Dec. 14, 1954 M. LOEWENSTEIN 2,696,646

METHOD AND APPARATUS FOR SEMICONTINUOUS CASTING

Filed May 29, 1951 5 Sheets-Sheet 1

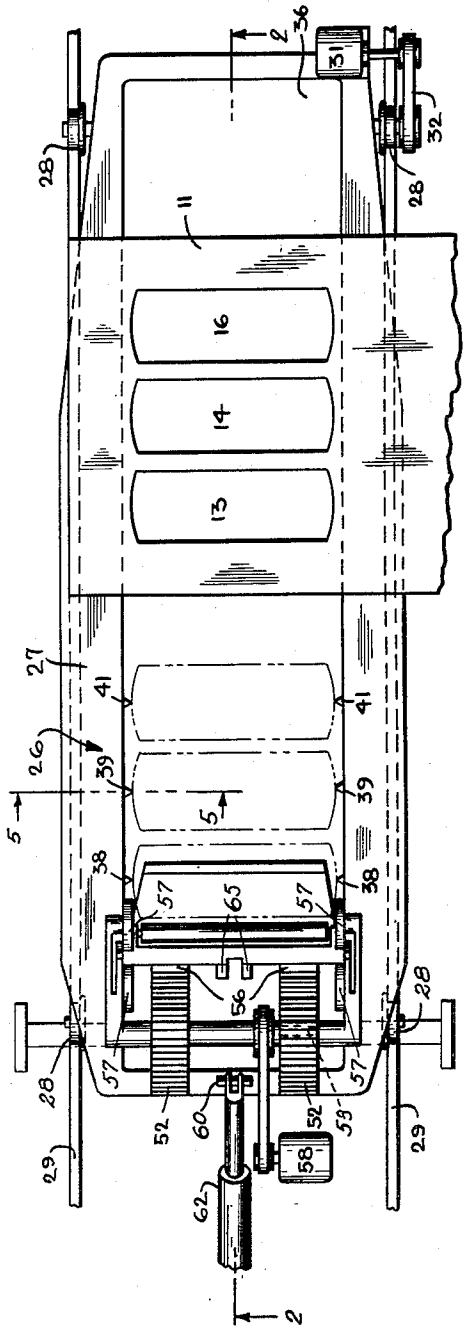
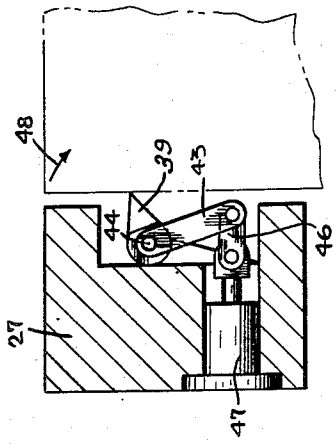


