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PROCESS FOR THE CONTINUOUS TREATMENT OF STEEL

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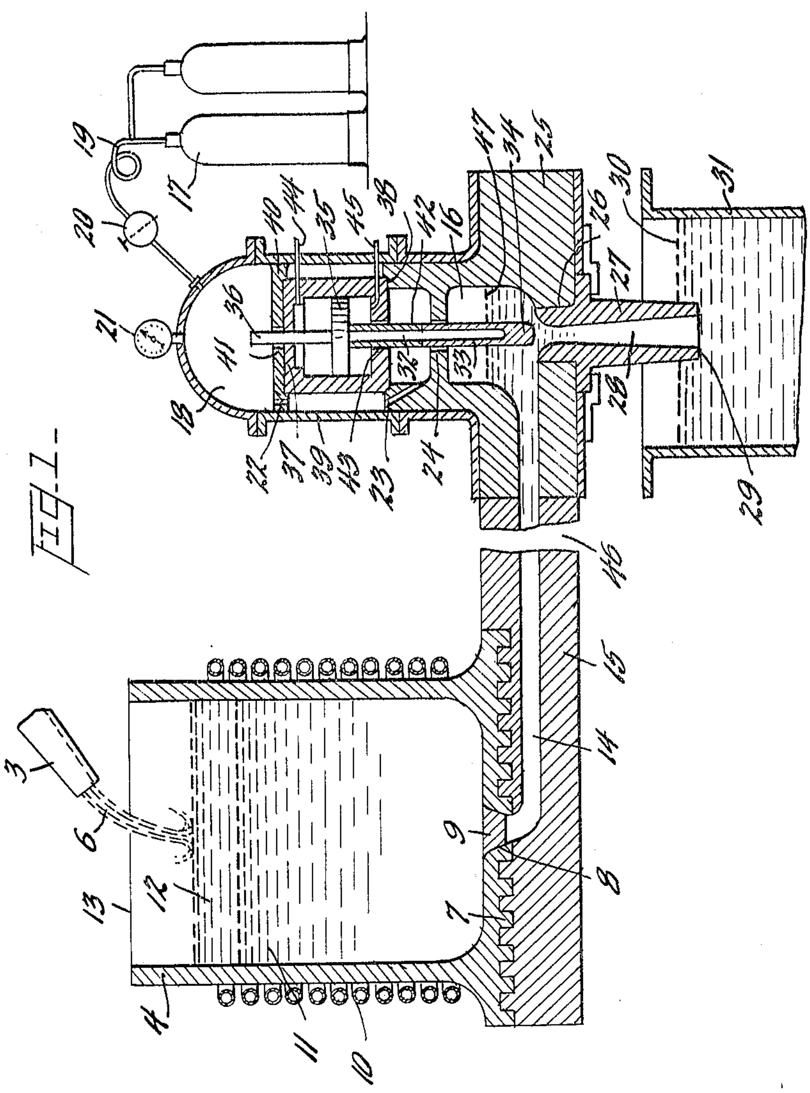

FIG. 1.

