ABSTRACT: A plant for continuously casting metal including an oscillating curvilinear mold. Adjacent the curvilinear mold and defining a further curvilinear path exists a system for secondary cooling. The secondary cooling system comprises a series of curvilinear walking bars for maintaining the desired shape of the billet and for pulling the ingot from the mold. Adjacent the bars exist two rows of rollers above and below the path of the billet, the rollers defining the curvilinear path of the billet such that the radius of curvature becomes increasingly continuously greater to an infinite value. There then may be a rectilinear path of rollers, followed by a cutting device for cutting the continuous billet into usable lengths.
The present invention relates to plants for continuous casting of metal comprising an intermediate vessel; a curvilinear mold complete with an oscillating mechanism; a system for secondary cooling; and a device for cutting the continuous ingot or billet (for example see Pat. No. 1,173,316, granted in France).

In such plants, the system for the secondary cooling is designed in such a manner that it retains the billet to be crystallized within the curvilinear section, and after complete crystallization, the billet is strained by straightening devices and led out along a horizontal line.

The productive capacity and height of these plants depend upon the radius of curvature of the mold, which, in its turn, determines the possible length of the system of the secondary cooling and the speed of the billet to be crystallized passing through the plant.

An increase in the productive capacity of these plants is connected with an increase in their overall dimensions and hence in the cost of their manufacture.

An object of the present invention is to provide such a plant for continuous casting of metal which would be capable of effecting the casting of metal at high-casting speeds and maintaining a high quality of the billets obtained.

Another object of the present invention is to decrease the height of the continuous casting plant to the minimum value.

These objects are achieved due to the fact that in a plant for continuous casting of metal, comprising an intermediate vessel; a curvilinear mold complete with an oscillating mechanism; a system for secondary cooling; and a device for cutting the continuous billet, the system for secondary cooling is essentially a structure composed of walking curvilinear bars with two rows of rollers straightening the billet to be crystallized located behind the bars and extended an extended curve of the radius of curvature of the walking bars, which curve gradually increases from the radius of curvature of the walking bars to an infinite value.

For increasing the length of the roller zone of the system for secondary cooling, it may be provided with a rectilinear section complete with rollers being an extension of the curvilinear section.

It is expedient that the rollers of the lower row should be, at least partially, driven.

Furthermore, between the rollers there may be provided sprayers for supplying cooling fluid.

The nature of the present invention may become more fully apparent from a consideration of the description of an exemplary embodiment thereof, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a side elevational in partial cross section of a general view of the plant according to the present invention;
FIG. 2 is a cross-sectional view, taken along the line II—II of FIG. 1;
FIG. 3 is a cross-sectional view, taken along the line III—III of FIG. 1.

The plant for continuous casting of metal comprises a working platform 1 (Fig. 1), on which a carriage 2 is mounted on rails.

An intermediate vessel 3 is mounted on the carriage 2, said vessel being provided with a nozzle 4 for tapping the metal.

Directly under the nozzle 4 there is provided a curvilinear mold 5 mounted on an oscillating mechanism 6.

Under the mold 5 there is disposed a system of the secondary cooling comprising walking curvilinear bars 7, moving along guides 8, and a roller zone, composed of two rows of rollers 9 and 10 retaining a billet 11 to be crystallized both from above and below, and also straightened.

The walking curvilinear bars ensure the drawing of the billet 11 from the mold 5 simultaneously with the cooling thereof without any deformation of its skin, and the preservation of correct geometrical shape of the cross section of the billet 11.

Two rows 9 and 10 of the rollers are disposed behind (in the direction of billet travel) the walking curvilinear bars 7 within the roller section L, along a curve whose radius of curvature gradually increases from the radius of curvature R of the walking curvilinear bars 7 to an infinite value.

The law of plotting the curve is selected in such a manner that with the maximum speed of casting, the straightening of billet 11 occurred at deformation speeds that do not exceed the admissible ones.

For positioning the two rows 9 and 10 of the rollers along the curve within section L whose radius of curvature increases from the radius of curvature R of the walking bars 7 to an infinite value, the rollers of the lower (10) and upper (9) rows are mounted in bores of housings 12 and 13 (FIG. 2). The housing of the lower row 10 is disposed on the foundation on different heights, while the housing of the upper row 9 is connected to the housing of the lower row 10 by means of a rod 13c.

The section L of the two rows 9 and 10 of the rollers is disposed along the curve, and is extended by a rectilinear section L0 (FIG. 1) of these rows of rollers, which increases the extension of the system for secondary cooling without an increase in the height of the whole plant.

For moving the billet 11, the rollers 14 of the lower row 10 along the whole length of the roller zone are provided with a drive 15, composed of a reducing gear 16 (FIG. 2) and an electric motor 17, while rollers 18 (FIG. 1) of this row are not driven.

The arrangement of the driven rollers 14 in alternate order with nondriven rollers 18 provides for their adjustment with a minimum pitch.

The billet 11 is cooled with water supplied through sprayers 19 disposed between the mold 5 and walking bars 7, and sprayers 20 provided in the lower 9 and upper rows 10 of the roller zone.

In the walking bars 7 there are provided channels 21 (FIG. 3), along which water circulates cooling the billet 11 due to a contact of the working surfaces of the walking bars 7 with billet 11.