Fig 1

Fig 5



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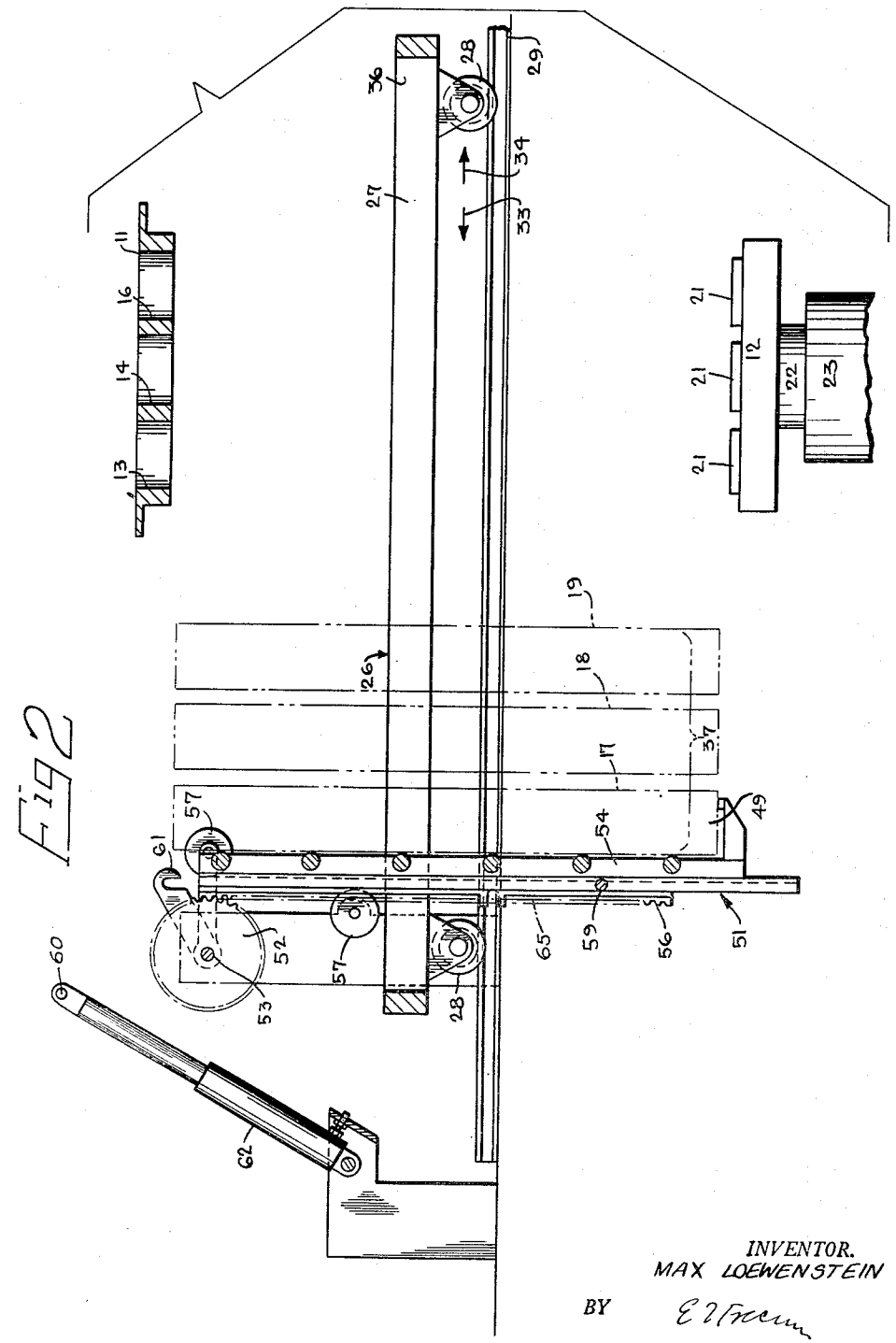

