United States Patent [19]

Pomey

[11] **3,845,809**

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[54] **MEANS FOR THE CONTINUOUS CASTING OF STEEL**

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Related U.S. Application Data

[63] Continuation of Ser. No. 813,102, April 3, 1969, abandoned.

[30] **Foreign Application Priority Data**

Apr. 3, 1968 France 68.146863
June 27, 1968 France 68.156841

[52] **U.S. Cl.** **164/259,** 164/281, 164/57
[51] **Int. Cl.** **B22d 11/10**
[58] **Field of Search** .... 164/55, 57, 66, 73, 82, 164/259, 266, 281; 266/34 T, 39; 75/123 AA, 123 CB

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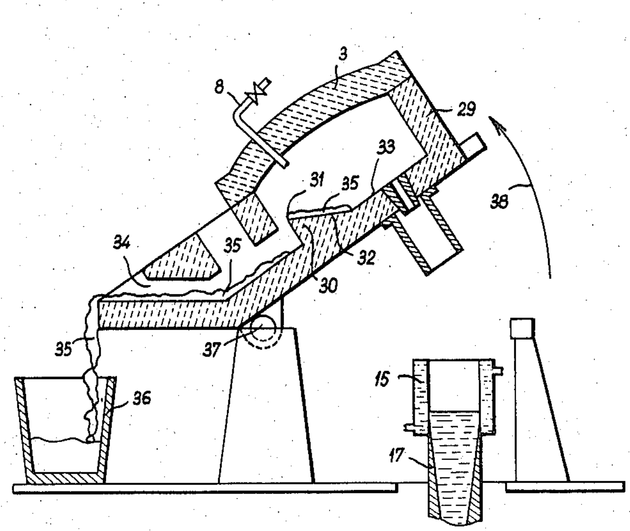
[57] **ABSTRACT**

A method and apparatus for continuous steel casting in which a tubular copper ingot mould is fed with molten steel through an intermediate, so-called "tundish" pool filled in turn by means of a steelwork ladle. The molten steel, during its passage from the intermediate pool to the ingot mould, is isolated from the surrounding atmosphere by means of a dipper pipe made of sintered vitreous silica. the lubrication between the copper walls of said ingot mould and the steel undergoing a solidification therein is provided by a synthetic slag excluding any organic oil, the slag, which covers the steel surface in the ingot mould being selected from the group of substances having such viscosity and wetting capacity with respect to copper and steel that they can on the one hand penetrate by capillarity action between the copper of the ingot mould and the steel being solidified therein, and on the other hand be carried along in the form of an extremely thin layer between said copper and steel. An additive selected from the group comprising tellurium, selenium, a mixture of these two elements and a chemical combination of one of these two elements is added either into the steelwork ladle, during the filling thereof from a steelwork furnace and before the steel therein is poured into the intermediate pool, or into the intermediate pool, the addition taking place progressively and continuously throughout the casting operation.

4 Claims, 9 Drawing Figures



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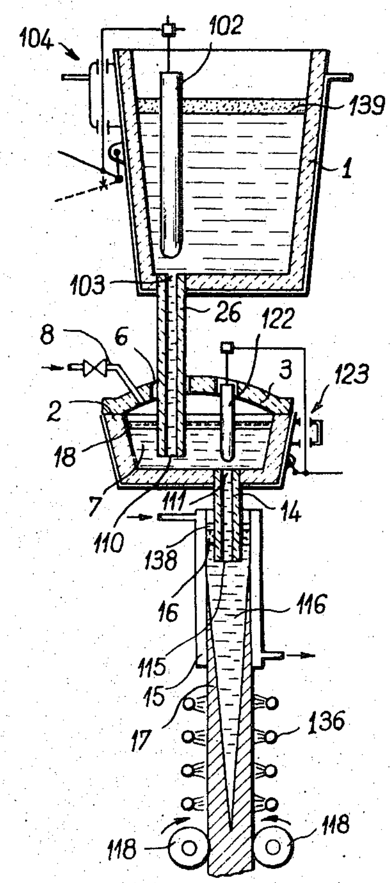