To preserve the correct geometrical shape of the billet 11 (FIG. 1), and to provide for a reliable contact of the working surfaces of the walking curvilinear bars 7 and the two rows 9 and 10 of the rollers with the surface of the billet 11 over the whole length of the system for secondary cooling, the adjustment of the spacing of the walking bars 7 and two rows 9 and 10 of the rollers is effected with due account of the contraction of billet 11 during its crystallization and cooling.

For cutting up the continuous billet 11 emerging from the system for secondary cooling, there is employed a gas-cutting machine 22, while for handling the cutoff portion 23 of the billet 11 there is provided a roller table 24.

The casting of metal on the proposed plant is effected as follows.

Into the cavity of the curvilinear mold 5 there is introduced a dummy bar (which is not shown in the drawings) covering the mold bottom with its head.

The intermediate vessel 3 is placed over the curvilinear mold 5 in such a manner that the nozzle 4 should be disposed above its cavity.

Thereafter, the intermediate vessel 3 is filled with molten metal, flowing via the nozzle 4 into the cavity of the curvilinear mold 5, wherein there occurs the initial crystallization of the molten metal.

The crystallizing metal, disposing itself along the internal surface of the curvilinear mold 5 and the surface of the dummy bar surface, forms a billet (ingot) 11 with a liquid phase therein, whose skin adheres to the surface of the dummy bar head. The body of the dummy bar (which is not shown in the drawing) is located between the working surfaces of the walking curvilinear bars 7.
The walking curvilinear bars 7 gradually extract the dummy bar, and together with it the billet 11 to be crystallized, from the curvilinear 5.

The billet 11 is cooled with water supplied by sprayers 19, disposed between the curvilinear mold 5 and walking curvilinear bars 7. When the billet 11 reaches the working surfaces of the walking bars 7 the billet is further cooled, through its contact with the cooled walking bars.

The walking curvilinear bars 7 have a radius of curvature equal to the radius of curvature of the inner walls of mold 5. The walking bars contact the billet perpendicular to its top and bottom faces and move the billet along the curvilinear path in known manner, as seen for example in U.S. Pat. No. 2,895,190. In FIG. 3 some of the walking bars are shown in clamped position, and other of the walking bars are shown in retracted position.

As the billet 11 is pulled from the mold 5, the molten metal is continued to be supplied into the latter so that there occurs a continuous forming of billet 11.

To prevent the skin of the billet 11 from sticking to the internal surface of the mold 5, the latter is vibrated in an oscillating manner by means of an oscillating mechanism 6 simultaneously with a supply of a lubricating substance placed in the cavity of the mold 5.

The billet thus continuously formed is fed by the walking bars 7 into the roller zone. Within the roller zone, the crystallizing billet 11 is moved by driven rollers 14 between the two rows 9 and 10 of the rollers provided within the section L having a curve whose radius of curvature gradually increases from the radius of curvature of the walking bars 7 to an infinite value, which ensures a progressive straightening of the billet 11, which operation is effected under the conditions where the liquid phase is present inside said billet 11.

Further, the billet 11 is directed into the rectilinear section L, of the roller zone.

The cooling of the crystallizing billet 11 in the roller zone is effected by water supplied through sprayers 20.

When the billet 11 passes through the system for secondary cooling, there occurs a gradual crystallization of the liquid phase inside the billet, and its complete crystallization should not occur until the moment of its emergence from rectilinear section L.

The continuous billet 11, emerging from the system for secondary cooling, is cut up by a gas-cutting machine 22 into parts 23 that are transported by the aid of a roller table 24.

The retaining of the crystallizing billet 11 and its contact-cooling by the walking bars 7, as well as its gradual straightening in the roller zone along L, and the presence of the rectilinear section L, of the roller zone, which may be extended without any variation in the design of the whole plant,—all this provides for an improvement in the quality of the billets obtained, a decrease in the height of the whole plant, and an increase in the casting speed.

We claim:

1. A plant for continuously casting metal comprising an intermediate vessel; a curvilinear mold positioned under said vessel, said mold having oscillating means; a system adapted to secondarily cool the continuously cast billet comprising a series of walking curvilinear bars juxtaposed said mold along the curvilinear path of said billet and having the same radius of curvature as said mold, said bars adapted to pull said billet from said mold and maintain its desired shape, two rows of rollers mounted adjacent said bars and above and below the curvilinear path of said billet, said rollers defining said curvilinear path such that the radius of curvature becomes increasing continuously greater to an infinite value; and a device adapted to cut the continuous billet emerging from said secondary cooling system.

2. A plant according to claim 1, wherein for increasing the roller zone of said system of secondary cooling it is provided with a rectilinear section complete with rollers, being essentially an extension of said continuously varying curvilinear section.

3. A plant according to claim 1, wherein some of the rollers of one of said rows are driven.

4. A plant according to claim 1, wherein between the rollers there are provided sprayers for supplying cooling fluid.

5. A plant according to claim 2, wherein some of the rollers of one of said rows are driven.

6. A plant according to claim 2, wherein between the rollers there are provided sprayers for supplying cooling fluid.

7. A plant according to claim 3, wherein between the rollers there are provided sprayers for supplying cooling fluid.

8. A plant according to claim 5, wherein between the rollers there are provided sprayers for supplying cooling fluid.