Fig 2

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METHOD AND APPARATUS FOR SEMICONTINUOUS CASTING

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Fig 3

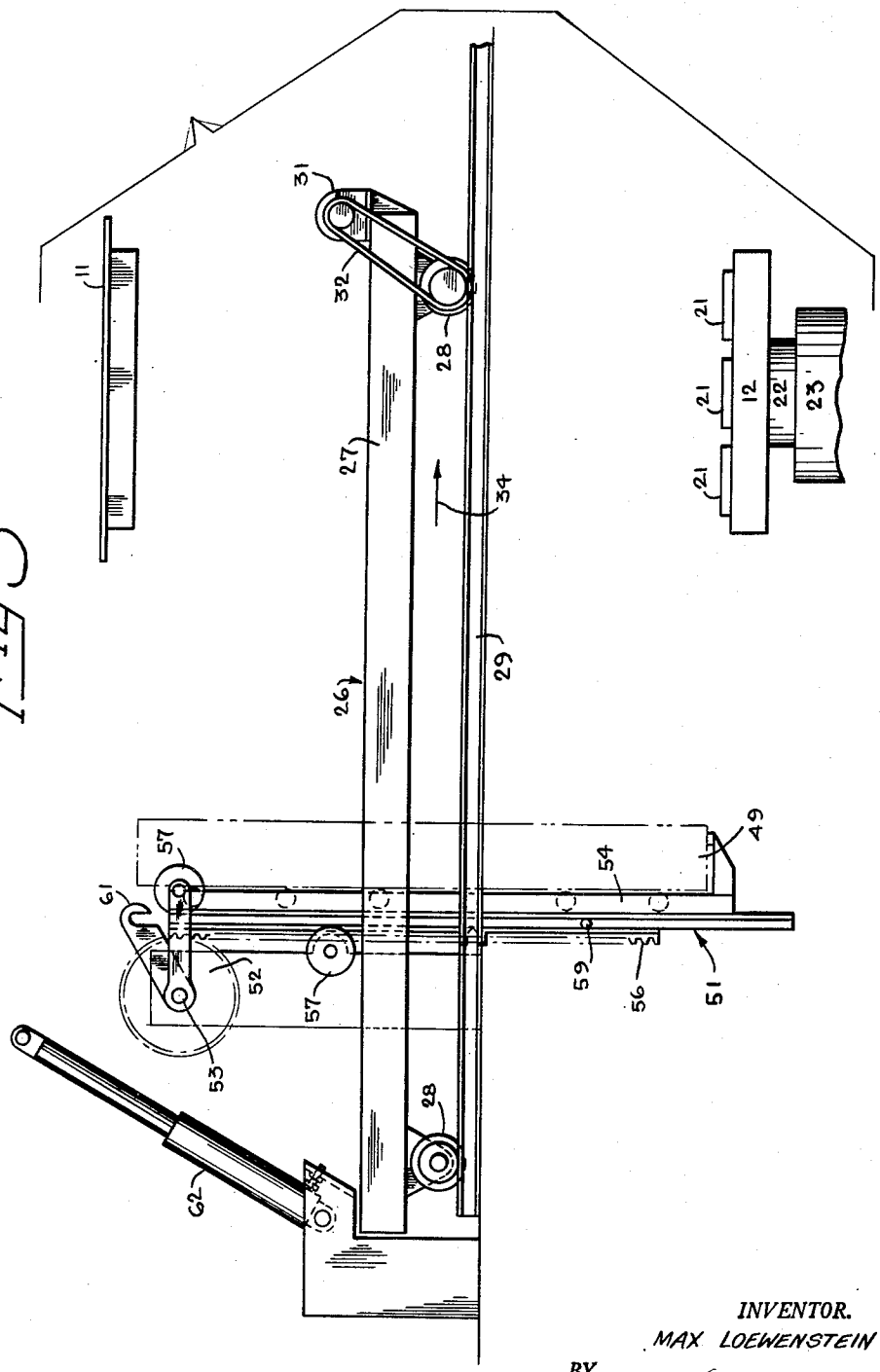

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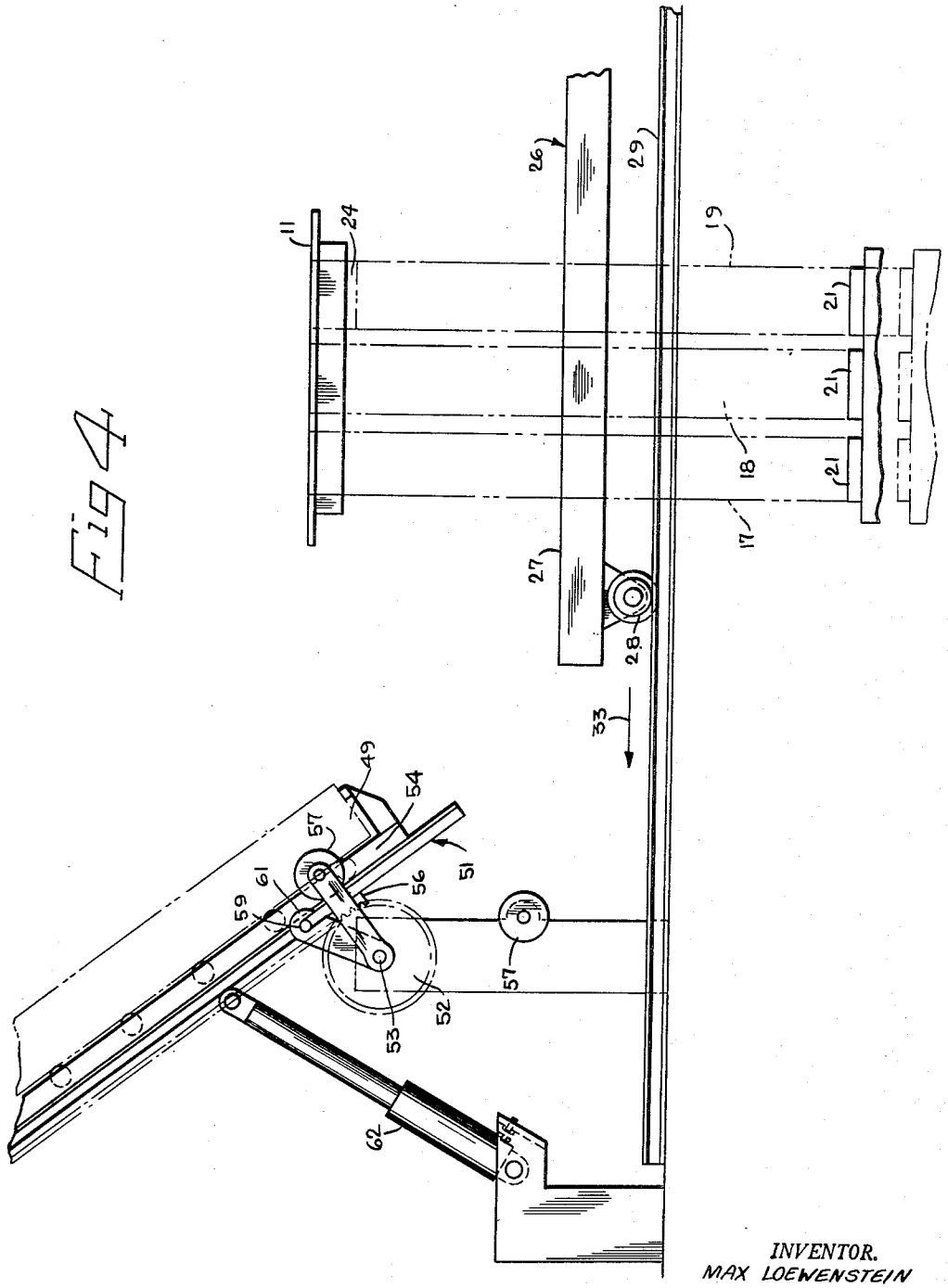
Fig 4



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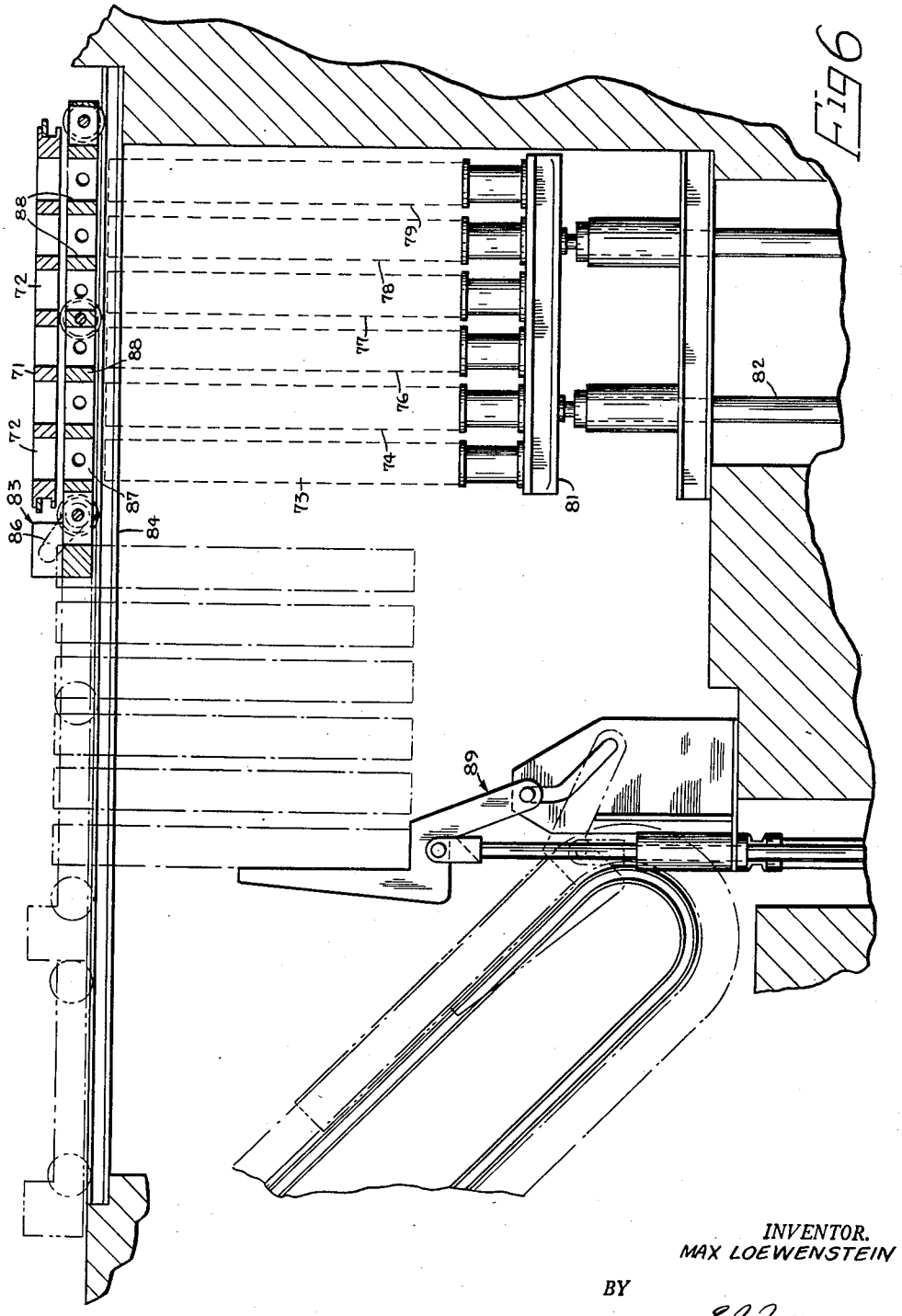

Fig 6

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2,696,646

METHOD AND APPARATUS FOR SEMICONTINUOUS CASTING

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Application May 29, 1951, Serial No. 228,890

7 Claims. (Cl. 22—57.2)

The invention relates to casting of metal billets or slabs and relates more particularly to such casting in a series of intermittent continuous casting operations, known as "semi-continuous" casting operations.

Casting of this type is customarily carried out in a water cooled mold with vertical casting passage or passages, with a bottom assigned to the mold that is moving vertically downward during casting operation. When the billets or slabs have attained the desired length, the casting operation is interrupted for removal of the completed cast articles.

Heretofore, the removal of the completed articles has caused considerable delays, resulting in high cost and restriction of potential output of the casting installation. In accordance with the process customarily used, the molds must be lifted off their supports to enable the removal of billets or slabs after casting by means of overhead cranes or similar lifting device. During the time required for removal of mold and cast articles and, thereafter, replacing of the molds, the casting process has to be discontinued.

The instant invention has therefore among its objects to provide for semi-continuous casting wherein the casting operation is interrupted only for minimum periods and to discharge the cast articles without disturbing the water cooled molds in their position and even while the casting operation is resumed. Further objects include the speedup of the overall semi-continuous operation, the saving of cost and the simplification of operation.

Further objects and advantages of the invention will be set forth in part in the following specification and in part will be obvious therefrom without being specifically referred to, the same being realized and attained as pointed out in the claims hereof.

With the above and other objects of the invention in view, the invention consists in the novel methods, construction, arrangement and combination of various devices, elements and parts, as set forth in the claims hereof, one embodiment of the same being illustrated in the accompanying drawings and described in the specification.

In the accompanying drawings,

Fig. 1 is a plan view of an apparatus in accordance with the invention;

Fig. 2 is a sectional view, taken on line 2—2 of Fig. 1, illustrating the parts in a first position for discharge;

Fig. 3 is an elevational view, showing the parts of Fig. 2 but illustrating them in the last position for discharge;

Fig. 4 is an elevational view, similar to Fig. 3, but showing the parts in the article pick-up position;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 1; and

Fig. 6 is a sectional view, embodying a modification.

In carrying the invention into effect in one of the embodiments which has been selected for illustration in the accompanying drawings and for description in this specification there is provided a mold member generally indicated at 11. In a preferred embodiment, the mold member 11 is fixed, and a bottom member 12 is movable vertically below the same, but it will be understood that the function of these members may be kinematically reversed without departing from the spirit and scope of the invention save as limited in the claims hereof.

Above the mold 11, there is provided a pouring mechanism for molten metal, but this is a well-known device and has not been illustrated in the drawings. While the molten metal is being poured into one or several of the

vertical molding passages 13, 14 and 16 of the mold 11, the bottom 12 moves downwardly. The billets or slabs 17, 18 and 19 rest on raised profiled platforms 21 of the bottom 12; one platform 21 is for each of the mold passages and matches the profile thereof. For example, as shown in Fig. 1, the profile may be one of rectangular-like shape with concave arcuate end surfaces. In the initial or first position (not illustrated) of the movable bottom 12, the platforms 21 fit properly into the passages 13, 14 and 16, and the bottom 12 will then be moved to a second position marking the end of the casting operation for the particular slabs then in the mold, as shown in solid lines in Fig. 4.

The bottom 12 may be moved vertically by any suitable conventional means, such as for instance, by a piston 22 of a hydraulic cylinder 23.

After the slabs 17, 18 and 19 have been cast, the pouring of molten metal is interrupted. This may be accomplished either manually, or automatically when the bottom 12 has reached the second position.