Fig-1

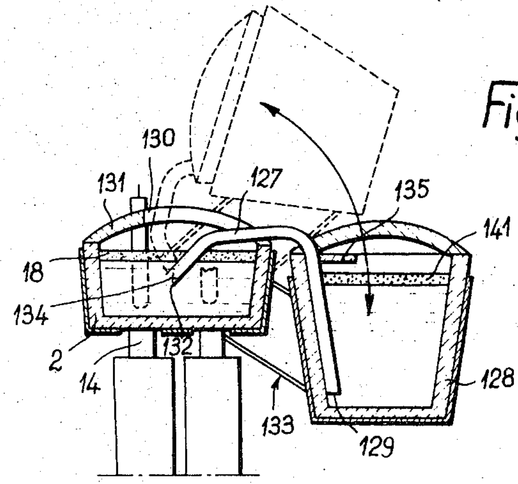

Fig-2

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Fig- 3

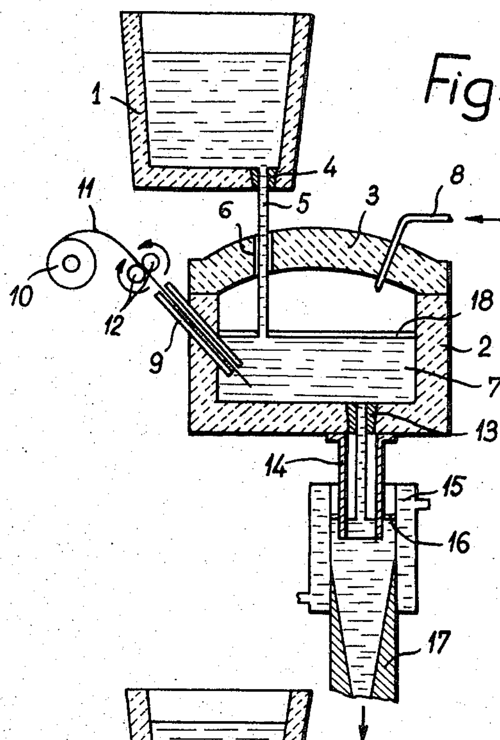
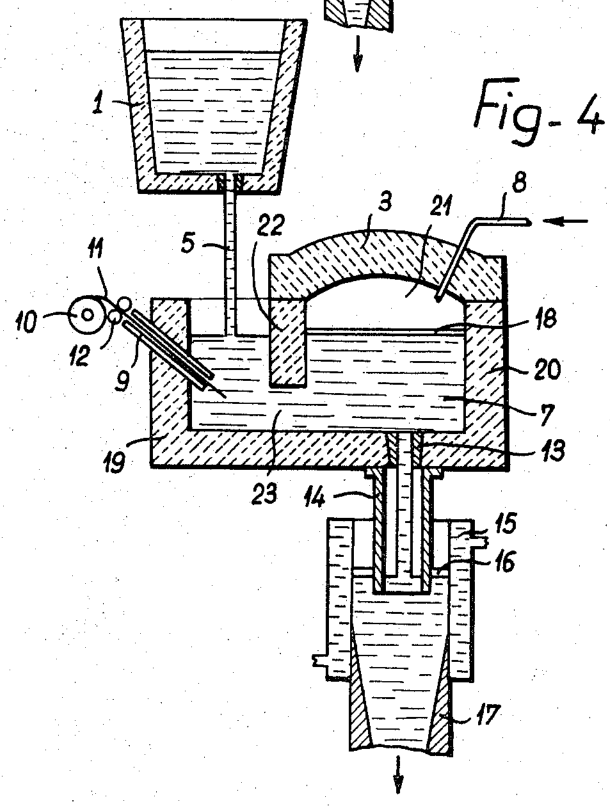


Fig- 4



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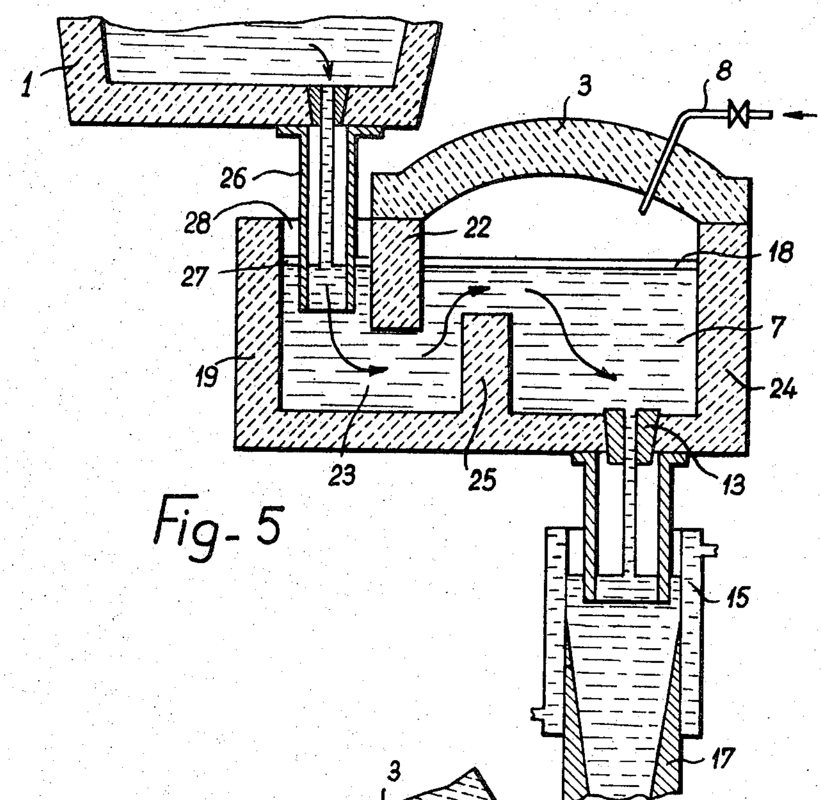