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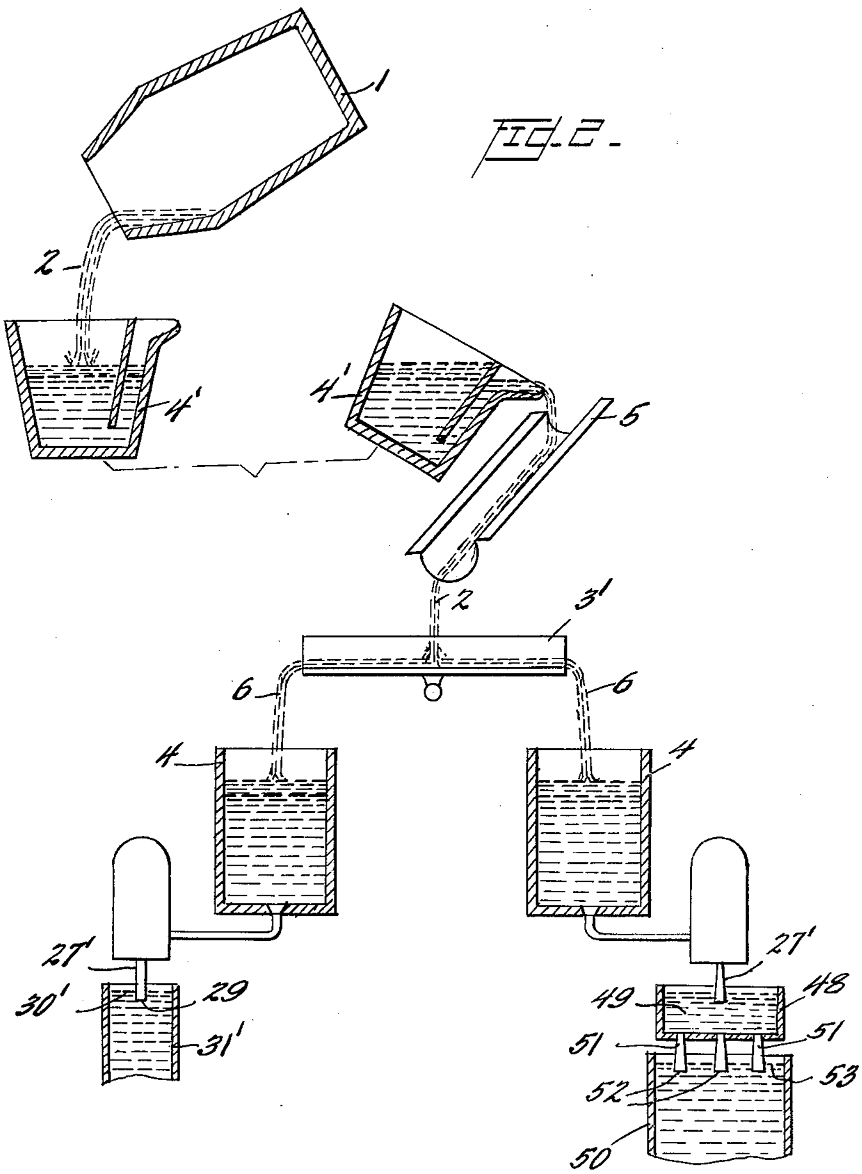
FIG. 2



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PROCESS FOR THE CONTINUOUS TREATMENT OF STEEL

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2 Claims. (Cl. 75—13)

The present invention relates to a process for treating steel, especially steel supplied to a continuous casting installation.

Although the principle of the continuous casting of metals has been known for a long time, its practical application in industry has come up against many obstacles which still considerably limit its use. For instance, the following drawbacks are of importance:

(1) Killed steels deoxidised with aluminum have not yet been continuously cast successfully on an industrial scale. This is a serious shortcoming for this class of steel which is particularly in demand, for instance, for deep drawing operations.

(2) Continuous casting processes known to date are intermittent in that the continuous casting apparatus is charged ladle by ladle. When one ladle is empty, the casting is interrupted and the refractories or linings then have to be repaired or renewed. Also, before casting can be renewed, other operations such as reheating and the insertion of a plug ingot are necessary. This considerably reduces the productivity of a continuous casting installation and thus increases the price.

(3) Basic converter steel has not been continuously cast in a manner satisfactory in regard to metallurgical and other technical considerations. This is especially to be regretted, since steel from basic converters is now comparatively cheap and moreover the production cycle could be much more easily integrated with continuous casting than the production cycle of the larger Siemens-Martin and electric furnaces.

It is in fact determined that the finishing temperatures of converter heats vary too much for the continuous casting of the metal. There is also the difficulty that a significant percentage of batches are too cold for the process. The steel cannot be superheated, that is to say, heated above the normal temperature achieved when the chemical processes of conversion are finished, without a serious deterioration in quality. This difficulty is even more significant with deep drawing steels, that is to say, those which are low in carbon and phosphorus, for which the casting temperatures should be higher, while the temperature at the end of actual manufacture has to be lower.

It is also to be noted that the killing with aluminum of converter steels is more difficult than the killing of Siemens-Martin on electric furnace steels, and that, in any case, it results in an undesirable drop in temperature which mitigates against successful continuous casting.

One aim of the present invention is to make possible the continuous casting of steels killed with aluminum and manufactured in a top or bottom-blown converter.

The invention consists in a continuous process for treating steel, comprising the steps of pouring the steel in an open container, heating the steel in the container by electrical induction, deoxidising the steel in the container and continuously passing the steel from the container, out of contact with the air, into a mould.

This method allows the temperature of the metal delivered to the mould to be precisely controlled and also permits the carrying out of metallurgical treatment in the container. The process may actually be considered

a combination of the classical method of ingot combined with a continuous Duplex treatment in an induction furnace. A normal casting temperature may be used in the method and such temperature may be any well known in the art.

In the case of converter steels, the converter heat can conveniently be terminated with the metal some 20° C. below that obtained in the classic method. By this technique, the phosphorus and carbon at the end of the heat treatment are surprisingly low, for instance, 0.015% and 0.010–0.015% respectively. The metal is then preferably The metal is then preferably transferred to a teapot ladle in which the slag separates and which serves for transport. In order to avoid undue cooling, we prefer not to add any deoxidising agent in the converter or even in the ladle. Aluminium for deoxidation is added in the container, in which, moreover, the composition of the steel is finalized. Also, alumina, amongst other impurities, comes out in the supernatent slag owing partly to the stirring action due to this method of heating.

The invention will now be described for example with reference to the accompanying drawings, in which

FIGURE 1 is a vertical sectional view of an apparatus for feeding in a continuous casting apparatus, and

FIGURE 2 is a diagrammatic view showing the use of the apparatus, the metal being supplied to the container by modified devices.

As shown in FIG. 1, the steel **6** being poured from a refining apparatus is fed through a spout **3** into an induction furnace or container **4**. The deoxidising or killing agents are continuously added to the furnace **4** from above, and alloying additions can also be added continuously. **8** denotes an opening in the lower part of the furnace **4** which is blocked by a plug **9**. The furnace **4** is heated by a coil **10** in which any suitable medium is provided for heat transfer.

The opening **8** is connected with an auxiliary chamber **16** by means of a duct **14** lined with refractory material **15**. This auxiliary chamber **16** is filled with an inert gas such as nitrogen or argon under gauge or controlled pressure, supplied by cylinders **17** through a union member **19**, a regulating valve **20**, and a dome **18**.

The gas pressure is measured by a gauge **21** and the gas passes to the chamber **16** by the ducts **22**, **23**, and **24**. The auxiliary chamber **16** is lined with refractory material **25** and in its lower portion has an opening **26** in which a nozzle **27** is placed and which is of specially resistant refractory material. The bore **28** of this nozzle diverges in the manner of a Laval tube so as to minimize disturbance of the steel which has already passed therethrough.

The lower end **29** of the nozzle **28** is always held below the level **30** of liquid steel in a mould **31**, of a continuous casting installation. **31** could also represent a feeder supplying a mould indirectly.

The auxiliary chamber **16** is traversed by a metal stopper rod **32** composed of a refractory material **33** and it is arranged to be cooled but the appropriate apparatus for this is not shown. The lower end of the rod **32** carries the actual stopper **34** which is made of a sufficient length to allow for wear. The rod **32** passes through the gas duct **24** and is fixed and connected into a piston **35** and another rod **36**. The piston is placed in a cylinder **37** mounted between the dome **18** and the chamber **16**, and the cylinder rests in a groove **38** in the refractory member **25**. The cylinder **37** is also fixed in an external metal housing **39** by a plate **40** pierced by a hole **41** through which the rod **36** passes. Between the refractory member **33** and the piston **35** there is a metal sleeve **42** for protecting the rod **32** and cooperating with an opening **43** in which it is guided. The movement of the piston **35** in the cylinder **37** is controlled by pressure fluid passed through two pipes **44** and **45** by a control system which is not shown to simplify the drawing of FIG. 1.

The apparatus functions as follows:

At the beginning of a casting operation, steel is poured as a jet **6** into the furnace or crucible **4** through the spout **3**. The metal is covered by a suitably prepared supernatant or layer of slag **12**. After the heating coils **10** have been energised, the temperature of the steel has been adjusted and the continuous addition of deoxidising agent to the metal has been begun, the rod **32** is pressed downwards against the nozzle **27**. The regulating valve **20** is opened and gas blown into the chamber **16** and the duct **14**. The pressure of this gas is then increased until the plug **9** is blown out of the hole **8**.