In order to remove the slabs from the mold, the bottom 12 is then moved further downwardly to a third position, shown in broken lines in Fig. 4 in which the slabs 17, 18 and 19 have been drawn downwardly below the mold 11 for a distance sufficient so that there will be a top clearance space 24 between the underside of the mold 11 and the upper surfaces of the slabs.

A transport mechanism, generally indicated at 26, is arranged to remove the slabs from their casting position (Fig. 4) towards discharge.

The transport mechanism 26 comprises a carriage that includes a frame 27 which surrounds an opening 36, and the frame 27 is supported on rollers 28 that run on horizontal tracks 29. A driving mechanism, such as a motor 31 and a belt drive 32, is provided to move the frame 27 horizontally in opposite directions, namely the direction 33 to move the slabs towards the discharge position 37, and in the direction 34 to return the frame 27 to the pick-up position for the subsequently cast series of slabs.

The frame 27 has an opening 36 that surrounds an area which exceeds the area stretching between the path of the bottom 12 and the area 37 that defines the discharge position of the slabs. By this arrangement, as shown in Fig. 2 the slabs, following their pick-up, are deposited in the discharge area 37 while at the same time the bottom 12 may return to its first position, unobstructed by any part of the frame 27, for casting the next series of slabs.

In order to pick up the slabs, there is provided for each slab a pick-up mechanism, such as oppositely disposed paired grippers generally indicated at 38, 39 and 41 for the slabs 17, 18 and 19 respectively. The grippers are disposed in the frame 27, as best shown in Fig. 5. A typical gripper in accordance with the invention comprises a contact member 42 that is rigidly connected to a lever 43, and is pivoted together therewith at a point 44 that is fixed relative to the frame 27. The lever 43 is pivoted to a link 46, and the latter is shiftable horizontally, for instance by a hydraulic cylinder and piston arrangement 47, or by any other suitable mechanical pneumatic or electromagnetic means. The hydraulic arrangement 47 may be actuated in opposite directions by remote control (not shown in detail), to move the contact member 42 arcuately in the direction 48 into the active position, illustrated in Fig. 5, or in an opposite direction to an inactive position wherein it is retracted in the frame 27.

Opposite pairs of grippers, such as the grippers 38, the grippers 39, or the grippers 41, are actuated simultaneously, and preferably all of the grippers for all of the slabs may be removed into active position simultaneously by any suitable well-known synchronizing device—though retraction may have to take place separately for each pair, for reasons pointed out below.

Although only two grippers are shown for each slab, it will be understood that the number of grippers for each slab may vary therefrom.

The grippers are so positioned in the frame 27 that in the pick-up position (Fig. 4) the grippers 38 will be aligned with and be in proper gripping position for the slab 17, and the grippers 39 be aligned with the slab 18, and the grippers 41 be in gripping position for the slab 19.

After the slabs have been cast and lowered out of the

mold **11**, contact member **42** of each gripper will be actuated, as explained in the foregoing, and brought into the active position in which the member **42** makes contact with the surface of the slab to which it is assigned.

After contact is thus made by the grippers, the bottom **12** is again lowered, into a fourth position shown in Figs. 2 and 3. Owing to this additional lowering, each slab will be held between the opposite grippers of a pair assigned thereto, and all of the slabs will be suspended in the space that stretches between the mold **11** and the bottom **12**.

The slabs will then be transported away from the casting or pick-up position by movement of the frame **27** in the direction **33** until the last slab **19** had cleared the path of the bottom **12**. The slabs can then be discharged. Owing to the extent of the opening **36**, the bottom **12** can thereafter be moved upwardly to its first position for resumption of the casting.

The discharge of the slab may either be carried out by means of overhead cranes to remove the slabs out of the frame **27**, or by means of special removal equipment, one embodiment of which will now be described.

The special equipment for removing slabs, is generally indicated at **51**. It provides for removing one slab after the other in succession, in a single discharge position **49** that corresponds to the last slab position in the discharge area **37**. The equipment **51** comprises two aligned gears **52** journalled about a fixed axis **53**. An elevator **54** is provided that has two spaced racks **56**, and each rack is in mesh with a gear **52**. Guiding rollers **57** are arranged on opposite sides of the elevator **54** to guide the latter vertically for a portion and to permit backward tilting thereof subsequently. The gears **52** may be driven by any suitable conventional power drive, for instance power drive generally indicated at **58**, that is energized by an electric motor. Normally, the elevator **54** is in an upward position, shown in Fig. 4, in which it clears the path of the frame **27** and allows the latter to transport the slabs from the casting position towards the discharge position.