Fig-5

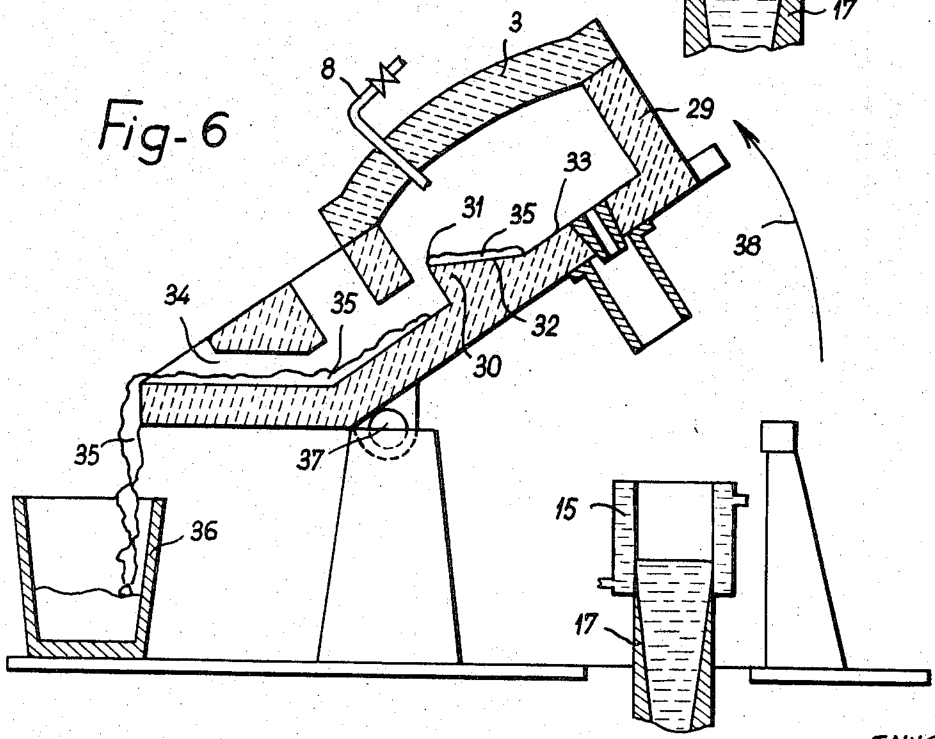

Fig-6

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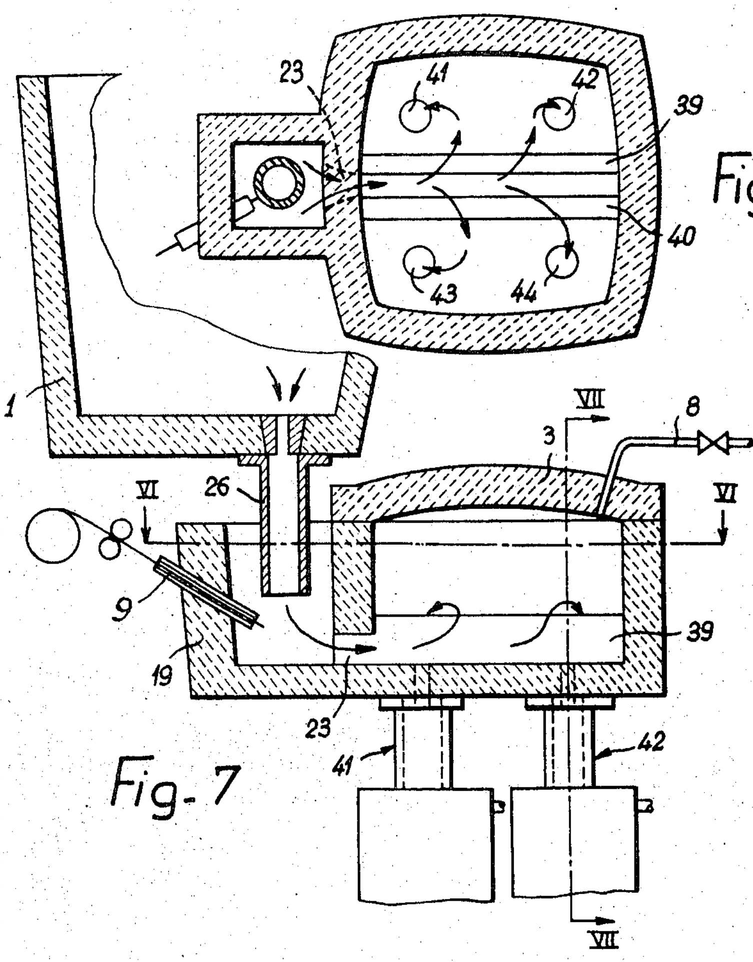

Fig- 8

Fig- 7

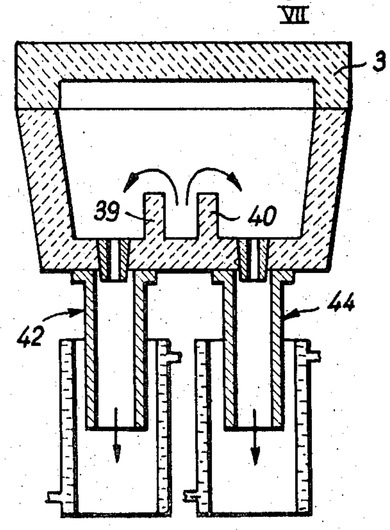

Fig- 9

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MEANS FOR THE CONTINUOUS CASTING OF STEEL

This is a continuation of application Ser. No. 813,102, filed Apr. 3, 1969.

It is known that the continuous casting of steel is a process affording lower production costs due partly to the elimination of the steel feeders required for the conventional ingot moulding as a consequence of the tail cut-off loss and more particularly the head dropping of each ingot, and partly to the fact that the casting is carried out by forming only small sections, thus eliminating the roughing cost involved in any ingot casting, due to the larger sections required. Moreover, the steel quality is improved, due, on the one hand, to the better transverse properties resulting from a lesser working given an equal final section and, on the other hand, to the fact that the rapid setting taking place continuously by parallel "slices" eliminates any liquation and segregation, whereby the steel properties are uniform from the beginning to the end of the bar casting run, the chemical composition being on the other hand uniform from the outer periphery to the central axis of the cast bar. This homogeneity is extremely desirable from many points of view, for example on account of the greater reproductibility of the distortions occurring during the hardening of machined parts.

