United States Patent [19]

Bengel et al.

[11] **3,863,356**

[45] **Feb. 4, 1975**

[54] **METHOD AND APPARATUS FOR CHECKING GUIDE-ROLL ALIGNMENT IN A CONTINUOUS-CASTING MACHINE**

[75] Inventors: **Thomas G. Bengel,** Plum Borough; **Joseph S. Giunia,** Monroeville Borough; **Thomas E. Nicely,** Westmoreland, all of Pa.

[73] Assignee: **United States Steel Corporation,** Pittsburgh, Pa.

[22] Filed: **Sept. 18, 1972**

[21] Appl. No.: **289,922**

[52] **U.S. Cl.** **33/286,** 33/228

[51] **Int. Cl.** **G01c 15/00**

[58] **Field of Search** 33/228, 286, 293

[56] **References Cited**

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Primary Examiner—Harry N. Haroian
Assistant Examiner—Richard R. Stearns
Attorney, Agent, or Firm—Walter P. Wood

[57] **ABSTRACT**

A method and apparatus for checking the vertical and rotational alignment of guide rolls of a continuous-casting machine with respect to one another and with respect to a mold thereabove. Apparatus includes a self-centering target which is suspended into the roll pass from a reeling mechanism mounted on the mold. The target is moved to various levels in the roll pass and sighted on with a transit mounted on a stand over the mold and centered with respect to the mold.

4 Claims, 7 Drawing Figures

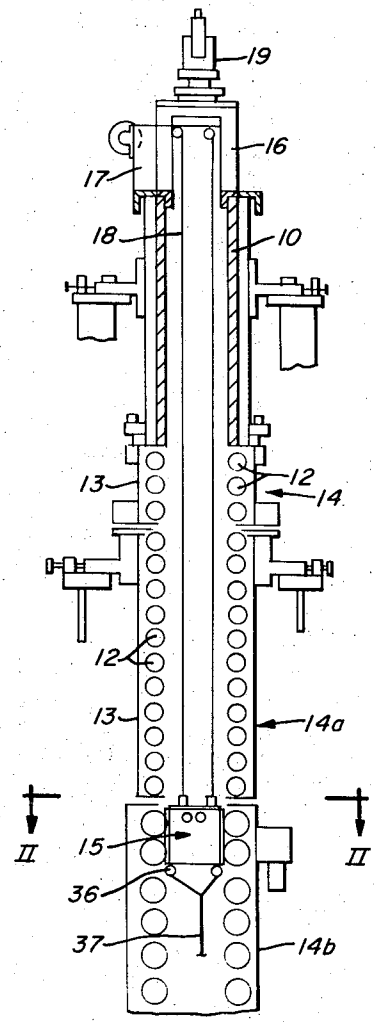


FIG. 7

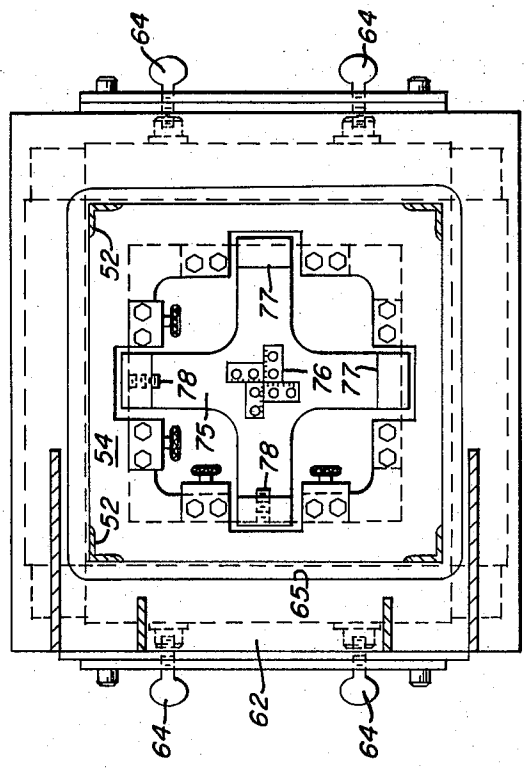

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62
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64

