the result of long experiments. The invention is based on the idea that a predetermined amount of metal can be thoroughly degasified if, with reference to the degasifying process, it is not considered as a whole but portions of it are degasified in succession, these portions being again added to the metal remaining behind as often as is necessary to obtain the desired degree of degasification of the whole of the metal. Only by degasification in portions in this way is it possible to use a vacuum vessel which is of particularly simple construction and is provided with only a single pipe connection and is of

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comparatively small dimensions, and which can now be incorporated directly in a steel-works producing steel either in large quantity or of high quality.

Starting from these considerations the invention relates to a process of degasifying metal melts, for example molten iron and steel, in a vacuum vessel disposed over a container for the molten metal and into which the metal is drawn up through a pipe, degasified and then allowed to run out again. The novel feature of this process is that only a portion of the amount of metal to be degasified which is present in the container, for example a ladle, is introduced each time into the vacuum vessel through the pipe which opens into the vacuum vessel and after the portion has been degasified is returned through the same pipe to the metal remaining in the container or ladle these operations being repeated a number of times until the whole amount of metal to be treated has reached the desired degree of degasification. The filling and emptying of the vacuum vessel in portions can take place most simply by altering the depth to which the pipe dips into the metal. For this purpose either the vacuum vessel or a container arranged below it for the metal melt is so arranged that their distance apart can be periodically varied. An installation having a fixed vacuum vessel which is charged from a truck having a platform of which the height is adjustable and which carries the ladle has proved satisfactory, the ladle filled with the melt to be degasified being carried on the platform.

When the vacuum vessel is filled and emptied in portions by altering the depth to which its pipe extends into the container, the vacuum pumps effects degasification continuously. There may, however, be some conditions when this is not desired. In this case a stationary vacuum vessel which is charged from a simple truck carrying a ladle can also be filled and emptied with portions, the pressure in the vacuum chamber being periodically altered, for example, by admitting gas before the chamber is emptied.

The method of the invention and means for carrying it out will now be described, by way of example, with reference to the accompanying drawings. In the drawings

Figure 1 illustrates diagrammatically a vertical section through the degasifying apparatus,

Figures 2 and 3 show similar views of the apparatus under different conditions,

Figure 4 is a diagram how the degasification process proceeds, and

Figure 5 is a diagram to explain some experiments with a model.

Referring to Figures 1-3, the apparatus consists of a fixed vacuum vessel 1 which is mounted on a platform B. The vacuum vessel is lined with refractory brick-work 2 and is enclosed air-tightly by a metal jacket 3. The effective space 4 within the vessel may be relatively small.

A pipe 6 which is lined on the inside with refractory brick-work 5 opens into the bottom of the vessel 1. The end of the pipe is surrounded by refractory brick-work 7 and a conical sheet metal body 8 is placed on the end of the pipe, the object of the body 8 being to displace to the side any slag on the surface of the steel melt S when the pipe 6 is introduced into the melt.

A pump 9 is mounted on the platform B beside the vacuum vessel 4 and is connected by a pipe 10 to the space 4 within the vacuum vessel.

The metal to be degasified is brought to the vacuum vessel 1 on a truck 11. A ladle 12 containing the melt stands on a platform 13 which can be raised and lowered by a hydraulic cylinder 14. Figure 1 shows the posi-

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tion which the ladle and the pipe 6 which dips into the steel melt occupy before the beginning of the vacuum treatment.

Figure 2 shows the conditions after a vacuum has been established in the chamber 4 of the vessel 1 and the ladle 12 standing on the platform 13 of the truck 11 has been raised, so that the pipe 6 is immersed more deeply in the molten steel S. The conical body 8 shown in Figure 1 has meanwhile been melted and a part of the steel content of the ladle has been raised about 1.4 m. by the atmospheric pressure. The space inside the vacuum vessel is then filled to the extent indicated in the drawing.

After this part of the steel to be treated has been degasified for about 30 seconds the ladle 12 is lowered without altering the vacuum in the vessel 1 and is brought into the position illustrated in Figure 3. The metal, except for a portion remaining in the pipe 6, then flows back into the melt remaining in the ladle 12. The raising and lowering of the ladle and the inlet and outlet of a portion of the molten metal into and out of the ladle 12 caused thereby is repeated until the entire contents of the ladle have been degasified to the desired extent.

The diagram illustrated in Figure 4 and which has been drawn from the results of a practical experiment with the degasification process of the invention confirms the unexpected result that by a repeated introduction of only a part of the molten metal to be degasified into a vacuum vessel and the return of this part to the remainder of the metal in the ladle it is possible thoroughly to degasify the entire melt in a short time.

The diagram shows the pressure variations when degasifying a melt of 80 tons. The melt consisted of unalloyed steel containing 0.35% C. When degasifying this melt, 4 tons of the steel were introduced thirty times in succession into the vacuum vessel, degasified in it and then returned to the melt remaining in the ladle. The suction output of the pump amounted at a pressure of 5 Torr. to 2,000 cubic metres per hour.