A relay, not shown, which is actuated by the dislodgment of the plug **9** checks the flow of the gas and transmits a signal to the hydraulic control system so that it causes the piston **35** to travel upwards and access into the nozzle **27** is freed.

The killed steel then flows through the duct **14** into the chamber **16** which is filled to the level **47**, and then through the spout **27** into the ingot mold **31**.

The position of the piston **35** is then adjusted to regulate the flow of steel from the chamber **16**. The gas pressure in the latter is automatically controlled by a system, not shown, in dependence upon the height of the steel **11** in the furnace or crucible **4**.

If it were to be adapted for the continuous casting of heavy gauge products, the mould could be fed by means of several nozzles **27** connected in parallel, or through a feeder dividing the metal into several streams. In this latter case, additional precautions would be necessary to keep the steel out of contact with the air as much as possible.

In the showing of FIG. 2, a converter **1** pours molten steel **2** into one of the teapot ladles **4**. The steel from each ladle **4** is poured into a gutter **5** which passes it into a central pivoted gutter **3'** which in turn passes into one of two crucibles **4** (in the FIG. 2 transfer into both crucibles **4'** simultaneously is shown).

The steel is drawn off from the crucibles **4** and emerges through nozzles **27'**. The steel can then either be passed directly into the mould **31'**, the lower end of the nozzle **27'** being held below the lever **30'** in this mould as much as possible, or else the metal can be poured into an intermediate feeder **48** feeding the mould **50** of another continuous casting apparatus through several nozzles **51**. The latter are carefully spaced and are long enough to penetrate through the metal surface **53**. The means for preventing access of air to the metal in the feeder **48** has not been shown.

The process described overcomes the difficulties mentioned at the beginning of the specification in a remarkably efficient manner, more especially in that they teach the protection of a steel low in carbon and phosphorus,

killed with aluminum free of alumina, in a condition suitable for continuous casting. The rate of flow can easily by adjusted. There is also no danger of the re-introduction of alumina into the steel owning to oxidation after killing.

The reduction to practice of such a process and the associated apparatus for handling such steels is considered to constitute a substantial advance over known techniques. The simplicity of the process, its partial self-regulating action and its great adaptability will suit it for the large-scale production of steel of a quality not previously known.

The process and apparatus described are particularly well adapted for use with converter steels though part or all of the apparatus could also be used for steel manufactured by other methods.

What I claim is:

1. In the continuous process of treating liquid steel refined in a converter and intended to furnish continuously steel killed with aluminum and free from inclusions capable of creating surface defects and utilizing a crucible heated by induction, comprising after refining the steel evacuating it from the converter by means of a ladle and at a temperature of about 20° C. lower than the normal temperature of casting, pouring the steel into a crucible heated by induction and pouring the additions of aluminum and other deoxidizing agents, and the constituent elements of a slag capable of fixing the alumina, the capacity of the crucible being utilized as a reserve to permit the casting of the steel without interruption when the feeding is interrupted for changing the ladle, the materials contained in the crucible being subjected to gyratory movements by electric induction, so that the inclusions of alumina and others resulting from the killing are fixed by the said slag, and evacuating the steel in a continuous manner protected from the air.

2. In the continuous process according to claim **1**, in which the killing and deoxidizing agents are added to the steel in the crucible in a continuous flow.

References Cited by the Examiner

UNITED STATES PATENTS

1,309,162	7/19	Walker	75—13
1,318,164	10/19	McConnell	75—13
2,193,034	3/40	Mars	266—38
2,225,373	12/40	Gross	22—201.1 X
2,253,421	8/41	DeMare	75—13
2,339,337	1/44	Hulme	266—38
2,741,555	4/56	Cuscoleca et al.	75—60 X
2,788,270	4/57	Nisbet et al.	266—34
2,837,790	6/58	Rozian	22—57.2
2,976,339	3/61	Gruber et al.	266—34

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