As a rule, since the cast bar (of which the outer crust or "skin" is solidified by cooling) must slide downwards in to the tubular ingot mould, some kind of lubrication must be provided between the steel skin and the copper wall of the ingot mould. To this end, it is customary to cause mineral oil to flow on the surface of the steel bath and along the walls of the ingot mould. Thus, any undesired "seizure" or adherence between the ingot mould and the cast steel bar is safely avoided.

On the other hand, it is known to manufacture steel grades of which the machining by cutting tools is greatly facilitated by using appropriate addition elements. These additions consist inter alia of sulfer and lead, but tellurium is characterized by properties considerably higher than those of these two elements, because the use of tellurium will but modify only very slightly the mechanical properties of the end products, and the machinability by cutting tools is improved to a degree well above that attainable by the use of sulfur and lead. Under these conditions, there is a great demand for steels with a tellurium content ranging from 0.02 to 0.10 percent. These steels are manufactured according to conventional ingot casting procedures, tellurium being added as a rule in the form of small grains during the casting operation, from the moment when about one-fourth of the steel has been poured into the ingot mould and until the ingot mould is filled completely with molten steel. Whatever the technical method resorted to, a certain irregularity in the tellurium distribution is observed and this detrimental fact is due either to the time selected for incorporating the addition to the steel or volatilization and air combustion losses, or to the liquation taking place during the solidification. Therefore, the tellurium content is not sufficient in the peripheral layers of the ingot and is rather excessive in the core portion thereof, especially on the head side. Under these conditions, the machinability and the mechanical properties required for the ultimate service are not obtained in a reliable and uniform manner.

In view of the foregoing, various attempts have been made for casting tellurium steels continuously in order to avoid the drawbacks set forth in the last paragraph. Unfortunately, all these attempts failed up to now, and so far as the inventor is aware, no commercial method and means for manufacturing tellurium steel under continuous casting conditions has been introduced successfully. The cause of these repeated failures is ascribable to the fact that when it is attempted to cast tellurium steel continuously, a succession of very strong explosions takes place in the ingot mould and would certainly lead to disastrous consequences if the operation were not stopped immediately. The cause of these explosions is still mysterious and unexplained. In addition to this flaw producing inconvenience, the steel casting jet between the intermediate or tundish casting melt and the ingot mould is attended by tellurium loss due to volatilization and oxydizing and the smoke released by this jet is extremely toxic for the personnel.

The U.S. Pat. No. 3,465,811 to De Castelet relates to the continuous casting performed in a plant comprising at least one tubular copper ingot mould to which molten steel is fed through a tundish or intermediate pool filled in turn by using a conventional steelwork ladle and comprising a chamber formed in its lower portion with a sealable nozzle of the type used in ingot mould casting; the steel is isolated from the surrounding atmosphere by a dipper duct of sintered vitrous silica during its passage from the tundish to the ingot mould, the lubrication between the copper walls of the ingot mould and the steel undergoing solidification therein being effected for example by using synthetic slag and excluding organic oil. This slag, which covers the steel in the ingot mould, is selected among those having such viscosity and wetting property with respect to copper and steel that they can penetrate by capillarity action between the copper lining the ingot mould and the steel during the solidification thereof, so as to be carried along between said copper and steel media.

Advantageously, the existence of a reducing atmosphere in the tundish, the protection of the metal surface in the plant by means of a fine layer of synthetic slag and the coating of the slag layers with a pulverulent refractory material having heat insulating properties, such as graphite, are factors giving particularly satisfactory results.

The ladle can be discharged into the tundish or intermediate pool through a substantially vertical duct of sintered vitrous silica constituting an extension of the refractory nozzle provided in the bottom of the ladle, a stopper controlled like a plug being provided for sealing the nozzle orifice. The ladle duct may also be bent and in this case the flow control means comprise a handling apparatus so designed that it can cause the ladle to tilt about a horizontal axis passing substantially through the outlet orifice of which the inlet lies in the vicinity of the bottom of said ladle and as near as possible to said axis.

Duct means or pipes of sintered vitrous silica are prepared according to the known methods. They can be manufactured by preparing vitrous silica, then grinding this silica into a fine powder and putting same in suspension in pure water with a preferably organic emulsifier to produce a slip subsequently poured into a porous plaster mould in which the powder is deposited regularly to constitute a consistent layer or skin lining the walls, then discharging the excess slip therefrom, stripping by opening the plaster mould, drying and sintering the assembly according to the method well known to ceramists, i.e. by compressing this mass under a relatively high pressure at a temperature ranging from 1,100° to 1,200°C and below the melting or devitrification temperature.

Now it was discovered that the above-described operating conditions, constituting the subject-matter of the above said Pat. No. 3,465,811 are suitable for solving the problem set forth hereinabove, that is the problem of manufacturing by a continuous casting process all steels containing an addition selected from the group consisting of tellurium, selenium, a mixture of these elements and a chemical combination comprising one of these elements.

It is the object of the present invention to provide a method of utilizing the equipment described in the above said Patent **3,465,811** and this method is characterized in that, under said working conditions, tellurium, or selenium is added either wholly to the steelwork ladle used for transporting the molten steel from the steel-making furnace to the continuous casting equipment, or gradually to the intermediate pool or tundish between the steelwork ladle and the ingot mould; in this last instance, the addition in the form of fine grains takes place gradually throughout the casting operation.

It is worth pointing out that in this case the continuous casting operation takes place in a fully adequate manner, without any loss of tellurium (or selenium), without any release of toxic vapours or smokes, and above all without producing any explosion. This last point induces the inventor to believe that the explosions observed heretofore are ascribable to the reaction taking place between the tellurium (or selenium) and the organic oil or its decomposition products, since if the casting were carried out by pouring the steel into conventional ingot moulds but after coating the walls of the ingot moulds with mineral oil the explosions thus produced would be so powerful that it would even be impossible to fill the mould completely, whereas the same operating procedure can take place without the slightest incident when tellurium-free (or selenium-free) steels are used.

Thus, the present invention permits the continuous casting of steels containing from 0.02 to 0.10 percent of tellurium.

It will be seen that tellurium steels obtained according to the method of this invention from bar cast under continuous casting conditions and subsequently rolled have properties definitely better than those of bars having the same cross-section but obtained from tellurium steels cast into conventional ingot moulds and subsequently rolled. The machinability of the tellurium steels according to this invention is improved considerably, as well as the mechanical properties of the parts obtained therefrom, under actual service conditions. This result is due to a substantial improvement in the homogeneity of the tellurium distribution and also to the possibility of fixing this tellurium concentration at a considerably more accurate value. It will be noted that the aforesaid improved homogeneity is observed not only in the distribution from the core to the outer periphery, but also in the distribution throughout the length of the bar, from the head or beginning of the first bar to the tail or end of the last bar cast during a same heat or run.

Of course, the foregoing is applicable to all steel grades and types, such as very mild steels having a very low carbon content (<0. 15 percent by weight), all the range of carbon steels up to extrahard steels (<0.80 percent by weight), the complete range of special construction alloy steels containing elements such as Ni, Cr, Mo, etc... with the usual contents. This method is also applicable to steels containing both tellurium and sulfur, or lead and tellurium, or sulfur, lead and tellurium, these elements being added for improving the machinability by cutting tools.

This invention is also concerned with a tundish or intermediate pool arrangement permitting of introducing into the metal, in a particularly advantageous and economical manner, the addition selected from the group comprising tellurium, selenium, a mixture of these two elements and a chemical combination of one of these elements.

This arrangement is therefore applicable to equipments and plants of the type described and illustrated in the above said Pat. No. 3,465,811 i.e., more particularly to an intermediate pool or tundish comprising a vault for isolating the steel contained in said pool from the surrounding atmosphere, said intermediate pool being adapted to be supplied with an inert, neutral or reducing gas through a duct creating an adequate atmosphere within said pool. The arrangement is characterized in that this intermediate pool comprises at least one passage for introducing the additive-forming substance, said passage opening into said pool in the vicinity of the point where the casting jet issuing from the steelwork ladle is incorporated into the molten steel contained in the pool.

An intermediate pool or bath meeting the above requirements is furthermore advantageous in that it not only permits introducing the above-mentioned addition into the molten metal but also to use aluminum as a deoxidizer, or to incorporate in a particularly homogeneous manner very dense additives such as lead, lead sulphide and iron sulphide, etc... into the molten metal.

Thus, it is another object of this invention to produce a novel lead steel.

As far as deoxidation is concerned, the plants described in the above said Pat. No. 3,465,811 ensured an improvement in the final deoxidation of steel when the latter is deoxidized in the furnace or in the ladle by using conventional elements such as manganese, silicon, silico-calcium, etc... except aluminum, which was widely considered as unsuitable for continuous steel casting processes.

Now, by virtue of the present invention, the complementary calming action and also the regularization of the steel grain can be obtained by adding aluminium or an aluminium alloy containing about 0.05 to 0.10 percent of magnesium. A dipper pipe of sintered vitrous silica extending through the wall or the vault of the pool structure opens beneath the steel surface contemplated in the vicinity of the casting jet introduced into the pool. A feed device is provided for driving a light-alloy tape or wire through said dipper pipe at a rate sufficient to cause this tape or wire to be still in the solid state when it penetrates into the mass of liquid steel in the pool.

The steel contained in this intermediate pool is covered by a slag layer of adequate composition; this slag may consist of eutectic slag of the SiO_2, CaO, Al_2O_3 type, containing for example fluxing or reducing agents. It is protected against premature cooling by the vault overlying the pool.

The presence of a vault and of a controlled atmosphere affords a good thermal and chemical insulation of the steel mass. In this case, a reducing gas such as propane may be resorted to while preventing the hydrogen from being captured by the steel due to the presence of the interposed slag layer.

To improve the aluminium distribution in the steel mass before the latter reaches one of the casting nozzles leading to the ingot moulds, the pool advantageously comprises a lateral extension formed at its upper portion with an aperture for receiving the jet of molten steel from the steelwork ladle; this lateral extension further comprises the passage for introducing the additive; however, said steel jet aperature communicates through an immersed duct with the lower portion of the main chamber.

The permanent immersion of this duct seals the capacity containing said atmosphere between the vaults and the free steel surface in the pool, the slab being thus retained and prevented from moving toward said lateral extension. Thus, the scoria and the reaction inclusions can rise and be collected by the slag covering the steel mass in the pool.

Moreover, to preserve a good uniformity of the liquid steel composition before this steel flows through a casting nozzle into the ingot moulds, the pool may be provided with at least one intermediate partition wall of refractory material, interposed on the bottom of the pool, upstream of said nozzle, throughout the length of the steel passage, the upper edge of said partition wall being lower than the minimum level contemplated for the steel bath.

This partition wall will thus cause the steel flowing from said lateral extension to flow upwards into the pool.

Up to now, the addition of heavy products such as lead, galena or lead sulphide, pyrite or iron sulphide, selenium, tellurium and their chemical compounds to the steel was attended by serious difficulties or was even impossible in the case of a continuous casting process.

It is known, for instance, that under conventional continuous casting conditions it was scarcely possible to produce lead-containing free-cutting steels. In these steels the lead content ranges as a rule from 0.10 to 0.20 percent. Lead is added in general into the casting jet delivered to the ingot mould and it is also known that lead, which is denser than steel, comes together immediately along the ingot axis, at the vortex of the inverted cone constituted by the interface between the already solidified steel and the still liquid steel. Obviously, this uneven distribution makes the steel product ill-suited for the use contemplated.

The above disclosure concerning lead is also true for the other above-mentioned heavy additives.

Now it was discovered that the plants equipped according to this invention with dipper pipes disposed between the intermediate pool and the ingot moulds, with intermediate pools provided with a lateral extension, and with a partition wall of the type described herein, permitted a reliable elimination of the drawbacks set forth hereinabove.

A dipper pipe of sintered vitrous silica can be used between the steelwork ladle and the lateral extension of the intermediate pool, the use of this lateral extension being preferred for it prevents the oxidation of the steel jet without interfering with the introduction of lead shot about the pipe inserted into said lateral extension. In this case, the additive introduction passage and the opening for receiving the steel jet from the steelwork ladle are merged into a single structure.

It is remarkable that lead steel produced by a plant equipped according to the teachings of this invention has a lead distribution uniformity that cannot be obtained with the conventional ingot molding steel casting process. As a result, a remarkable constancy in the good machinability of the steel is observed and very high cutting speeds together with a long useful life of the cutting tools can be expected with certainty and make these steels highly valuable for many applications. Therefore, these steels should be considered as completely new products constituting a complementary object of the present invention.

Other features and advantages of this invention will appear as the following description proceeds with reference to the attached simplified drawings illustrating typical forms of embodiment of the intermediate pool or tundish structure of this invention. In the drawings:

FIG. 1 is a diagrammatic sectional view of a plant for carrying into effect the process according to this invention;

FIG. 2 illustrates diagrammatically and in sectional view a modified form of embodiment of a plant according to FIG. 1;

FIG. 3 illustrates in vertical section a plant for introducing aluminium into the steel bath of the intermediate pool;

FIG. 4 is a modified form of embodiment of the structure shown in FIG. 3, wherein the pool is provided with a lateral extension;

FIG. 5 is a sectional view showing a plant for introducing additions in the form of very dense substances, the intermediate pool being equipped with a partition wall;

FIG. 6 is another modified form of embodiment wherein the intermediate pool structure provided with a lateral extension and a partition wall is designed for facilitating the removal of slag and impurities, and

FIGS. 7 to 9 are different sectional views of a four casting lines plant wherein the pool is equipped with two parallel longitudinal partition walls.

FIG. 1 shows only the essential elements of a plant for carrying into effect the process according to the invention. Therefore, the handling apparatus or means for positioning these elements, the supports therefor, the oxy-acetylenic ingot cutting follower devices, the members and devices constituting the process line from the setting ingots to the final discharge of the steel cut sections, and most of the control, supervision and regulation apparatus, inter alia, are not shown in this figure.

A steelwork ladle **1** containing the liquid steel is equipped with a plug and a movable stopper-rod **102** adapted to obturate the inlet orifice of a nozzle **103** provided in the bottom of the ladle. The device for starting and stopping the teeming operation is provided with manual, servo-assisted manual, or automatic control means **104**.

This nozzle **103** has an extension in the form of a refractory pipe **26** made of poreous sintered vitrous silica and extending through an orifice **6** formed in the vault **3** of an intermediate vessel **2** underlying the ladle **1.** The length of the refractory pipe **26** is such that its lower end extends through the slag layer **18** covering the liquid steel **7** and its outlet orifice **110** is immersed in the liquid metal.

The intermediate vessel **2** comprises a number of outlet nozzles corresponding to the number of ingot moulds to be fed from this vessel. In the case illustrated, the vessel **2** comprises only one discharge nozzle **111** adapted to be closed by a member such as a stopper-rod or plug **122** having control means **123,** also of the manual, servo-assisted manual, or automatic control type.

A pipe **8** leads into the cover or vault **3** to permit the introduction, into the space left between the slag **18** and the cover or vault **3,** of a non-oxidising and preferably reducing gas such as, inter alia, propane, coke-oven gas, etc...

Like the pipe **26** of ladle **1,** the pipe **111** of vessel **2** has a depending tubular refractory extension **14** made of poreous sintered vitreous silica of which the lower end projects to a certain extent into a vertical tubular ingot mould **15** of conventional type, for example having a copper double-wall with cooling water circulation means. The pipe **14** has a length sufficient to cause its outlet orifice **115,** in the operative position, to be immersed in the liquid steel **116** covered by a slag **16,** the steel level being maintained at a substantially constant value by exerting on the ingot position a gravity-responsive action transmitted through driving cylinders or rollers **118.**

Finally, water sprinkling sprays are disposed in the known manner at the outlet end of the ingot mould **15,** the water spray serving the purpose of accelerating the cooling of the ingot **17** during its solidification.

With this invention it is also possible to use a steelwork rocking ladle, as shown in FIG. **2.** In this case a pipe **127** of ladle **128** is bent, its inlet orifice **129** being located near the ladle bottom and its outlet end extending in such a manner through a slot **130** formed in the cover **131** of vessel **2** that its outlet orifice **132** is completely immersed in the liquid steel bath therein. The ladle is carried by a handling apparatus **133** so disposed that it can tip the ladle about its horizontal axis **134** located substantially in the plane of the outlet orifice **132.** Of course, the inlet orifice **129** must be positioned as close as possible to the level of this axis **134** yet near the bottom of the ladle. This ladle further comprises a barrier-forming partition **135** for preventing the slag and the liquid steel from overflowing when the ladle is inclined. As shown, this pipe **127** acts somewhat like a teapot spout, the steel flowing into the vessel and, as in the first form of embodiment, the steel contacts only the vitreous silica.

As contrasted with the conventional technique concerning the use of slags in continuous-casting ingot moulds, the steel teeming from the vessel **2** into the ingot mould **15** according to this invention will not pass through this slag which, therefor, remains perfectly still and prevented from being emulsified or entrained by the steel mass. According to this invention, it is therefore possible to cover the horizontal steel bath surface in the ingot mould with a fine layer of fusible synthetic slag **16.** The latter will advantageously be covered with a refractory heat-insulating powder **138** such as graphite, whereby the slag cooling may be reduced accordingly.

It may be noted that the liquid steel in vessel **2** and ladle **1** or **128** is also covered with a protective slag **139, 8** and **141,** respectively.

As it can be seen, there is no direct contact whatsoever between the moving liquid steel mass on the one hand and the atmospheric air, on the other hand, from the steelwork teeming ladle to the ingot solidifying in the mould.

As shown in FIG. **3,** a steelwork ladle **1** is provided for supplying molten steel to an intermediate pool or tundish **2** covered by a vault **3.** The liquid steel jet **5** flowing out from the nozzle **4** of ladle **1** penetrates into the pool through an orifice **6** formed in the vault **3.**

An atmosphere is maintained between the vault **3** and the molten steel level or surface **7** by using a suitable gas fed through a duct **8** extending through said vault **3.**

A dipper pipe **9** of sintered vitreous silica extends through the lateral wall of the pool structure **2** and opens at a level beneath the surface contemplated for the molten steel, in the vicinity of the zone where the steel jet **5** is incorporated into the liquid steel bath **7.** A feed device consisting for example of a pair of rollers **12** rotating in opposite directions pulls an aluminium tape or wire **11** from a feed spool **10** and drives it into the dipper pipe **9.**

The intermediate pool **2** comprises a number of nozzles corresponding to the number of ingot moulds fed thereby. In the examples illustrated in simplified form in FIGS. **3** to **6** inclusive the pool comprises only one nozzle **13** adapted, like the nozzle **4** of ladle **1,** to be stopped by a plug (not shown), such as a stopperrod and a plug equipped with manual control and handling means, or equivalent manual power-assisted or fully automatic means. The nozzle **13** has an extension consisting of a refractory pipe **14** of sintered vitreous silica of which the lower end extends to a certain length into a vertical tubular mould **15** of conventional type, for example of the double-walled copper type with cooling water circulation supply means. The length of the pipe **14** is sufficient to cause its outlet orifice, under normal operating conditions, to be immersed in the liquid steel, the latter being covered by a slag layer **16**; the steel level is kept substantially constant by controlling the feed of mould **17** obtained either by gravity or by means of suitable driving cylinders or rollers (not shown).

Besides, the steel contained in the intermediate pool **2** is also covered with a slag layer **18.**

The pipes **9** and **14** of sintered vitreous silica are prepared according to known methods. They can be prepared by crushing vitreous silica, putting the resulting powder into suspension in pure water with an emulsifier, preferably of organic type, to obtain a slip subsequently poured into a poreous plaster mould in which the powder is deposited regularly to form a consistent crust on the mould walls, subsequently removing the excess slip, stripping the moulded body by opening the plaster mould, drying and sintering the moulded body according to a technique well known to ceramists.

The modified form of embodiment illustrated in FIG. **4** differs from the preceding plant by the provision of a lateral extension **19** open at the top and formed on one side of the intermediate pool **20.** This extension is separated from the inner or main chamber **21** of the pool structure by a refractory depending partition wall **22** leaving a free immersed passage **23** beneath its lower edge so that the extension **19** can communicate with the bottom of said main chamber **21.**

As in the preceding example a device **9** to **12** for feeding additive to the molten steel opens into the pool beneath the point where the molten steel is poured in jet form **5** into the liquid mass already filling the pool, but in this case the additive and the steel jet are directed into the lateral extension **19.**

The intermediate pool **24** illustrated in FIG. **5** comprises a refractory partition wall interposed on the bottom of the pool just downstream of the aforesaid depending partition wall **22** and upstream of the discharge nozzle **13**; the upper edge of this lower partition wall **25** is disposed beneath the minimum level of the liquid steel mass **7.**

The liquid steel flows along the path shown by the arrows and the first refractory partition wall **22** seals the atmosphere formed under the vault **3** from the free surface of steel **7** in the main pool **24** and retains the slag **18** therein by preventing it from communicating with the lateral extension **19**; however, the reaction scoria and inclusions can rise and be collected by the slag **18** covering the steel mass in the main pool **24.**

On the other hand, it is also possible to prevent the atmospheric oxidation of steel between the steelwork ladle **1** and the lateral extension **19** by providing beneath said ladle a depending pipe **26** of sintered vitreous silica and covering the steel mass contained in said lateral extension with sufficiently fusible synthetic slag **27.**

The additive introduction passage may consist of a dipper pipe **9** (FIG. **7**) or the upper aperture **28** receiving the molten steel jet **5** which is formed in said lateral extension **19** (FIG. **5**).

It is clear that when heavy or dense additives such as lead are to be introduced they cannot travel directly to the discharge nozzle **13** feeding the ingot mould **15** directly by gravity. In fact, the upstanding partition wall **25** prevents this gravity flow. As a result, the lead can flow beyond the partition wall **25** only by moving upwards, and this flow cannot take place unless the lead is either dissolved in the molten steel or in a state of very fine dispersion. The whirling movements occurring in the lateral extension **19** and in the bottom passage **23** between this extension **19** and the main pool **7** facilitate this dispersion and this dissolution.

The intermediate pool **29** illustrated in FIG. **6** comprises on the one hand a partition wall **30** of which the upper portion comprises a sharp edge **31** leading through an inclined plane **32** to the bottom **33** of the main pool and, on the other hand, a pouring spout **34** in horizontal alignment with, and communicating with the lower portion of, said extension. With this arrangement, when the casting heat or run is completed the synthetic slag **35** can be discharged completely into a slag pot **36** by simply tilting the pool structure about this spout **34** or better about trunnion means **37,** in the direction of the arrow **38.**

In case of casting accident or other emergency necessitating the immediate stopping of the casting operation, the steel remaining in the pool can be poured by tilting into a conventional ingot mould substituted for the pot **36.**

As will be seen in FIGS. **7** to **9,** the partition wall can be divided into two parallel partition walls **39** and **40** extending throughout the length of the pool and disposed on either side, respectively, of the vertical sectional plane of FIG. **7,** in order to ensure a symmetrical feed of the nozzles. The path followed by the molten metal is shown by the arrows.

If lead is added to the molten metal, this arrangement ensures a very uniform distribution of the heavy metal in pool structure comprising four vertical casting lines disposed symmetrically at the four corners of a square (see figure **8**).

I claim:

1. Equipment for the continuous casting of steel which comprises a steelwork ladle having a jet of molten steel feeding an intermediate pool of the so-called "tundish" type covered by a vault, said intermediate pool comprising a main chamber provided in its lower portion with at least one discharge nozzle adapted to be stopped, said nozzle being formed with a first extension including a substantially vertical refractory tubular duct of sintered vitreous silica adapted to feed at least one tubular ingot mould equipped with cooling means, the lower end of said tubular duct being immersed in themetal fillingsaid ingot mould during the casting operation, means to replace air in said main chamber by a suitable atmosphere supplied thereto via a gas pipe opening into said intermediate pool, said intermediate pool having at least one passage for introducing a suitable addition into said main chamber, said passage opening into the vicinity of the zone where the jet of molten steel delivered by the steelwork ladle is incorporated into the molten steel already contained in said pool, said intermediate pool further comprising a second lateral horizontal extension of said main chamber formed at its upper portion with an aperture for receiving the steel jet from said steelwork ladle, said addition introduction passage also formed in said second lateral extension, so that the addition is mixed in the liquid steel in the vicinity of the steel jet arrival, said intermediate pool further comprising at least one first refractory partition wall extending through said main chamber and interposed in the bottom of said pool downstream of the steel jet arrival and upstream of said nozzle, the upper edge of said first partition wall being disposed beneath the minimum level contemplated for the molten steel contained in said pool, and at least one second partition wall interposed in the top of said pool between said first partition wall and tubular duct, the bottom edge of said second partition wall being disposed beneath said minimum level, said first and second walls constituting a baffle for the passage of molten metal and causing homogenization of the metal before arrival at said discharge nozzle.

2. Continuous steel casting equipment according to claim **1,** wherein said passage is merged into said molten-steel receiving aperture.

3. Continuous steel casting equipment according to claim **1** wherein said first and second partition walls are disposed on either side of the longitudinal and vertical plane of symmetry of said second lateral extension and said main chamber.

4. Equipment for the continuous casting of steel which comprises a steelwork ladle having a jet of molten steel feeding an intermediate pool of the so-called "tundish" type covered by a vault, said intermediate pool comprising a main chamber provided in its lower portion with at least one discharge nozzle adapted to be stopped, said nozzle being formed with a first extension including a substantially vertical refractory tubular duct of sintered vitreous silica adapted to feed at least one tubular ingot mould equipped with cooling means, the lower end of said tubular duct being immersed in the metal filling said ingot mould during the casting operation, means to replace air in said main chamber by a suitable atmosphere supplied thereto via a gas pipe opening into said intermediate pool, said intermediate pool having at least one passage for introducing a addition into said main chamber, said passage opening into the vicinity of the zone where the jet of molten steel delivered by the steelwork ladle is incorporated into the molten steel already contained in said intermediate pool, said intermediate pool further comprising at least one refractory partition wall extending through said main chamber and interposed in the botton of said pool downstream of the steel jet arrival and upstream of said nozzle, the upper edge of said partition wall being disposed beneath the minimum level contemplated for the molten steel contained in said pool, said partition wall including a single transverse partition wall of which the upper edge includes a sharp angle connected by an inclined plane to the bottom of said pool, said partition wall forming a second lateral horizontal extension of said main chamber, and a pouring spout disposed in horizontal alignment with respect to, and communicating with the lower portion of, said second extension, said pool being mounted for tilting movement about a trunnion axis extending at right angles to the vertical plane of symmetry passing through said spout, said second extension and said chamber.

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