

## **CASTING DIE FOR CONTINUOUS CASTING OF BLOOMS, SLABS, AND BILLETS**

The invention relates to a mould for the continuous casting  
5 of blooms, slabs or billets according to the preamble of  
Claim 1.

Continuous casting moulds are known to be subjected to  
considerable thermal loads during operation as a result of  
10 the molten metal solidifying in the mould cavity.  
Consequently, said thermal loads cause thermal expansion of  
the mould walls and thus lead to deformations of the  
accurately produced mould cavity. Particularly undesirable  
are deformations transversely to the direction of casting,  
15 as they alter the conicity of the mould which is important  
for the solidifying process. Therefore, particular measures  
have to be taken in order to stabilise the mould walls in  
their position.

20 It is known from the generic EP-B1-1 468 760 to arrange a  
supporting shell around the copper mould tube forming the  
mould cavity, on which the mould tube is supported by  
support profiles extending in its longitudinal direction  
and distributed over the periphery. The mould tube is  
25 positively connected to the supporting shell via connecting  
profiles extending in the longitudinal direction, cooling  
ducts being arranged between the mould tube and the  
supporting shell for guiding cooling water, which are  
defined by the support profiles and/or the connecting  
30 profiles. The connecting profiles are, for example,  
configured as dovetail profiles or T-profiles which engage  
in corresponding grooves of the supporting shell. They are

inserted into the grooves in the longitudinal direction of the mould. This assembly is not always straightforward, as it results in friction on sealing elements provided between the mould walls and the supporting shell. The mould tube  
5 walls are respectively not only secured in the direction perpendicular to the casting axis, but also prevented from thermal expansion in the wall plane and/or supporting plane, transversely to the casting axis. The latter may lead to stresses and permanent deformation and fatigue  
10 cracks of the mould tube.

The object of the present invention is to provide a mould of the aforementioned type which, during the casting operation, has a high degree of dimensional stability and  
15 in which, however, deformations caused by thermal expansion of the mould walls may be substantially avoided.

This object is achieved according to the invention by a mould with the features of Claim 1.

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Further preferred embodiments of the mould according to the invention form the subject-matter of the dependent claims.

According to the invention, the connecting profiles are  
25 respectively configured as two profile strips outwardly projecting from the outer periphery of the mould tube and inwardly projecting from the inner periphery of the supporting shell, which engage in one another such that in the peripheral direction of the mould a clearance is  
30 present. As a result of the profile strips, the mould tube walls are held against the walls of the protective cover supporting said mould tube walls in the direction

perpendicular to the casting axis, but a displacement along the mould wall caused by thermal expansion is possible, primarily in the longitudinal direction of the mould, but also within the clearance provided transversely thereto in the peripheral direction of the mould. As a result, the stresses, the permanent deformations and fatigue cracks caused by the thermal expansion in the mould tube are substantially avoided. Not least, the assembly of the mould is also simplified.

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The invention is described hereinafter in more detail with reference to the drawings, in which:

Figure 1 shows in a perspective view an embodiment of a mould according to the invention with a mould tube and a supporting shell made up of four support plates;

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Figure 2 shows the mould according to Figure 1 in horizontal cross section;

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Figure 3 shows a horizontal partial section according to Figure 2 in enlarged scale;

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Figure 4 shows the mould according to Figure 1 in vertical cross section along the line IV-IV in Figure 2;

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Figure 5 shows one of the support plates in perspective view;

- Figure 6 shows a second embodiment of a mould according to the invention in horizontal cross section;
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- Figures 7a, 7b, 7c show a support plate and a part of the mould tube with two further support plates separated from one another as well as in an assembled state according to a further embodiment;
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- Figures 8a, 8b show in horizontal cross section a first embodiment of connecting profiles for connecting the mould tube to the supporting shell;
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- Figures 9a, 9b shows in horizontal cross section a second embodiment of connecting profiles for connecting the mould tube to the supporting shell;
- 20
- Figure 10 shows a mould plate for a plate mould with a corresponding support plate;
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- Figure 11 shows a further embodiment of a mould wall for a plate mould with corresponding support plates;
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- Figure 12 shows an embodiment of a mould according to the invention in perspective view with a mould tube and four support plates, and

Figure 13 shows a further embodiment of a mould tube which is rectangular in cross section with the supporting shell in horizontal cross section.

In Figures 1 to 4, a mould 1 is shown for the continuous casting of blooms, slabs or billets of rectangular cross section, which comprises a mould tube 2 made of copper, which forms a mould cavity 3, as well as a supporting shell 4 surrounding the mould 2. The supporting shell 4 is made up of four support plates 5, 5', which are connected to one another by means of screws 6. Between the mould tube 2 and the supporting shell 4, cooling ducts 10 are provided for guiding cooling water, which form part of a water circulation cooling system for the copper tube, and which are distributed over the entire periphery and substantially over the entire length of the mould tube 2 (see in particular Figures 2 and 4). The support plates 5, 5' are provided in the upper region and in the lower region with inlets and outlets 11, 12 connected to the cooling ducts 10, for the cooling water.

In the embodiment shown, the cooling ducts 10 are incorporated, for example machined, in the outer peripheral surface of the mould tube 2. The mould tube 2 is, on the one hand, supported via support profiles 15 on the supporting shell 4 and/or on the support plates 5, 5' extending in the longitudinal direction L thereof and distributed over the periphery and, on the other hand, said mould tube is releasably positively connected to said

support plates 5, 5' via connecting profiles 20 extending in the longitudinal direction. The cooling ducts 10 are in this case laterally defined by the support profiles 15 and/or the connecting profiles 20.

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According to the invention, the connecting profiles 20 are respectively configured as two profile strips 21, 22 which engage in one another, outwardly projecting from the outer periphery of the mould tube 2 and inwardly projecting from  
10 the inner periphery of the supporting shell 4. They are distributed over the respective mould side, the number thereof per side being dependent on the size of the mould. In the mould 1 which is rectangular in cross section, for example according to Figure 2, the wider support plates 5  
15 are each provided with four connecting profiles and the narrower support plates 5' are each provided with two connecting profiles 20.

The profile strips 21, 22 are preferably of nose-shaped  
20 configuration in cross section (as is described in more detail below with reference to Figures 8a, 8b and 9a, 9b) and engage in one another such that in the peripheral direction of the mould 1 a clearance is present. The mould walls are held in the position resting against the support  
25 plates 5, 5' in the direction perpendicular to the casting axis, but a mutual displacement along the mould wall caused by thermal expansion is possible, primarily in the longitudinal direction L of the mould, but also within the clearance provided transversely thereto, in the peripheral  
30 direction of the mould. In order to permit this displacement, the mould tube 2 is held in the corner regions thereof with a corresponding clearance relative to

the supporting shell 4. Each of the support plates 5, 5' is advantageously provided in its peripheral region with a sealing ring 23, 23' sealing the cooling zone, which is inserted into a channel 24 visible from Figure 5 which  
5 shows the support plate 5.

While the profile strips 21 are directly manufactured on the mould tube 2, i.e. are integral with the mould tube 2, in particular with large-sized moulds and with the presence  
10 of sealing rings 23, 23', it is advantageous in terms of assembly to design the profile strips 22 for the support plates 5, 5' separately, such as for example shown in Figures 2 to 4. These are then inserted into corresponding  
15 recesses 25 of the support plates 5, 5' and connected by means of screws 26 distributed over the entire strip length to the support plates 5, 5'. In this case, during the assembly no lateral displacement of the support plates 5, 5' on the sealing rings 23, 23' is required as the  
20 previously inserted profile strips 22 now only have to be tightened against the support plates 5, 5'.

As shown in Figures 6 and 7a, 7b, 7c, however, in particular with smaller moulds it is perfectly possible to manufacture the profile strips 22 for the support plates 5, 5' directly on the support plates 5, 5', i.e. to configure  
25 said profile strips integrally with the respective support plate 5, 5'.

In the smaller mould 1' shown in Figure 6, of square cross  
30 section, respectively only one connecting profile 20' is present, consisting of two profile strips engaging in one another, for each mould side (and a plurality of support

profiles 15'). The connecting profiles 20' connecting the mould tube 2' to the supporting shell 4', are respectively arranged in the central region of the respective mould wall.

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As required, according to Figures 7a, 7b, 7c a plurality of connecting profiles 20" may also be provided for each mould side, which consist of profile strips 21" integrally configured with the mould tube 2" and profile strips 22" integrally configured with the respective support plate 5". The mould tube 2" may comprise just one support profile 15" per side arranged in the centre region or a plurality of support profiles 15".