After the slabs have been transported far enough to clear the path of the bottom **12**, the movement of the frame **27** is brought to a stop, and the elevator **54** is lowered into the position shown in Fig. 2.

Then, the frame **27** is moved further in the direction **33** until the slab **17** reaches the discharge position **49**. Thereafter, the elevator **54** is operated to lift the slab **17** out of the frame **27** while the latter stands still. Simultaneously, contact member **42** is disengaged. The slab is first lifted vertically by the elevator, owing to the guiding rollers **57**. Near the end of the vertical movement, a pin **59** that is carried by the elevator **54**, will engage a hook **61** that is journalled on the axis **53**. This causes tilting of the elevator **54**, and after an initial period of tilting, the elevator **54** is engaged at its underside tails **65** by rollers **60** of a supporting mechanism **62** for further tilting until the slab is disposed horizontally for subsequent horizontal conveying. The rollers **60** may be formed on a piston of the hydraulic cylinder of the supporting mechanism **62**.

After one slab has thus been conveyed, the elevator **54** is returned to its lifting position within the frame **27**, and the frame **27** is again moved in the direction **33** to deposit on the elevator **54** the next slab, for instance the slab **18**. This continues until all of the slabs have been lifted out of the frame **27** by the elevator **54**.

If an elevator of this type is used, the opening **36** of the frame **27** has to be long enough to provide clearance for the elevator **54** prior to the lifting of the first slab **17**.

Prior to the lifting of each slab, the oppositely disposed grippers thereof have to be released, while the grippers of the other slabs will still have to be maintained in active gripping position.

A modified device is disclosed in Fig. 6. A water cooled mold **71** is shown that has vertical casting passages **72**. Articles to be cast, such as billets **73**, **74**, **76**, **77**, **78** and **79** are shown, in broken lines, below the mold **71**. The position shown is that in which the movable bottom **81**, after completion of the casting to the desired length has been moved downwardly for a small distance, under the power of a hydraulic apparatus **82**, to remove the billets out of the mold **71**.

Underneath the mold **71** there is provided a horizontally movable carriage **83** that runs on tracks **84**, and is movable by a propelling mechanism **86** from the position shown in solid lines, over an intermediate position shown in dot-and-dash lines, to a terminal position shown in dash-and-double-dot lines in Fig. 6. The carriage **83** has side walls **87** and, between the positions for the billets, there are provided reinforcing transverse elements **88**. Near the side walls **87**, there are provided gripping means for each billet, similar to those shown in the previous embodiment, and not illustrated in detail in Fig. 6.

In the position shown in solid lines in Fig. 6, the billets are shown below the carriage **83**. In order to suspend them therein, the bottom **81** will have to be moved upwardly until the top of the billets can be gripped by the gripping means for suspension.

After all the billets have been suspended, the carriage is first moved to the intermediate position, wherein the first billet **73** will be released by the gripping means for support and subsequent removal by a conveyor mechanism generally indicated at **89** that is disposed, at least partially below the tracks **84**.

Subsequently, the carriage **83** will be moved for short distances corresponding to the distances between the succeeding billets, for removal of all of the billets in succession, until the carriage has reached the terminal position.

The bottom **81** may be raised into its top position and casting resumed as soon as the carriage **83** has been moved out of the path of the molds.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific exemplifications thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims they shall not be limited to the specific exemplifications of the invention described herein.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. In a method of casting simultaneously a plurality of metal articles, such as billets or slabs in a semi-continuous operation in a fixed mold having a vertically movable separate bottom, the steps comprising, casting simultaneously a plurality of articles in a continuing casting flow, thereafter interrupting the casting, then removing simultaneously all of said articles by gravity downwardly out of the mold, simultaneously suspending all of said cast articles in the space beneath the mold, removing the suspended articles together at an angle to the vertical so as to clear the path of said bottom, and releasing one slab after the other, in predetermined succession, from the suspension.

2. In a method of casting profiled metal articles, such as slabs or blocks, in a semi-continuous operation, in a mold member having a separate bottom member, at least one of said members being movable vertically relative to the other, the steps comprising, casting at least one article in a continuous vertical casting operation, thereafter interrupting the casting operation, then separating the article from the mold, gripping said article, thereafter moving the article downwardly so that it will be suspended, moving the suspended article substantially horizontally off the path of said movable member, and removing the article from its suspension.