FIG. 1

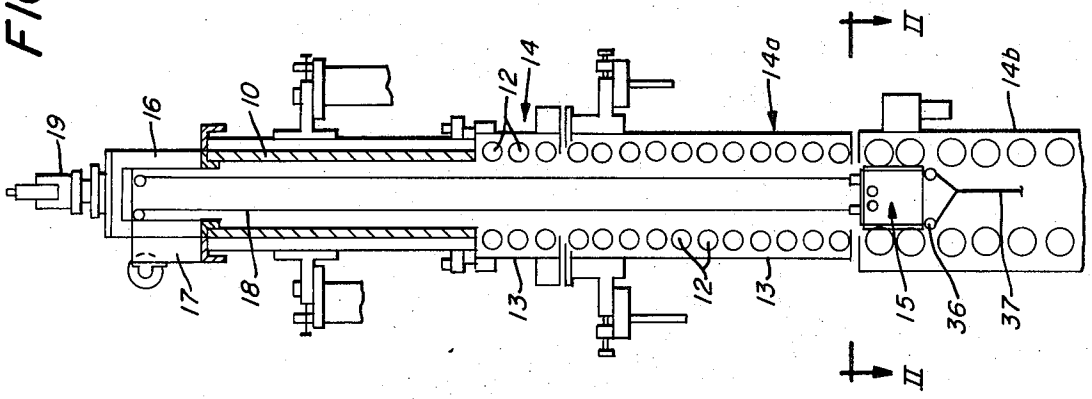

19
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12
14
14a
II
14b
17
18
13
12
13
15
36
37
II