15 In the embodiments according to Figures 6 and 7a, 7b, 7c, during assembly the respective support plate 5" has to be displaced laterally relative to the mould tube wall, until the profile strips 21", 22" are engaged. Even with the presence of sealing rings, in this case the assembly is substantially simpler than in the moulds known from EP-B1-1 468 760, relative to which there is no comparison between the amount of lateral displacement in the mould according to the invention and the longitudinal displacement during assembly according to EP-B1-1 468 760. Additionally, the 20 respective support plate 5" may be slightly obliquely positioned until engaged and as a result friction on the sealing ring is avoided.

Particularly advantageous cross-sectional shapes of the 30 profile strips 21, 22 are visible from Figures 8a, 8b and 9a, 9b. The profile strips 21, 22 which are nose-shaped in cross section, project by an amount a from a bottom surface

27 and/or 28 of the mould tube 2 and/or the support plate 5. The profile strip 21 of the mould tube 2 has a support face 29 with which it rests in the assembled state against the bottom surface 28 of the support plate 5 and vice versa, the support plate 5 comes to bear with a support face 30 on the bottom surface 27 of the mould tube 2. The profile strips 21, 22 respectively have a rounded nose 31 and/or 32 which is oriented in the peripheral direction of the mould, with a radius  $r_1$ , which is engaged from behind by a similarly rounded recess 33 and/or 34 opposing the nose in the peripheral direction with a radius  $r_2$ . The radius  $r_2$  of the recesses 33, 34 is in this case slightly greater than the radius  $r_1$  of the two noses 31, 32. When joining the two profile strips 21, 22, the nose of the one profile strip engages in the recess of the other profile strip, and namely with a lateral clearance of, for example,  $\pm 0.1$  mm, which is produced from the difference of the two radii  $r_1$ ,  $r_2$ , so that within this clearance a mutual displacement caused by thermal expansion may occur along the mould wall in the peripheral direction of the mould.

Naturally, a mutual displacement caused by thermal expansion in the longitudinal direction of the profile strips 21, 22 is also possible, i.e. in the longitudinal direction of the mould. In this manner, stresses, plastic deformation and fatigue cracks in the mould tube, which are otherwise caused by the thermal expansion, are avoided.

The size of the mould is important for the amount of lateral clearance. With larger moulds, a larger clearance has to be additionally ensured. A possible cross-sectional shape of the nose-shaped profile strips 21, 22 for larger

moulds is shown in Figures 9a, 9b, where the nose 31' and/or 32' of the one profile strip 21 and/or 22 is able to engage respectively in the recess 34' and/or 33' of the other profile strip 22 and/or 21 with greater clearance in the peripheral direction.

Instead of an integral mould tube 2 and/or 2' and/or 2", it is also possible and perfectly usual to make up the mould forming the mould cavity as a plate mould with mould tube walls formed from individual copper plates or the like. One or more support plates are thus associated with the individual mould plates and/or mould tube walls, which form the supporting shell around the plate moulds.

Figure 10 shows as an example a mould plate 42 of a plate mould for continuous casting of thin slabs. The longitudinal sides of such moulds are 1 to 2 m and the narrow sides only 50 to 10 mm wide. The mould plates 42 on the longitudinal sides are provided in the upper region with a bulged portion 50 for the immersion tube, i.e. the extension of the mould tube wall is not straight in all parts. Also, the support plate 45 associated with the mould plate 42 is provided on the inner face with a corresponding recess 51. The cooling ducts 10 are in turn provided between the mould plate 42 and the support plate 45, and which are defined by the support profiles 10 and/or the connecting profiles 20.

According to the invention, the connecting profiles 20 are, in turn, configured as two profile strips 21, 22 engaging in one another with noses 31, 32 oriented in the peripheral direction of the mould and engaging in one another with

clearance. In the oblique region of the bulged portion 50 and/or of the recess 51, the noses 31, 32 are also obliquely oriented, parallel to the mould inner surface 50a, 50b. Thus it is also possible for this wide and  
5 relatively thin copper plate, which is subjected to significant thermal expansion relative to the more solid steel support plate, actually to expand along the mould wall. In this variant, it is naturally advantageous to design the profile strips 22 for the support plate 45  
10 separately and to insert said profile strips into the support plate 45.