3. In a machine for casting profiled metal ingots, in a semi-continuous operation, including a mold member having a vertical casting passage, and a bottom member in registry with said passage, at least one of said members being movable vertically relative to the other to and from an initial position of proximity for casting start, in combination with, an article discharge area laterally spaced from said passage, a transport mechanism for the completed cast article comprising a frame movable at an angle to the vertical between a receiving position wherein a part of said frame is in registry with said passage and a releasing position wherein the said frame part is in registry with said article discharge area, means for supporting said frame throughout its movements, driving means for moving said frame, and a mechanism supported in the said part of said frame and being actuable to grip the side surfaces of said ingot to suspend said ingot releasably.

4. In a machine for casting profiled metal ingots in a semi-continuous operation, including a mold member having a vertical casting passage, and a bottom member in registry with said passage, at least one of said members being movable vertically relative to the other to and from an initial position of proximity for casting start, in com-

bination with, an article discharge area laterally spaced from said passage for a distance sufficient to clear the path of said movable member, a transport mechanism for the completed cast article comprising a frame movable at an angle to the vertical beween a receiving position wherein a part of said frame is in registry with said passage and a releasing position wherein the said frame part is in registry with said article discharge area, said frame surrounding an opening dimensioned in excess of the space extending between the casting passage and the article discharge area, means for supporting said frame throughout its movements, driving means for moving said frame, and a mechanism supported in the said part of said frame and being actuable to grip the side surface of said ingot to suspend said ingot releasably.

5. In a machine for casting profiled metal articles, such as slabs or billets, in a semi-continuous operation, including a mold member having a vertical casting passage, and a bottom member in registry with said passage, at least one of said members being movable vertically relative to the other to and from an initial position of proximity for casting start, in combination with, an article discharge area laterally spaced from said passage for a distance sufficient to clear the path of said movable member, a transport mechanism for the completed cast article comprising a frame movable at an angle to the vertical between a receiving position wherein a part of said frame is in registry with said passage and a releasing position wherein the said frame part is in registry with said article discharge area, said frame surrounding an elongated opening longer than said distance, means for supporting said frame throughout its movements, driving means for moving said frame, and a plurality of grippers supported in the said part of said frame and being actuable by remote control to project from said part into said opening for gripping said ingot, and to be retracted from said opening for ingot release.

6. In a machine for simultaneously casting a plurality of profiled metal articles, such as slabs or billets, in a semi-continuous operation, including a fixed mold member having a plurality of adjacent vertical casting passages, and a vertically movable bottom member being in all positions in registry with all of said passages, in combination with, a single article discharge area for successive discharge of single cast articles laterally spaced from said bottom for a distance sufficient to clear the path thereof, a transporting mechanism for the completed cast

articles comprising a frame movable substantially horizontally, said frame surrounding an opening extending beyond all of the casting passages and the article discharge area, means for supporting said frame throughout its movements, driving means for moving said frame, and a suspension mechanism for said article supported by said frame and being actuable to grip the side surfaces of said articles for moving the same from the casting position to the discharge area, and to release each article in succession in the latter.

7. In a machine for simultaneously casting a plurality of profiled metal articles, such as slabs or billets, in a series of intermittent continuous casting operations, including a mold member having a plurality of adjacent vertical casting passages, and a bottom member in registry with all of said passages, at least one of said members being movable in a vertical path relative to each other, in combination with, a discharge mechanism operable for discharge of cast articles laterally spaced from said movable member for a distance sufficient to clear the path thereof, a transport mechanism for suspending and moving simultaneously all of the completed cast articles from their casting positions towards discharge and comprising a frame movable at an angle to the vertical, said frame surrounding an opening dimensioned in excess of the area extending between said discharge mechanism and the casting passage farthest spaced therefrom, means for supporting said frame throughout its movements, driving means for moving said frame, and a mechanism for each article supported by said frame and being actuable to suspend releasably all of said articles simultaneously.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,148,391	McBride	Feb. 21, 1939
2,235,610	Ditges	Mar. 18, 1941
2,301,027	Ennor	Nov. 3, 1942
2,371,675	Cherry et al.	Mar. 20, 1945
2,425,362	Cherry et al.	Aug. 12, 1947
2,563,844	Johnston	Aug. 14, 1951
2,582,329	Harter et al.	Jan. 15, 1952

FOREIGN PATENTS

Number	Country	Date
873,400	France	Mar. 23, 1942