FIG. 2

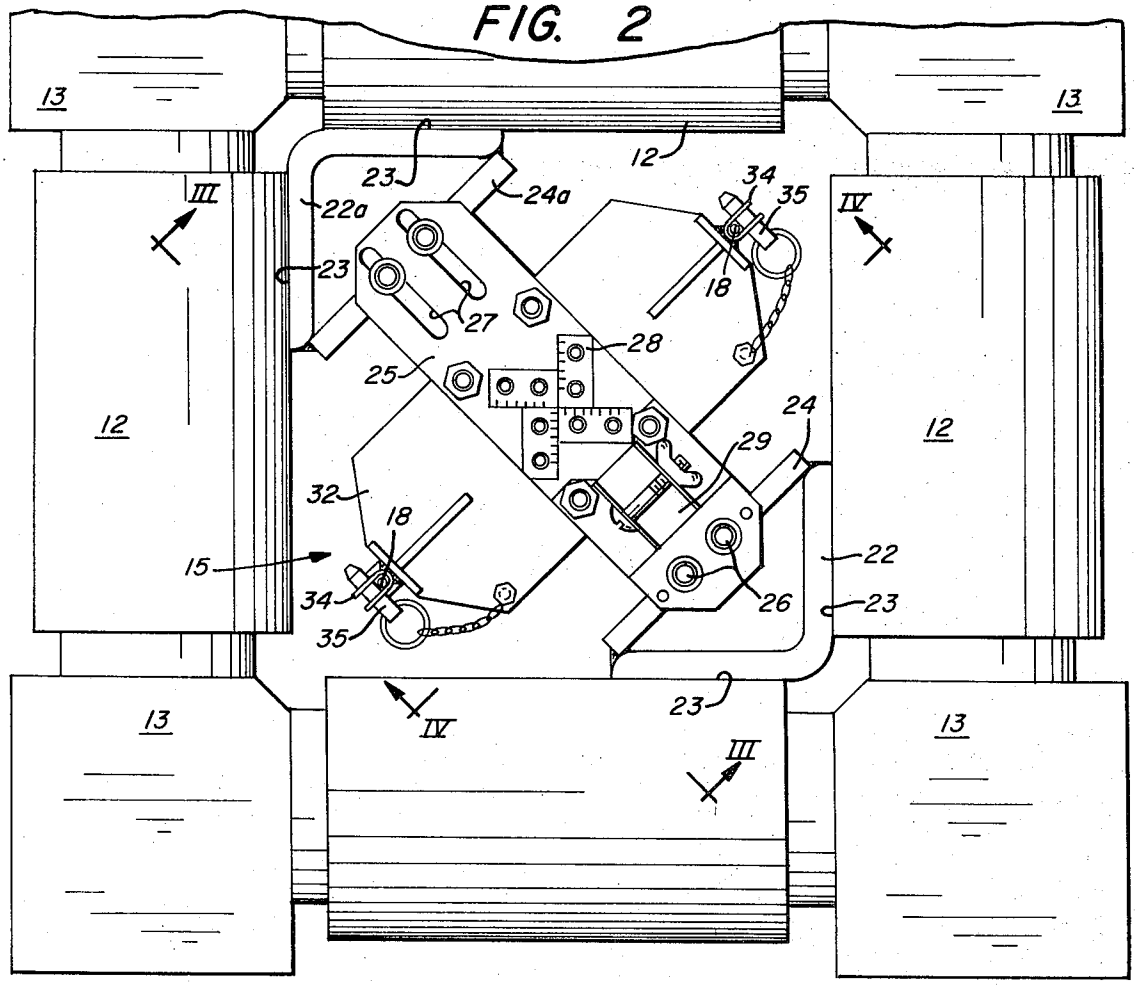

13
12
III
IV
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24a
22a
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FIG. 4

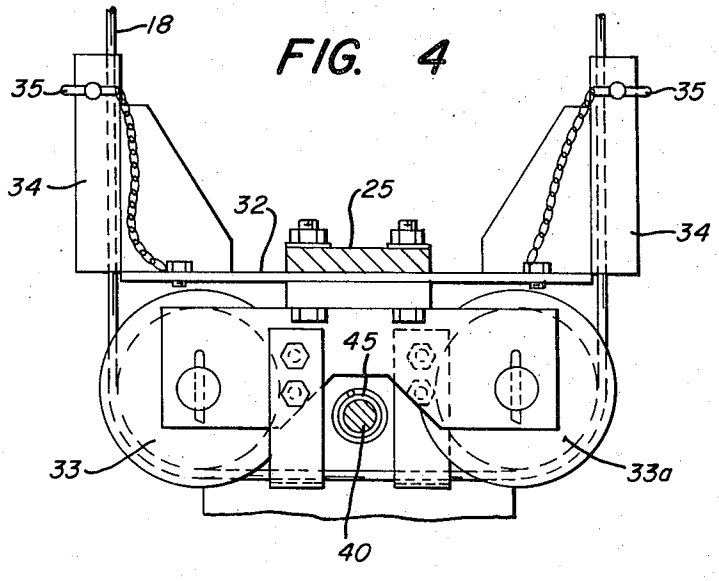

18
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33
33a
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FIG. 3

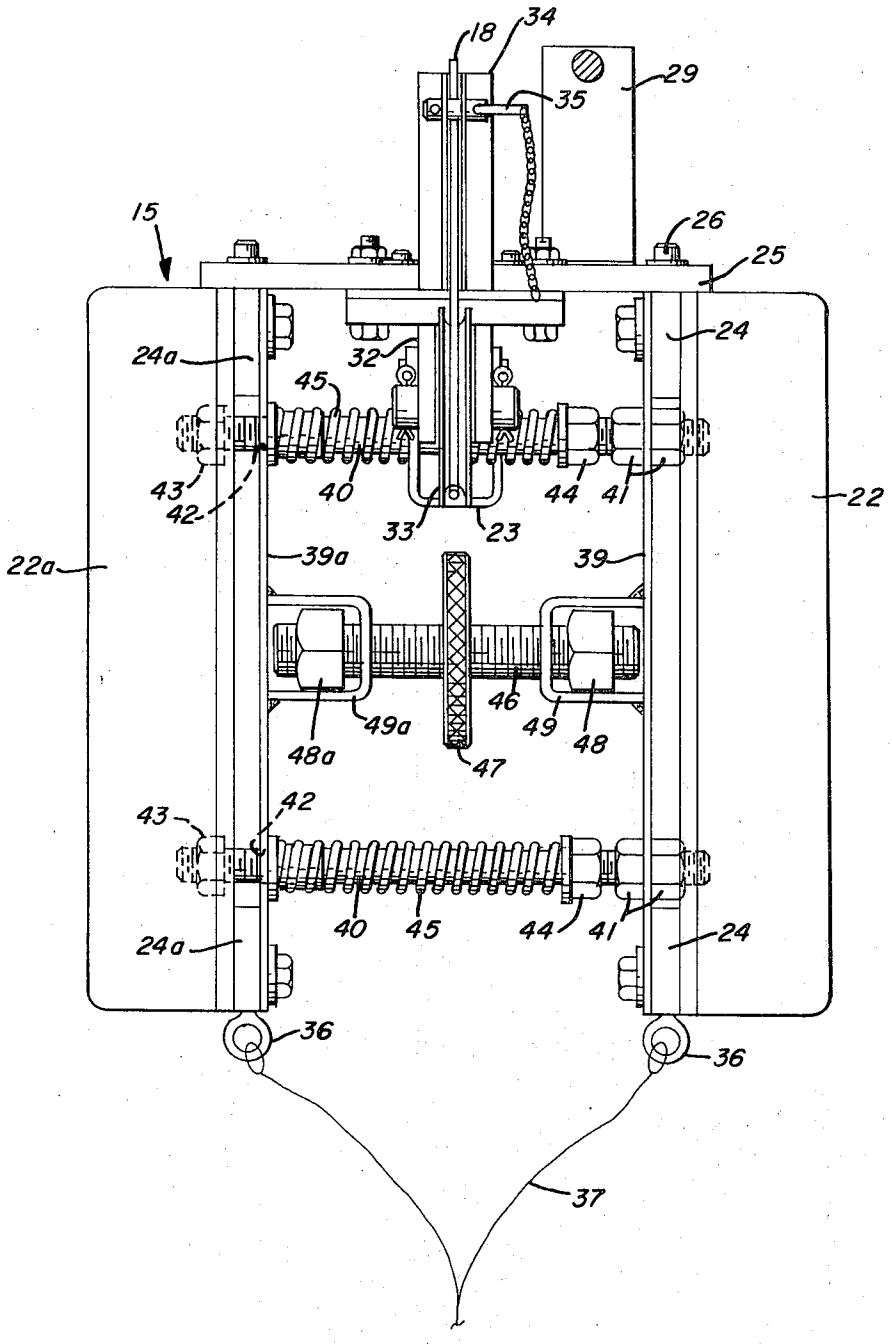

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39a
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49a
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48a
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24a
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FIG. 5

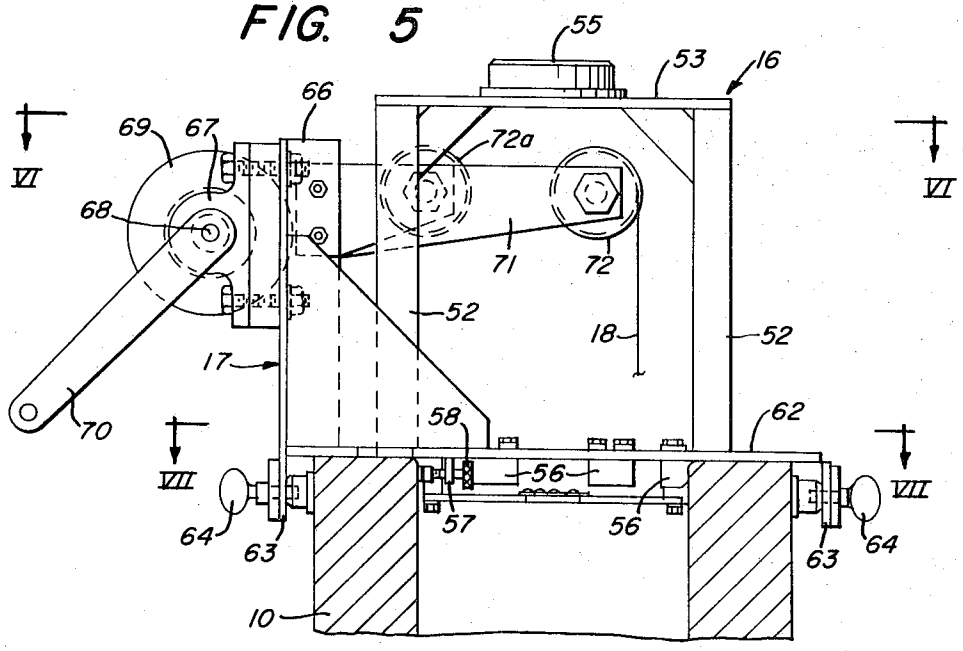
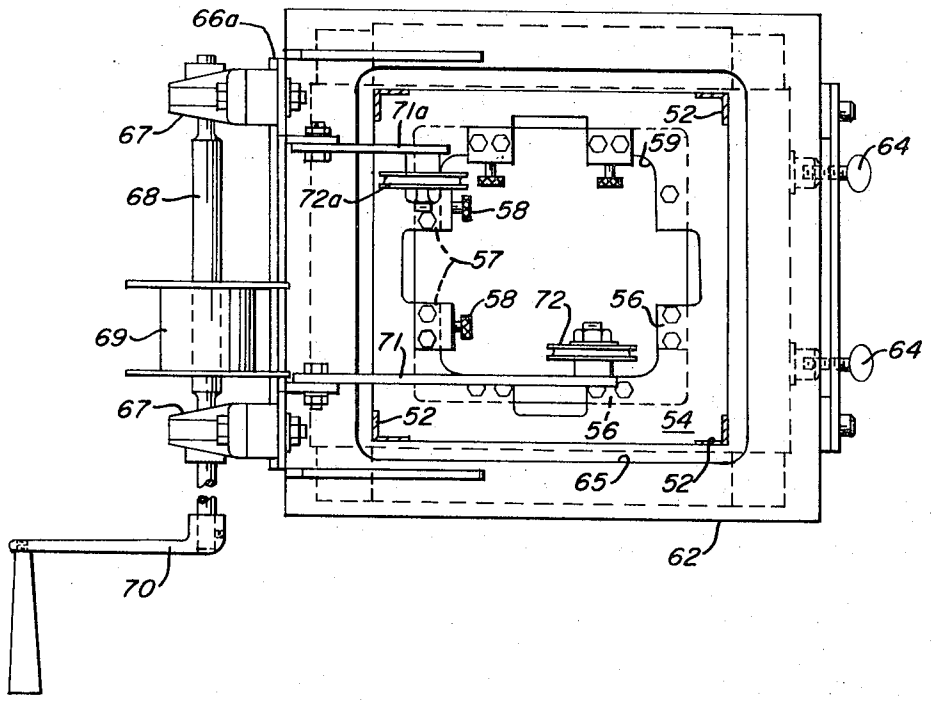

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72a
VI
VI
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18
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17
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VII
56
VII
64
63
57
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63
64
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FIG. 6


66a
71a
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72a
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METHOD AND APPARATUS FOR CHECKING GUIDE-ROLL ALIGNMENT IN A CONTINUOUS-CASTING MACHINE

This invention relates to an improved method and apparatus for checking guide-roll alignment in a continuous-casting machine.

In a conventional continuous-casting operation, liquid metal is poured through an open-ended water-cooled vertically oscillating mold. A casting, which at this stage has only a relatively thin solidified skin and a liquid core, emerges continuously from the lower end of the mold. Immediately beneath the mold the casting travels between guide rolls where water is sprayed on its surface to effect further solidification. The guide rolls define a pass which confines the casting and which must be accurately aligned both vertically and rotationally throughout its height and accurately aligned with the mold. Any misalignment of the guide can cause defects in the casting, or even rupture the skin and cause a break-out of liquid metal.

Although our invention is not limited to use with casting machines of any specific construction, it is particularly useful as applied to guide rolls which are journaled in sectional racks of the construction shown in Hofmann and Stull U.S. Pat. No. 3,672,438 of common ownership. The patent shows vertically aligned rack sections, each of which includes a rigid cage and idler rolls journaled within the cage to encompass four sides of a casting. Each rack section is supported on a respective pair of arms hinged to a supporting structure, whereby the arms and section can swing out of the path of the casting to enable the section to be lifted from the arms and removed for servicing. When the rack sections are returned to their operative positions in the path of the casting, they must of course be accurately realigned, and this is accomplished by inserting shims between the cages and the supporting structure.

Heretofore roll alignment has been checked either by suspending a plumb bob from the mold through the rack sections and measuring the distance from the plumb bob line to reference surfaces or points on the rack sections, or by sighting down the roll rack from a vertical transit mounted on a tripod over the mold. Neither procedure has been fully satisfactory. Small movement of the supporting structure or plumb bob line interferes with accuracy. Use of a plumb bod is time-consuming, especially since the interior of the rack sections is not easily accessible. When a vertical transit is used, it is necessary to insert a target repeatedly at different levels in the rack, likewise a time-consuming and awkward procedure.

An object of our invention is to provide an improved method and apparatus for checking roll alignment and achieving greater accuracy than procedures used heretofore, and also accomplishing the operation more easily and expeditiously.

A more specific object is to provide a roll-alignment checking apparatus which includes a self-centering target movable vertically between guide rolls to all levels below a mold, and a reeling mechanism and a transit stand both to be mounted on the mold for suspending the target and supporting a vertical transit.

A further object is to provide, as a subcombination of the foregoing apparatus, a self-centering target for installation between the guide rolls of a continuous-casting machine.

In the drawings:

FIG. 1 is a diagrammatic vertical sectional view of a mold and guide rolls on which our alignment-checking apparatus is installed;

FIG. 2 is a top plan view of a roll-rack section in which is installed the self-centering target embodied in our apparatus, the view being taken on line II—II of FIG. 1;

FIG. 3 is a vertical section on line III—III of FIG. 2 with the roll-rack omitted;

FIG. 4 is a vertical section on line IV—IV of FIG. 2 again with the roll rack omitted;

FIG. 5 is a side elevational view of the reeling mechanism and transit stand embodied in our apparatus;

FIG. 6 is a horizontal section on line VI—VI of FIG. 5; and

FIG. 7 is a horizontal section on line VII—VII of FIG. 5.

FIG. 1 shows diagrammatically a portion of a continuous-casting machine which includes a mold **10** and series of guide rolls **12** below the mold. The latter are journaled in a suitable frame or cage **13**. Both the mold and guide rolls may be of conventional construction, or the guide rolls may be arranged in rack sections **14**, **14***a* and **14***b* constructed as shown in the aforementioned patent. Hence no more detailed description of the casting machine is deemed necessary.

Out alignment-checking apparatus comprises a self-centering target **15** installed within the pass defined by the guide rolls **12**, a transit stand **16** mounted on the mold **10**, and a reeling mechanism **17** also mounted on the mold. We suspend the target from the reeling mechanism with a flexible double line **18**. The stand **16** carries a conventional vertical transit **19**.

FIGS. **2**, **3** and **4** show details of the self-centering target **15**. The target includes a pair of diagonally opposed vertically extending angle irons **22** and **22***a* which afford four roll-contacting faces **23** each lying at a right angle to the adjacent such face. Mounting bars **24** and **24***a* are welded across the angle irons **22** and **22***a* respectively at the upper and lower ends of each angle iron. A diagonally extending grid support **25** spans the space between the two upper mounting bars, and is fixed to the upper edge of bar **24** with cap screws **26**, but slidably connected to the upper edge of bar **24***a* with similar cap screws which extend through slots **27**. The upper face of support **25** carries a grid pattern **28**, the center of which lies on the vertical center line of the roll pass when the roll-contacting faces **23** are in contact with rolls **12**, that is, when the target is set to be sighted on, as hereinafter explained. The support **25** preferably also carries a light stand **29** which contains a battery operated light directed toward the grid pattern **28**.

We bolt a sheave housing **32** to the underside of the grid support **25** and journal a pair of sheaves **33** and **33***a* within the housing at opposite ends thereof. The housing extends diagonally of the roll pass, but at right angles to the grid support **25**. The line **18** extends under support **25** and housing **32** and around sheaves **33** and **33***a*, as shown in FIG. **4**, for supporting and raising the target. At its opposite ends the housing carries upstanding guides **34** for the line **18**. Removable pins **35** retain the lines in the guides. The bottom edges of the mounting bars **24** and **24***a* carry eye bolts **36** to which we connect a line **37** for pulling the target downwardly through the roll pass.

We bolt vertically extending plates 39 and 39*a* to the two mounting bars 24 and to the two mounting bars 24*a* respectively. We fix upper and lower bolts 40 to the plate 39 with nuts 41 which bear against opposite faces of the plate. Bolts 40 extend diagonally of the roll pass in the same direction as the grid support 25. These bolts are slidably received in holes 42 in the plate 39*a*, and carry nuts 43 limiting relative outward or expension movement of the plate and angle iron 22*a*. Bolts 40 carry additional nuts 44 and compression springs 45 which bear at opposite ends against nuts 44 and plate 39*a*, thus urging the angle irons apart to expand the target. An adjusting screw 46, which has right and left hand threaded sections extending in opposite directions from a handwheel 47 fixed to its midportion, is threadedly engaged with nuts 48 and 48*a*. These nuts are slidably but non-rotatably mounted in brackets 49 and 49*a* carried by the plates 39 and 39*a* respectively.

To insert the target 15 in the roll pass or remove it therefrom, we turn the screws 46 in a direction to pull the two angle irons 22 and 22*a* toward each other against the action of springs 45 and thus contract the target. In this position of adjustment the target can move freely through the mold 10. When the target is within the rolls, we turn the screw in the opposite direction a sufficient distance that the springs 45 expand the target and force the roll-contacting faces 23 of angle irons 22 and 22*a* into contact with rolls 12. In this position the grid pattern 28 is centered within the roll pass. It is of course necessary that each target be dimensioned to fit a specific set of guide rolls.

FIGS. 5 and 6 show details of the transit stand 16 and reeling mechanism 17. The transit stand includes four legs 52, a top plate 53 fixed to the upper ends of the legs and a base plate 54 fixed to the lower ends. The top plate 53 carries a conventional transit adapter 55 on which we mount the aforementioned transit 19. The base plate 54 carries four depending fixed blocks 56, two of which abut one inside of mold 10 and the other two of which abut a second inside face of the mold at right angles to the first. The base plate 54 also carries four depending brackets 57 in which thumb screws 58 are threadedly engaged. Two of the thumb screws abut one inside face of mold 10 opposite two blocks 56, and the other two thumb screws abut the fourth inside face of the mold. The central portion of the base plate is open as indicated at 59.

The reeling mechanism 17 includes a mounting plate 62 which has depending brackets 63 and thumb screws 64 threadedly engaging the brackets. The central portion of plate 62 is open as indicated at 65. We mount the reeling mechanism on mold 10 by tightening the thumb screws 64 against two opposed outside faces of the mold. One edge of plate 62 carries a pair of upstanding legs 66 and 66*a* which carry a pair of aligned bearings 67. A shaft 68 is journaled in bearings 67 and carries a reel 69 and a hand crank 70. Relatively long and relatively short horizontal arms 71 and 71*a* are fixed to legs 66 and 66*a*. We journal sheaves 72 and 72*a* to arms 71 and 71*a*, which sheaves are tangentially aligned with sheaves 33 and 33*a* respectively of target 15. Line 18 is attached at one end to sheave 72*a*, extends around sheaves 33 and 33*a* on the target 15, as already described, and around sheave 72, and is wound on reel 69. Thus turning the reel in the counterclockwise direction pulls the target upwardly through the roll pass.

For the purpose of properly aligning the transit 19 with the roll pass, we temporarily mount a mold target 75 within the opening 59 in the base plate 54 of the transit stand 16. The upper face of the mold target carries a grid pattern 76 similar to the grid pattern 28 on the self-centering target 15. The mold target has fixed blocks 77 and adjustable set screws 78 which engage the base plate 54 at the inner edge of its opening 59 to center the grid pattern 76 with respect to mold 10. With the grid pattern centered, we can center the transit 19 with respect to the mold.

According to our method of checking alignment of the guide rolls 12, we contract the self-centering target 15 and insert it through the mold 10 into the roll pass. We install the transit stand 16, transit 19, and reeling mechanism 17 on the mold. We lower the self-centering target approximately to the bottom of the guide roll rack, and operate the adjusting screw 46 to expand the angle irons into contact with the rolls. We center the transit 19 by using the mold target 75 and remove the latter. We sight down the mold and rack on the grid pattern 28, moving the target successively to various higher levels along the height of the rack. As long as the rolls are properly aligned, the grid pattern 28 remains centered and angularly aligned with respect to the transit. Any vertical or angular misalignment is readily corrected, as by inserting or removing shims in the example of a mold rack constructed as shown in the Hofmann and Stull patent.

From the foregoing description it is seen that our invention affords a simple effective method and apparatus for checking the alignment of guide rolls of a continuous-casting machine. Apparatus of similar construction readily can be dimensioned and proportioned for guide rolls which define a pass of any rectangular cross section. The apparatus is highly accurate and overcomes problems heretofore encountered.

We claim:

1. In an apparatus for checking alignment of guide rolls of a continuous casting machine with respect to one another and with respect to a mold thereabove, said apparatus comprising:
   - a target adapted to be lowered through a mold into the roll pass;
   - a vertical transit;
   - a stand for positioning and centering said transit over the mold;
   - a reeling mechanism adapted to be mounted on the mold; and
   - a line suspending said target from said reeling mechanism for moving said target to various levels within the roll pass to be sighted on by said transit;
   - the improvement in which said target includes:
   - a pair of diagonally opposed angle irons having roll-contacting faces at right angles to one another;
   - a diagonally extending support;
   - means fixing said support with respect to one angle iron and permitting relative sliding movement between said support and the other angle iron;
   - spring means urging said angle irons apart to expand said target;
   - means for contracting said target against the action of said spring means; and
   - a grid pattern on said support centered with respect to the roll pass when the target is expanded into contact with the rolls.

2. An apparatus as defined in claim 1 comprising in addition a mold target for temporary installation on the mold to enable said transit to be centered.

3. An apparatus as defined in claim 1 in which said target further comprises a sheave housing carried by said support, and sheaves journaled to said housing,

said line extending around said sheaves.

4. An apparatus as defined in claim 1 in which said reeling mechanism includes a mounting plate, a reel, and means journaling said reel on said mounting plate, said line being wound on said reel.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,863,356 Dated February 4, 1975

Inventor(s) Thomas G. Bengel et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 18, after "guide" -- rolls -- should be inserted.

Column 2, line 27, "Out" should be -- Our --.

Column 3, line 8, "expension" should be -- expansion --;

line 39, after "inside" -- face -- should be inserted.

Signed and sealed this 20th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
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