Figure 11 shows a copper mould tube wall 52 of a plate mould for the continuous casting of preliminary double-T  
15 sections, which has a web part 52a, two flange parts 52b and one respective oblique part 52c connecting the web part 52a to the respective flange part 52b. A support plate 55a is associated with the web part 52a. The flange parts 52b are also provided with one respective support plate 55b.  
20 Between the support plate 55a for the web part 52a and the support plate 55b for the flange parts 52b, respectively one support plate 55c is arranged extending along the oblique parts 52c and overlapped by the adjacent support plates 55a, 55b. Even in this case, the support profiles 10  
25 and/or the connecting profiles 20 are present, said connecting profiles being configured as two profile strips 21, 22 engaging in one another with noses 31, 32 oriented in the peripheral direction of the mould and engaging in one another with clearance. The noses 31, 32 are also in  
30 this case always oriented parallel to the mould inner surface in the peripheral direction of the mould, even in the region of the oblique parts 52c. In contrast to the

embodiment of Figure 10, however, the profile strips 22 are always perpendicular to the respective wall part. Thus, with this shape of mould, consideration also has to be given to the thermal expansion of the entire area of the individual mould walls of the mould tube.

Both with the plate mould according to Figure 10 and with the plate mould according to Figure 11, the noses 31, 32 are arranged symmetrically relative to the centre plane (A) extending transversely to the longitudinal extension of the mould which is of elongate configuration.

Figure 12 shows a mould tube 60 with a mould cavity 3 which per se is designed in the same manner as that according to Figure 1 to Figure 5, and thus not described further in detail. As a particularity, however, the support plates 61, 62 are not configured as a supporting shell forming a box, but they are fastened independently from one another by means of the profile strips according to the invention to the four external walls 60' of the mould tube 60 which are respectively present. These support plates 61, 62 are advantageously designed to be trapezoidal in horizontal cross section and form a planar surface resting on the respective outer wall 60' of the tube 60, so that the cooling ducts 10 machined into the outer face in the tube 60 are covered thereby. These support plates 61, 62 thus form only one type of reinforcement of the relatively thin-walled mould tube.

The mould tube 60 is held together with the support plates 61, 62 in a mould housing, not shown in more detail, which is in two parts and, to this end, may comprise a centre

flange, not shown, which surrounds the support plates 61, 62. The cooling water in the inside of the mould housing is conducted upwards on the lower face through the cooling ducts 10 of the tube and reaches the mould housing again on the upper face.

In this variant according to Figure 12, a simplified embodiment of a mould, in particular, results as the support plates 61, 62 are not connected to one another. Naturally, these support plates could also be of different design, for example by the cooling ducts being associated with these support plates.

A further mould 1" with an elongate rectangular cross section according to Figure 13 has a mould tube 71 and a supporting shell 74 surrounding said mould tube, the supporting shell 74 being divided in its longitudinal direction at the points 74' and thus consisting of four cover parts which are screwed together at these points 74'.

The particularity of this mould 1" is that according to the invention only on the two elongate sides of the mould 1" are two respective connecting profiles 70 provided, which are arranged symmetrically to the centre axis A of the longitudinal sides. These connecting profiles 70 are configured per se to be the same as those according to Figure 2 and therefore not explained further in detail. Due to the relatively thin wall of the supporting shell 74, on the outer face thereof, in the vicinity of the connecting profiles 70, longitudinal profiles 76 and moreover transverse profiles 77 are welded. The longitudinal profiles 76 are secured by screws. Naturally, more than two

such connecting profiles 70 could also be associated per side.

## Claims

1.     Mould for the continuous casting of blooms, slabs or  
billetts comprising a mould tube (2; 2'; 2") and/or  
5     plate mould surrounded by a supporting shell (4; 4')  
and/or support plates (61, 62), the mould tube (2; 2';  
2") and/or the plate mould being supported via support  
profiles (15; 15'; 15") on the supporting shell (4;  
4') and/or on the support plates (61, 62) extending in  
10    its longitudinal direction (L) and distributed over  
the periphery and being positively connected thereto  
via connecting profiles (20; 20'; 20") extending in  
the longitudinal direction, cooling ducts (10) for  
guiding cooling water, defined by the support profiles  
15    (15; 15'; 15") and/or the connecting profiles (20;  
20'; 20"), being arranged between the mould tube (2;  
2'; 2") and/or the plate mould and the supporting  
shell (4; 4') and/or supporting plates (61, 62),  
characterised in that the connecting profiles (20;  
20    20'; 20") are respectively configured as profile  
strips (21, 22; 21", 22") outwardly projecting from  
the outer periphery of the mould tube (2; 2'; 2")  
and/or the plate mould and inwardly projecting from  
the inner periphery of the supporting shell (4; 4')  
25    and/or the support plates (61, 62), which engage in  
one another such that in the peripheral direction of  
the mould a clearance is present.
  
2.     Mould according to Claim 1, characterised in that the  
30    profile strips (21, 22; 21", 22") are nose-shaped in  
cross section, respectively one nose (31, 32; 31',  
32') of the one profile strip (21, 22; 21", 22")

oriented in the peripheral direction of the mould engaging in a recess (33, 34; 33', 34') engaging behind the nose (32, 31; 32', 31') of the other profile strip (22, 21; 22", 21").

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3. Mould according to Claim 1 or 2, characterised in that the mould tube (2; 2'; 2") has a square or rectangular cross section and the supporting shell (4; 4') is made up of four support plates (5, 5'; 5", 61, 62), a  
10 connecting profile (20') or a plurality of such connecting profiles (20; 20") - distributed over the mould side - arranged in the centre region and comprising two profile strips engaged in one another being associated with each mould side.

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4. Mould according to Claim 3, characterised in that the profile strips (21"; 22") forming the connecting profiles (20'; 20") are integrally configured with the mould tube (2'; 2") and/or with the respective support  
20 plate (5").

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5. Mould according to Claim 3, characterised in that the profile strips (22) associated with the support plates (5, 5') are respectively inserted into a recess (25)  
of the support plate (5, 5') and connected, preferably screwed, to the support plate (5, 5').

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6. Mould according to one of Claims 3 to 5, characterised in that the mould tube (2; 2'; 2") is held in the corner region of the supporting shell (4; 4') with a clearance.

7.     Mould according to one of Claims 1 to 6, characterised  
in that the profile strips (21, 22; 21", 22")  
substantially extend over the entire length of the  
mould tube (2; 2'; 2") and/or the supporting shell (4;  
5     4').
8.     Mould according to Claim 1 or 2, characterised in that  
the plate mould forming the mould cavity is made up of  
a plurality of copper plates (42) and/or of mould tube  
10     walls (52) formed in a plate-shaped manner, one or  
more support plates (45; 55a, 55b, 55c) being  
associated with each plate (42) and/or mould tube wall  
(52) and being connected thereto via the connecting  
profiles (20) configured as profile strips (21, 22)  
15     engaging in one another.
9.     Mould according to Claim 8, characterised in that the  
profile strips (21, 22) are of nose-shaped  
configuration in cross section, respectively one nose  
20     (31, 32) of the one profile strip (21, 22) oriented in  
the peripheral direction of the mould engaging in a  
recess (33, 34; 33', 34') engaging behind the nose  
(32, 31) of the other profile strip (22, 21), the  
noses (31, 32) in each region of the mould tube wall  
25     (52) being oriented parallel to this wall part.
10.    Mould according to Claim 9, characterised in that the  
noses (31, 32) are arranged symmetrically relative to  
the centre plane (A) extending transversely to the  
30     longitudinal extension of the mould.

11. Mould according to Claim 1, characterised in that support plates (61, 62) are provided which are fastened independently of one another by means of the profile strips to the respective outer walls (60') of the mould tube (60).  
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12. Mould according to Claim 11, characterised in that the support plates (61, 62) rest against the mould tube (60), such that the cooling ducts (10) machined into the outer face in the tube (60) are covered by the support plates.  
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13. Mould tube for a mould according to one of Claims 1 to 7, characterised in that connecting profiles (20; 20'; 20'') are provided which are respectively configured as outwardly projecting profile strips (21; 21'').  
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14. Plate mould for a mould according to one of Claims 1, 8, 9 or 10, characterised in that connecting profiles (20) are provided which are respectively configured as outwardly-projecting profile strips (21; 21'').  
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15. Support plates for a mould according to one of Claims 1 to 12, characterised in that connecting profiles (20; 20'; 20'') are provided which are respectively configured as inwardly-projecting profile strips (22; 22'').  
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16. Mould according to Claim 1, characterised in that connecting profiles (70) are associated with only two opposing sides of the mould (1''), preferably in a  
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symmetrical arrangement relative to the centre axis A  
of these sides.