It will be seen from the diagram that each time a new portion of steel is admitted, the pressure in the vacuum vessel is increased owing to the gas escaping from the steel. It will also be seen that the pressure maxima, even after two periods, continuously decrease and reach their lowest value even after about 15 minutes. From this point onwards the degasifying work of the pump takes place practically at a vacuum below 20 Torr. and continues until the entire melt has been degasified to the desired extent.

Figure 5 illustrates an experiment with a model to show what takes place when the degasified portion of the metal is returned to the melt remaining in the ladle. The experiment was made with a glycerine-water mixture of the same viscosity as that of ordinary liquid steel. Figure 5a shows that a continuous stream flows out of the pipe from the vacuum vessel when the ladle is lowered and the stream reaches the bottom of the ladle without being divided. The metal which is drawn into the vacuum vessel when the ladle is raised comes from the upper part of the metal in the ladle. On lowering the ladle, the metal in it remains as a layer below the metal flowing out of the pipe from the vacuum vessel, so that the portions drawn into the vacuum at first consist of a non-degasified metal and later of a metal which continuously contains less gas. Even after raising and lowering the experimental vessel three times the liquid in the stream is still in the lower part of the vessel, as shown in Figure 5b. If later the lowering of the vessel is accelerated and, therefore, the kinetic energy of the stream of liquid flowing out is increased, as shown in Figures 5c-5e, a vigorous mixing of the liquid in the receiving vessel takes place. It will be seen, therefore, that the progress of the degasification

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can be controlled by the speed with which the ladle is moved.

The experiments with the model were also confirmed by practical trials. After 80 tons of steel had been degasified by the process of the invention, 100 kg. of finely powdered ferro-silicon were added to the metal in the ladle and the contents of the ladle were treated in portions of 4 tons as during the degasification. The test samples taken on casting the charge gave absolutely uniform silicon-contents in the steel.

In carrying out the process of the invention it is advisable to heat the degasification vessel either by resistance heating, or by carbon rod heating, or by induction, arc or glow discharge heating.

During degasification the molten metal to be treated can also be alloyed. For this purpose the vacuum vessel is provided with, for example, a sluice-like container, which is not illustrated in the drawing, from which the alloying medium can be introduced into the vessel.

I claim:

1. A discontinuous process for the degasification of molten metals comprising maintaining a substantially constant, subatmospheric pressure in a vacuum zone provided with a molten metal interconnecting passageway, maintaining a bath of molten metal in adjustable relationship with respect to said zone, flowing said metal into said zone by immersing said passageway in said bath and reducing the distance between said zone and said bath to such an extent that only a portion of the metal is drawn into said vacuum zone, degasifying said metal portion in said zone by the application of said substantially constant, subatmospheric pressure thereto, increasing the distance between said bath and said zone to discharge the degasified metal portion from said zone to said bath, and successively repeating the steps of decreasing and increasing the distance between said bath and said zone until the metal in said bath is brought to the desired degree of purity.

2. A discontinuous process for the degasification of molten metals comprising maintaining a bath of molten metal in a position to be raised and lowered, maintaining a substantially constant, subatmospheric pressure in a vacuum zone provided with a molten metal admission and discharge passageway above said bath, causing said metal to be drawn into said vacuum zone by lowering said passageway into said bath and reducing the distance between said zone and said bath to such an extent that only a portion of the metal is drawn into said vacuum zone, subjecting said withdrawn molten metal to said substantially constant, subatmospheric pressure in said vacuum zone to remove entrained gases therefrom, discharging the degasified metal into said bath by increasing the distance between said zone and said bath, and repeating said distance decreasing and increasing steps until the molten metal in said bath is brought to the desired degree of purity.

3. A discontinuous process for the degasification of molten metals comprising maintaining a bath of molten metal and a vacuum zone maintained at a substantially constant, subatmospheric pressure, said bath and said zone being in adjustable, spaced relationship with respect to each other, said vacuum zone having a molten metal admission and discharge passageway, causing said metal to be drawn into said vacuum zone by lowering said passageway into said bath and reducing the distance between said zone and said bath to such an extent that only a portion of the metal is drawn into said vacuum zone, subjecting said withdrawn molten metal to said substantially constant, subatmospheric pressure in said vacuum zone to remove entrained gases therefrom, discharging the degasified metal portion into said bath by increasing the distance between said zone and said bath, and repeating said distance decreasing and increasing steps until the molten metal in said bath is brought to the desired degree of purity.

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4. In an apparatus for degasifying molten metal, a vessel having only one molten metal receiving and discharging passageway, a lining of refractory brick-work in said vessel, said vessel and said container being in communication through only a single, downwardly extending pipe of which one end opens into said vessel and the opposite free end extends into the container for the metal to be degasified, said pipe being made of refractory brick-work and enclosed by a metal jacket and an outer ring of refractory materials protecting the lower end of said pipe, said pipe having a conical body of metal attached to the free end thereof, said body of metal being adapted to push aside the slag when said pipe is introduced into the molten metal in said con-

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tainer, and means to alternately increase and decrease the distance between said vessel and said container, whereby said molten metal is sequentially degasified in portions.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,929,704

March 22, 1960

Fritz Harders

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 1, after "metal" insert -- in a container --.

Signed and sealed this 27th day of December 1960.

(SEAL)

Attest:
KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents