

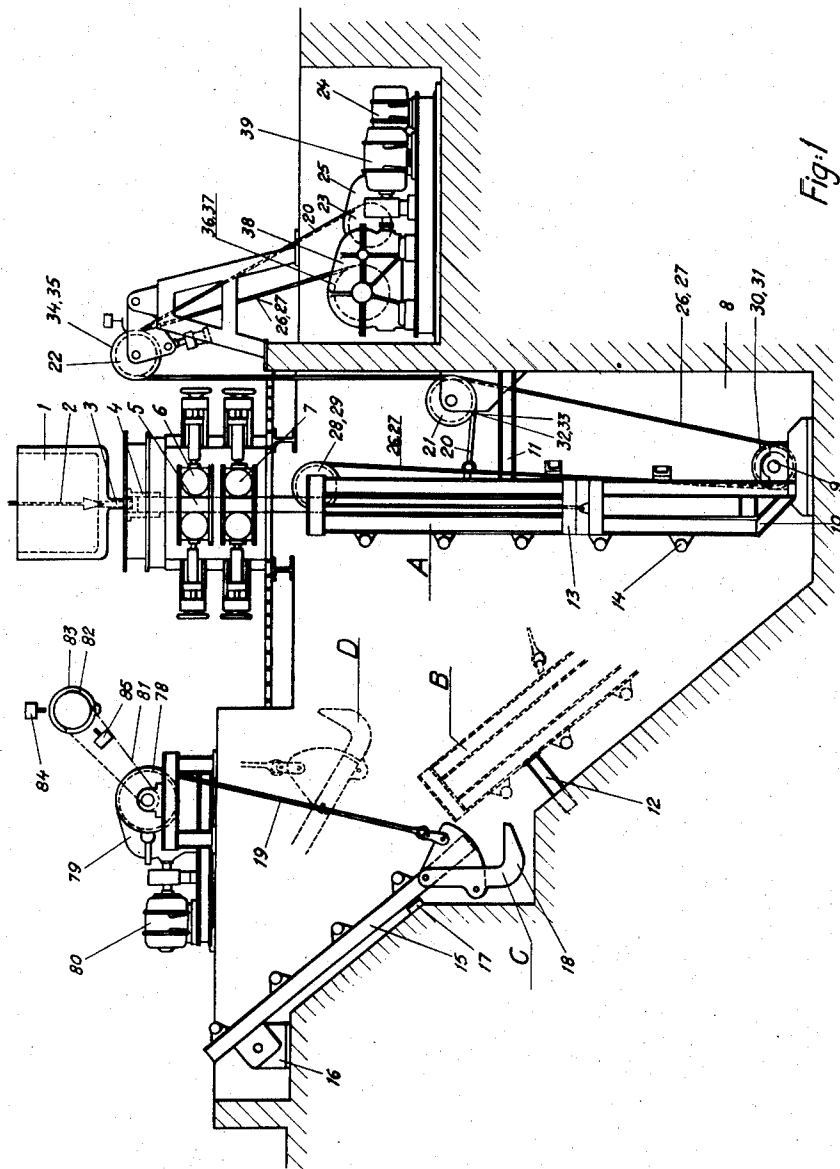
Aug. 11, 1959

P. S. E. FREDRIKSSON ET AL
APPARATUS FOR REMOVING THE CASTING IN
CONTINUOUS CASTING PROCESSES

2,898,650

Filed June 24, 1955

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

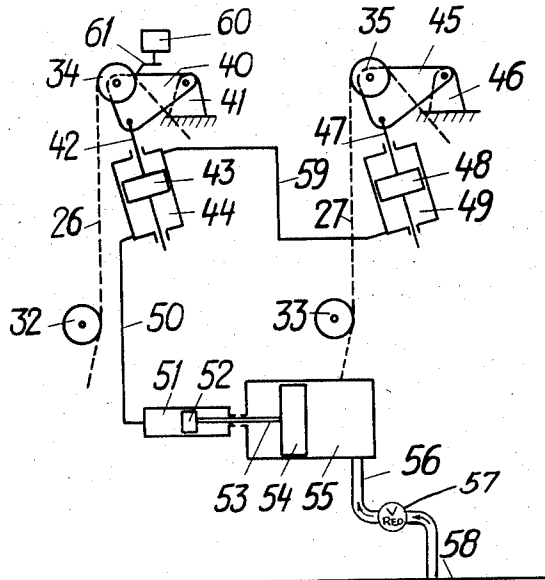


Fig. 2

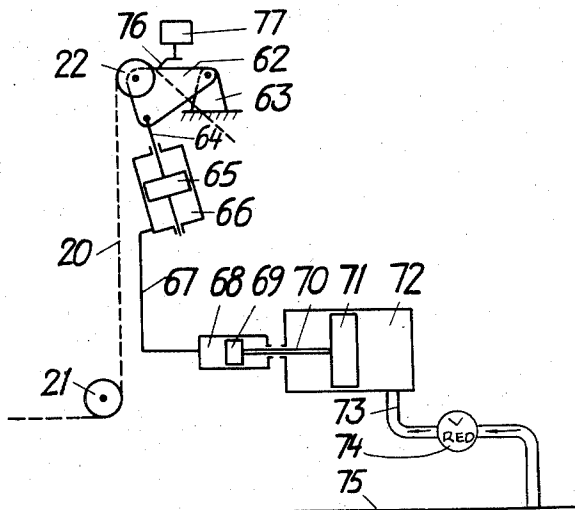


Fig. 3

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Fig. 4

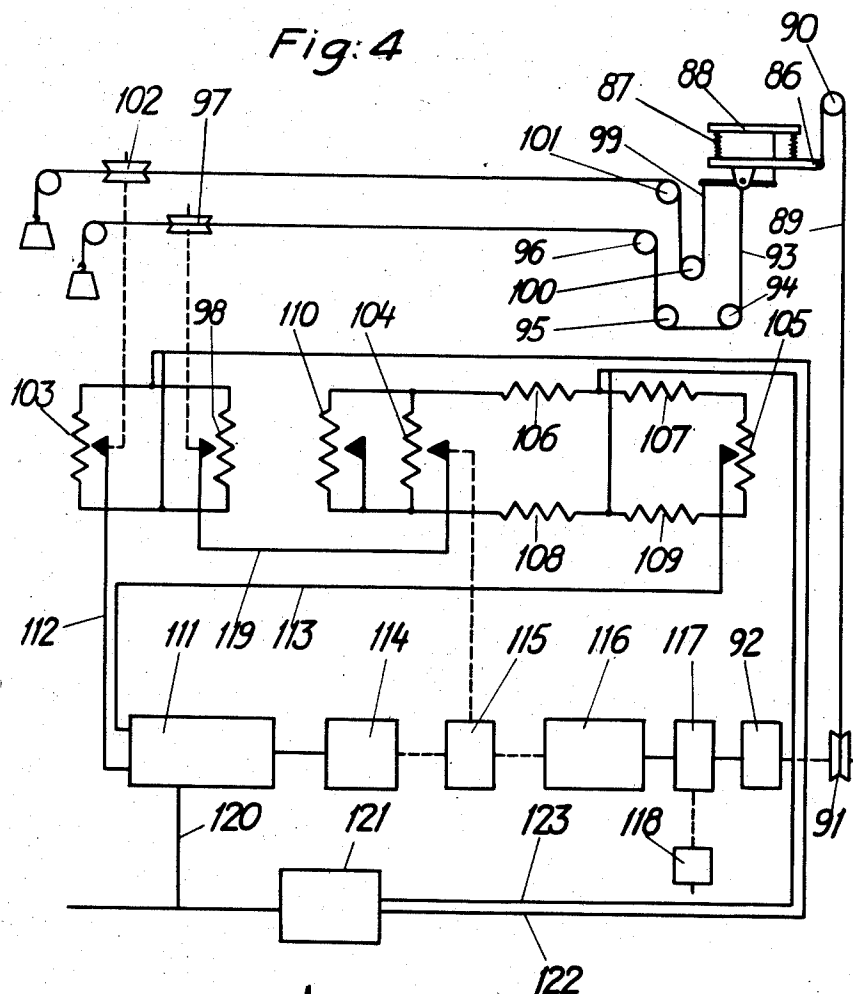
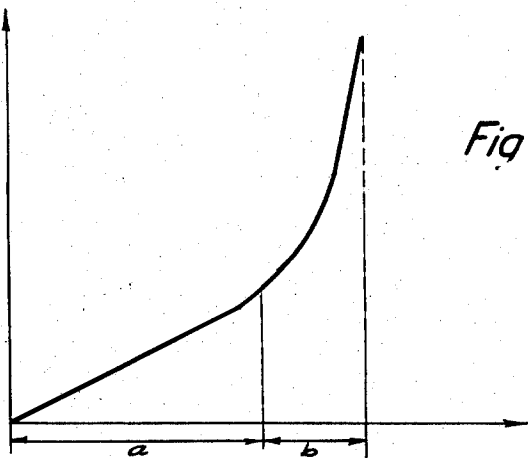


Fig. 5



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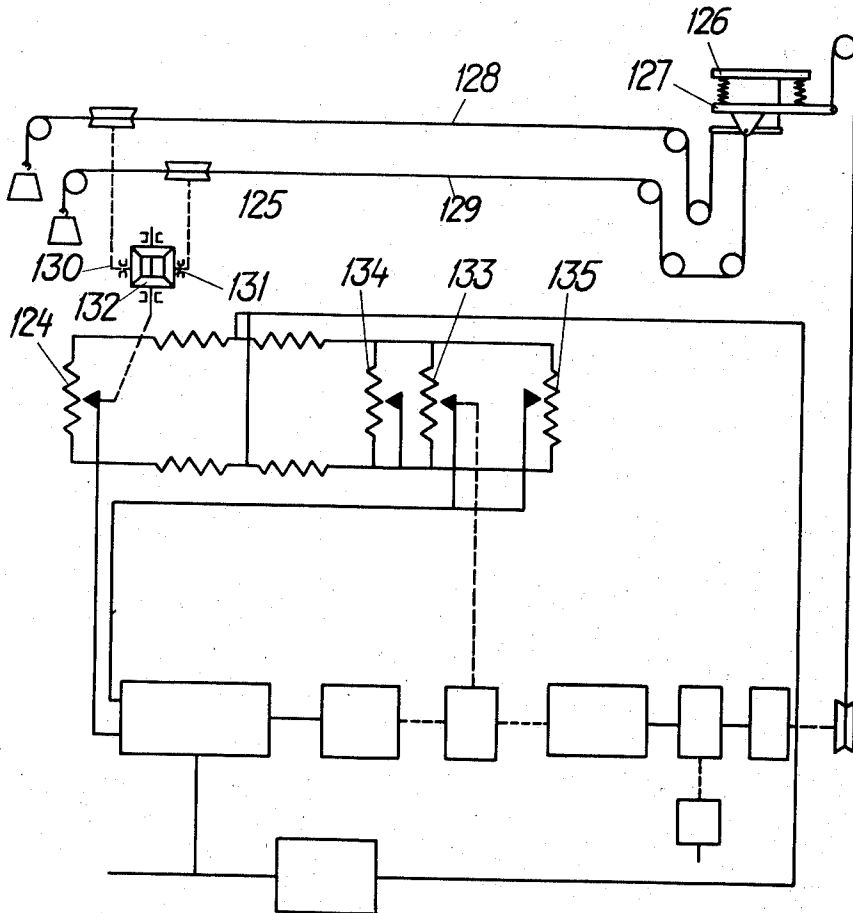


Fig: 6

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2,898,650

APPARATUS FOR REMOVING THE CASTING IN CONTINUOUS CASTING PROCESSES

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Claims priority, application Sweden June 24, 1954

5 Claims. (Cl. 22—57.2)

The present invention relates to a method and means for the extrusion casting of ingots of ferrous metals and non-ferrous metals according to which the ingots are discharged from the casting machine in a substantially vertical direction.

Up to now such extrusion casting has been carried out substantially in a discontinuous or intermittent manner. In doing so it has been customary to utilize a plug which forms the bottom of the mold of the casting machine and as the material solidifies in the mold the column formed is moved downwardly. Upon completion of downward movement of the plug it rests on a table which is lowered as the ingot is discharged out of the mold. When the ingot has been completed it is removed from the table, whereupon the table is elevated and a plug inserted in the bottom of the mold for commencing the casting of a new ingot. The interruption in casting thus caused between the production of each new ingot means that the full capacity of the casting machine cannot be satisfactorily utilized. For better utilization of such capacity it has been suggested to adopt a continuous casting procedure in which an interruption of casting between the different ingots is avoided, so that a continuous column is taken out of the casting machine, which column during its vertical movement downwardly is cut off for obtaining an ingot of a desired length. According to one suggestion the solidified column is fed downwardly between positively operated feeding rolls, the feeding speed of which defines the rapidity of the downward motion of the column. The column then is cut by means of a special cutting machine which accompanies the column in its downward motion so that the motion of the cutting means will be synchronized with the feeding operation of the feeding rolls. In such procedure, however, very complex guide and control means are required and the risk of errors in operation is considerable. A further deficiency connected with such suggested arrangement resides therein that it cannot operate in a satisfactory way immersed in water which is desirable for cooling of the ingots.

The present invention deals with a method and a means by which it will be possible to obtain a very high degree of utilization of the capacity of the casting machine, which capacity will approach that of continuous casting and at the same time the objectionable features encountered in the continuous casting described above are avoided and simplicity and security in operation of the intermittent casting procedure is maintained.

In applying the method embodying this invention, ingots of a limited length are formed in an essentially continuous operation. Such a principle was earlier suggested, wherein the different ingots were separated in relation to each other by the utilization of partition members of suitable material. However, it has been proved that such suggested partition or separating members which were of a solid nature cannot advantageously be used in practice. Thus, the perimeter surface of the

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separating or partition members has to be made of such value, that metal is not allowed to pass between the partition member and the surrounding inner surface of the mold. In such case, however, a partition member closely fitting the wall of the mold, will by reason of the heating brought about when supplying molten metal above the member, expand and jam in the mold. In accordance with this invention a very effective separation of the ingots is obtained while simultaneously preventing molten metal from flowing around the sides of the separating material by using metal chips or the like e.g. of the same metal as that which forms the ingots. In using such chips they are packed in the mold on top of the solidified ingot, thereby effectively preventing the flow of molten metal into the space between the ingot and the wall of the mold. Regarding the height of the plug of chips it may be mentioned that the same frequently does not amount to a figure exceeding 10 mm. Furthermore the resilient consistency of the cake of sealing chips permits thermal expansion to occur without the cake getting jammed between the walls of the mold. By using the same metal as that of the ingots no injurious effect upon the composition of the ingots results and in the subsequent handling the presence of impurities is avoided. It is preferred to have a plug of a material having as high a heat conductivity as possible. Therefore, this method is particularly advantageous in the production of metal or metal alloys including copper.

In order to be able to fully utilize the possibility of casting separated ingots in immediate succession according to the invention it is desirable to have the finished ingot immediately removed from the place below the casting machine to which the ingot has been moved by the feed rolls in order to provide space for the next ingot and the present invention also includes an arrangement for such rapid removal of the ingots.

Figure 1 shows a diagrammatic vertical section through a pit for receiving ingots arranged below the casting machine, which pit is provided with an arrangement embodying the invention.

Figure 2 diagrammatically shows certain control means included in the arrangement shown in Figure 1.

Figure 3 diagrammatically shows certain other control means included in the arrangement shown in Figure 1.

Figure 4 diagrammatically shows a modified embodiment of the control means shown in Figure 2.

Figure 5 is a chart of the characteristics of a driving means for an ingot receiver platform shown in Figure 4.

Figure 6 diagrammatically shows a further modified embodiment of the control means shown in Figure 2.

In Figures 1 to 3 inclusive, reference numeral 1 diagrammatically indicates a melting pot, heat-keeping furnace, ladle or the like to which metal may be supplied in a way not shown. Reference numeral 2 designates a valve means for the control of the flow of molten metal through the pipe 3. Reference numeral 4 diagrammatically indicates a mold designed as a cooling ring in which the metal will solidify while flowing downwardly. The solidified ingot 5 is fed downwardly by means of two sets of feeding rolls 6, 7, which in the embodiment shown are positively operated. Arranged in a pit 8 located below the rolls 6, 7 is an ingot receiver 10 pivotally supported in a bearing 9, which receiver in the embodiment shown is formed as a framework. The framework may be tilted from the vertical position A shown in full lines in Figure 1 in a counter clockwise direction to the position B indicated by dotted lines. The movement is limited by the stops 11 and 12. Arranged in the framework 10 is an ingot receiving platform 13, which is adapted to be moved longitudinally of the framework. Furthermore

the ingot receiver 10 is provided with supporting rollers 14 so as to form a roller path in the longitudinal direction of the ingot receiver. Pivotally supported on one side of the pit is a roller path portion 15, which in its receiving position shown in the figure forms an extension of the ingot receiver 10 when the ingot receiver 10 occupies its position B. The roller path portion 15 is pivotally supported at its upper end in a bearing 16, with its lower end abutting against a stop 17. A hook member 18 is pivotally supported by the lower end of the roller path portion 15. The hook member 18 may be lifted by means of a wire 19 while passing through slots or openings in the upper portion of the ingot receiver 10. Thereby the roller path portion 15 by means of the wire 19 and the hook member 18 fixed therein may be lifted up to approximately a horizontal position.

The turning of the ingot receiver between the positions A and B may be controlled by means of the wire 20, which is passed over pulleys 21, 22 to the winding drum 23 which is operated by the motor 24 via the gearing 25.

The displacement of the ingot receiver platform 13 along the ingot receiver 10 is controlled by the wires 26, 27 which are arranged in pairs in a side by side relation and passed over pulleys 28, 30, 32, 34 and 29, 31, 33, 35, respectively, from the winding drums 36 and 37, respectively, which are driven by the motor 39 via the gearing 38.

The pulleys 34, 35 are adapted to actuate pistons in a way which will be evident from the diagrammatic showing in Figure 2. As will be evident from this figure the pulley 34 is mounted at one corner of an angular piece 40 which is pivotally supported at another corner on a bracket 41. Pivotally connected to the angular piece 40 is a piston rod 42, the piston 43 of which operates in the cylinder 44. Also shown in Figure 2 is an angular piece 45 which is pivotally connected to the bracket 46. Journalled on the angular piece 45 is the pulley 35 for the wire 27 and pivotally connected to the piece 45 is the piston rod 47, the piston 48 of which operates in the cylinder 49. Although the angular pieces 40 and 45 and accessories, for the sake of clearness, are shown in Figure 2 as located alongside, in reality they are preferably located one behind the other as shown in Figure 1. The portion of the cylinder 44 located below the piston 43 communicates through a conduit 50 with the interior of the cylinder 51 in which operates a piston 52. Fixed to the piston 52 is a piston rod 53 to the other end of which is fixed a second piston 54 which operates in a cylinder 55. The cylinder 55 communicates through the conduit 56 and a reduction valve 57 with a conduit 58 which communicates with an air supply, not shown.

The portion of the cylinder 49 located below the piston 48 communicates through the conduit 59 with the portion of the cylinder 44 located above the piston 43. The system comprising the lower portion of the cylinders 44, 49, conduits 50, 59 and the left portion in Figure 2 of the cylinder 51 is arranged to be filled with a suitable fluid medium such as oil.

A switch 60 is arranged to be actuated by an arm 61 which is connected to the angular piece 40. This switch 60 closes and opens the electrical current supply to the motor 39.

In a similar manner as shown in Figure 3, the pulley 22 for the wire 20 is mounted on an angular piece 62 pivoted to a bracket 63 and connected to a piston rod 64, to which is connected a piston 65, which operates in a cylinder 66. The cylinder 66 is connected through a conduit 67 to another cylinder 68, in which operates a piston 69 which piston is fixed to a piston rod 70 to the other end of which is fixed a piston 71, which operates in a cylinder 72. The right portion of cylinder 72 communicates through a conduit 73 via a reduction valve 74 with a conduit 75 which communicates with an air supply. Arranged on the angular piece 62 is an arm 76 which actuates a switch 77 controlling the motor 24.

For the control of the turning movement of the hook member 18 in relation to the roller path portion 15 and also the turning of the latter about the bearing 16, the wire 19 is passed over a winding drum 78 which via the gearing 79 is driven by the motor 80. Passed over the shaft of the winding drum 78 is an endless chain 81 which also is passed over a sprocket wheel 82 which is arranged on the same shaft as a cam plate 83. This cam plate actuates two switches 84 and 85 which control the motors 24, 39 and 80 in a way that will be later described.

The manner of operation of the arrangement is as follows:

In course of casting the ladle or metal receiver 1 is filled with molten metal. When the valve 2 is lifted the molten metal will flow through the pipe 3 downwardly into the mold 4, in which it is cooled in a suitable way, e.g. by means of water cooling. However, prior to opening the valve 2 the mold is closed adjacent the bottom by a so called blind-casting inserted therein. In subsequent casting operations the upper end of the preceding ingot will serve as a bottom in the mold, metal chips being packed down in the mold and distributed so as to form a parting plug or cushion above the ingot. When a preceding ingot is fed downwardly by the feeding rolls 6, 7 the new ingot in course of casting is fed downwardly resting upon the top end of the preceding ingot but separated therefrom by a parting member of metal chips in a way described. The chips are shoveled or otherwise deposited in the mold 4 to the desired thickness and serve to separate one ingot from the next. The speed of movement of the ingot is selected in such a manner that the solidification will continue in a desired way.

Before the upper end of the previous ingot has passed the lower set of rolls 6, 7, the ingot receiver platform 13 has been moved into the position shown in the drawing. While descending, the lower end of the ingot will strike against the ingot receiver platform 13 causing an increased load on the wires 26, 27, so that they are tightened. The wires through the pulleys 34, 35 and the angular pieces 40 and 45 will urge the piston rods 42, 47 and pistons 43 and 48, respectively, downwardly in the cylinders 44 and 49, respectively. This will force oil from the cylinder 44 through the conduit 50 into the cylinder 51, so that the piston 52 and with it the piston rod 53 and the piston 54 are urged to the right in Figure 2 against the air pressure in the right portion of the cylinder 55. The reduction valve 57 is set in such a way that the pressure exerted by the air against the piston 54 and thereby against the piston 43, which is connected to the angular piece 40, balances the weight of the ingot receiver platform 13. Thus, when the ingot imposes a load on the ingot receiver platform, the pressure set on the reduction valve 57 will be exceeded, whereupon the piston 54 will move to the right and the piston 43 downwardly in the cylinder 44. Thereupon the actuating arm 61 actuates the switch 60, so that the circuit to the motor 39 is closed, whereupon the ingot receiver platform 13 starts to move downwardly. The angular piece 45 carrying the pulley 35 and the piston means 48 will similarly control the operation of switch 60. The reason for having two wires 26, 27 is the fact that it is desired to avoid transverse forces upon the ingot receiver from the ingot receiver platform, which among other things would be encountered if the platform were merely supported by one wire. Thus, when the ingot receiver platform 13 moves downwardly, the load on the platform will decrease, whereupon tension in the wires 26, 27 will also be decreased. Due to this the arm 61 shown in Figure 2 will actuate the switch 60 to open the circuit to the motor 39. The downward movement of the ingot receiver platform is then interrupted whereupon the load exerted by the ingot against the platform is again in-

creased and the described procedure repeated during downward movement of the ingot.

The downward movement of the platform 13 is related to the rotation of rolls 6 and 7 to support the ingot and prevent elongation, but without exerting compressive forces thereon during downward movement sufficient to distort the same. Since the ingot upon leaving the rolls 6 and 7 is still in a deformable or semi-plastic condition, it is necessary to support the same by means of the platform 13 during downward movement, in order to prevent stretching or other distortion of the ingot.

When the ingot receiver platform 13 has moved downwardly to such an extent that the upper end of the ingot has left the lower set of rolls 7, the entire weight of the ingot will rest upon the platform 13. Then the wires are again tightened so that the switch 60 is closed and the motor 39 will continue operating until the ingot receiver platform 13 has arrived at its bottom position in the ingot receiver 10. Upon its arrival at this position a limit switch, not shown, is actuated which switch will cause the motor 39 to stop and also operates to start the motor 24 and pay out the wire 20, whereupon the ingot receiver and also the ingot receiver platform moves counter clockwise as viewed in Figure 1 into the position B shown in dotted lines, wherein the motion of the ingot receiver is arrested by the stop 12. This swinging movement of the ingot receiver is facilitated by the layer of chips forming a parting member between successive ingots thereby permitting moving of one ingot away from the next. The current supply to the motor 24 is now opened by means of another switch, not shown, and the motor 39 is started in a reverse direction, so that the ingot receiver platform is moved upwardly raising the ingot and discharging the same upon the roller path 15. When the ingot receiver platform 13 has arrived at its topmost position in the ingot receiver 10, the current supply to the motor 39 is opened and the motor 80 is started, whereupon the hook 18 by means of the wire 19 is moved in below and behind the lower end of the ingot which has moved out of the ingot receiver onto the roller path 15 thereby lifting the roller path 15 and the ingot lying thereon up to a horizontal position. This engagement of the hook 18 with the lower end of the ingot is possible by reason of the fact that as the ingot leaves the ingot receiver 10 the ingot moves transversely onto the roller path 15 thereby exposing a portion of the lower end of the ingot. The motor 80 is stopped by a limit switch 84 cooperating with the cam plate 83. At position D of the rollers 15 the motor 39 is again started in a reverse direction, whereupon the ingot receiver platform 13 is moved a distance downwardly in the ingot receiver 10 corresponding to the vertical position indicated in full lines in Figure 1. In this position of the ingot receiver platform a limit switch is actuated which starts the motor 24. Then the ingot receiver 10 is moved about the bearing 9 and raised up into its vertical position. The ingot receiver platform 13 and ingot receiver 10 now again are in position for receiving the next ingot which simultaneously has been carried downwardly by the feed rolls 6, 7, whereupon the procedure is repeated. Thereafter the ingot is removed in a suitable way from the roller path 15 and the path is then swung back into the position shown in full lines in Figure 1.

Concerning the automatic control of the movement of the ingot receiver 10 about the bearing 9, this substantially coincides with the control of the movements of the ingot receiver platform 13 and is performed substantially as follows:

Thus, when the ingot receiver platform 13 in its strict vertical movement from the position shown in Figure 1 reaches its bottom position in the ingot receiver, the platform will actuate a switch, not shown, which is arranged to close the current supply to the motor 24. The movement of the ingot receiver 10 then is started and this movement is continuous until the receiver engages

the stop 12, viz. to the position B in Figure 1. At the same time the ingot receiver also actuates a switch, not shown, which will open the current supply to the motor 24 and start the motor 39 in a reverse direction of rotation. The ingot receiver platform 13 is thereby moved in a slanting position upwardly along the ingot receiver 10 and carries with it the tilted ingot rolling on the rollers 14 and the roller path 15. In a certain position in connection with the stop 12 the ingot receiver platform 13 actuates a further switch, not shown, which controls the motor 80. Motor 80 via the gearing 79 and the wire 19 lifts the hook member 18 upwardly to a position behind the lower end of the ingot. Continued movement of the wire 19 raises both the hook member 18 and the roller path 15 with the ingot resting thereon upwardly approximately to the position D in Figure 1. Due to the rotation of the motor 80 the cam plate 83, however, via the chain 81 has been caused to rotate, whereupon at a point corresponding to the position D the plate will actuate one of the contacts 84 or 85 which closes the current supply to the motor 39, so that the same starts the upward movement of the ingot receiver platform. When subsequent thereto the ingot receiver platform has reached the desired position in the receiver 10 a limit switch, not shown, will be actuated, so that the motor 39 is stopped at the same time as the motor 24 is started thereby moving the ingot receiver back into its vertical position shown in Figure 1.

During all movements hitherto described which are transmitted to the ingot receiver 10 from the motor 24 through the wire 20 a definite control of the tension in the wire 20 is maintained due to the fact that in connection with Figure 3 the angular piece 62 is prevented from being swung downwardly by the piston 65, which rests upon an oil pad in the cylinder 66, conduit 67 and the left end of the cylinder 68. This oil pad is counteracted in turn by the twin-piston 69, 70, 71 in that the piston 71 is exposed to air pressure in the cylinder 72. This pressure is maintained through the communication of the cylinder 72 with a source of pressure 75 via a reduction valve 74, which is adjustable in such a way that the force transmitted by the wire 20 during the turning movements of the ingot receiver is not sufficient to swing the angular piece 62 downwardly which would mean that the contact arm 76 would be removed from the switch 77 thereby stopping the motor 24.

However, when the ingot receiver 10 has been returned from its slanting position B into its vertical position A the motor 24 continues operating to apply a force to the wire 20 exceeding that for which the control system is adjusted according to Figure 3. Consequently the angular piece 62 then is depressed so that the contact arm 76 will be removed from the switch 77, opening the current supply to the motor 24 which thereby is caused to stop. The force applied to the wire 20 remains thereafter until the motor, after being reversed, is started again at which time the ingot receiver platform 13 in the bottom position of its vertical movement actuates the switch, not shown, arranged at this point whereupon the procedure is repeated.

In relation to the different movements of the ingot receiver platform 13 it should be emphasized that it is necessary to automatically move the platform to a proper position to receive the ingot coming from the casting machine before the ingot has left the sets of rollers 6, 7. If the downward movement of the ingot receiver platform 13 is too slow in relation to the movement of the ingot this may affect the upper, relatively soft portion of the ingot, whereupon an unfavourable deformation may be caused. Such deformation may subsequently cause trouble during discharge of the ingot from the ingot receiver.

However, if the downward movement of the ingot receiver platform 13 is too rapid in relation to the downward feeding motion of the ingot, the ingot when

leaving the feeding rollers, 6, 7 may drop downwardly causing a blow against the platform. In case of great ingot weights such a blow may do damage to the entire structure. Consequently in an ideal case it should be ensured that the platform will touch with a small pressure the end of the ingot when the ingot is just leaving the feed rolls and that the operation of the platform is entirely automatic.

Such an ideal condition is obviously difficult to obtain but the invention using the alternative described above for the automatic control of the platform, offers the possibility of satisfying practical requirements in this respect.

In the preceding description merely the control of the limit switches 60, 77 and 84 has been described in detail. However, the remaining switches which are located below the water level in the pit 8 may be controlled in a corresponding way which should be obvious to each artisan as indicated by that which has been described concerning the last mentioned switches.

In the above described alternative for the control of the movement and adjustment of the ingot receiver and ingot receiver platform a certain lagging of the motor control cannot be entirely avoided and also a certain jerky tendency in the mode of operation which is due to the inertia of the mechanical transmitting means.

However, if a more regular movement is desired involving less counter pressure by the ingot receiver platform 13, this can be obtained by using the alternative control shown in Figure 4. In Figure 4 the ingot receiver platform is disclosed as comprising a lower member 86 on which is supported by means of springs 87 an upper member 88. Fixed to the member 86 is a wire 89 which runs over the pulley 90 to the winding drum 91. The wire 89 corresponds to the wires 26, 27 in the embodiment shown in Figure 1 and Figure 2. The winding drum 91 is arranged on the same shaft as the motor 92 corresponding to the motor 39 in Figure 1. Fixed to the member 86 is a control wire 93 which runs over pulleys 94, 95, 96 to the winding drum 97. The winding drum 97 in its rotation actuates the movable contact of a potentiometer 98. Fixed to the upper member 88 of the ingot receiver platform via a lever is a wire 99 which runs over pulleys 100 and 101 to a winding drum 102. The winding drum 102 actuates the movable contact in another potentiometer 103. The potentiometers 98 and 103 are suitably of multi-coiled potentiometer type and form together a complete Wheatstone bridge. A further bridge is arranged which includes the potentiometers 104 and 105 of which the potentiometer 104 preferably is of the multi-coiled type. Included in the bridge circuit are also resistances 106, 107, 108, 109 symmetrically arranged in relation to the potentiometers 104 and 105. Coupled in parallel to the potentiometer 104 is a further potentiometer 110. The movable contacts of the potentiometers 103 and 105 are electrically connected to a servo amplifier 111 through the leads 112 and 113, respectively. The servo amplifier 111 as diagrammatically shown in the drawing is coupled to a reversible motor 114 which in turn via a gearing 115 operates a rheostat 116. The rheostat controls the field circuit of a D.C. generator 117 which supplies voltage to the motor 92. The D.C. generator is mechanically coupled to an A.C. motor 118, which is driven by a suitable source of current, not shown. The gearing 115 operates the movable contact of the potentiometer 104. The movable contact of the potentiometers 98, 104 are electrically connected to each other by means of the lead 119. The servo amplifier 111 is supplied with electrical current through the leads 120 from the line voltage. The above described bridges, in which are included the potentiometers 98, 103 and 104, 105, respectively, are supplied with current from

the same line voltage via the transformer 121 through the leads 122 and 123, respectively.

The mode of operation of the arrangement shown in Figure 4 is as follows: When an ingot from the feed rolls designated by 6 and 7 in Figure 1 is fed downwardly towards the ingot receiver platform 86, 87, 88, the platform remains stationary in the same position as has been shown concerning the platform 13 in Figure 1. When the bottom of the ingot abuts the upper platform member 88, this member starts to move downwardly compressing the springs 87. In such positioning the wire 99 over the winding drum 102 will displace the movable contact of the potentiometer 103. This will cause an unbalance in the corresponding bridge system which causes the motor 92 to be actuated by the servo amplifier 111 and start. Thereby the lower platform member 86 via the wire 89 will be moved downwardly. At the same time as the motor 92 is actuated, the movable potentiometer 104 of the other bridge system is actuated via the gearing 115 in such a way that it tends to restore the balance in the bridge system.

The position of the lower platform member 86 is indicated in the bridge system through the intermediary of the wire 93 which over the winding drum 97 actuates the movable contact of the potentiometer 98. By adjusting the potentiometer 105 which may take place in a manual way the degree of compression of the springs 87 and therewith the desired contact pressure between ingot and platform may be adjusted. By means of the potentiometer 110 the sensibility of the arrangement may be adjusted, viz. the extent of movement of the lower platform member 86 which is caused by a certain movement of the upper platform member 88. By adjusting the potentiometers 105 and 110 it is thus rendered possible to cause the upper part 88 of an ingot receiver platform to follow the ingot in its vertical movements with a desired abutting pressure.

In contrast to the condition in the embodiment of Figures 1 to 3 inclusive the ingot receiver platform, when the ingot has left the feed rollers 6 and 7 in Figure 1, is arranged to be moved with an increased rapidity downwardly to its bottom position in the ingot receiver. This is obtained e.g. by providing the driving arrangement 91, 92, 116, 117, 118 with characteristics according to Figure 5, wherein the abscissa indicates the angle of turning of the rheostat and the ordinate the velocity of the motor. During the period while the ingot moves downwardly towards the receiver platform and while the ingot is continuously fed by the feed rollers the rheostat operates within the range of the characteristics designated by *a*. When the ingot has left the rollers and substantially entirely compresses the springs 87 the operation is in the range *b* which, as will be evident, results in an increased speed of the motor and additionally of the movements of the ingot receiver platform.

It should also be emphasized that the described arrangement has been merely set forth in a diagrammatic way and that in practice obviously counter-balances or springs must be arranged for the returning movement of the wires which is obvious to any artisan in this field. Furthermore it should be emphasized that the arrangement described with reference to Figure 4 merely substitutes for those parts of the arrangement of Figure 1 which controls the movement of the ingot receiver platform. The hook member 18 and roller path 15 may be operated for instance in the same way as has been stated in connection with Figure 1.

Shown in Figure 6 is another alternative for the control of the movement of the ingot receiver platform. Here substantially the same principle is applied as is used in Figure 4, the potentiometers 98, 103, however, being replaced by a potentiometer 124 and a differential gear 125. Thus, in the drawing reference numeral 126 designates an upper platform member and, 127 a lower platform member. A wire 128 runs from the upper

platform member 126, and a wire 129 from the lower platform member 127 which over winding drums control opposite gears 130 and 131 in the differential 125. The remaining two gears 132 in the differential actuated by the gears 130 and 131 drive the movable contact in the potentiometer 124. The potentiometer 124 is bridge-coupled with the potentiometer 133, which responds to the potentiometer 104 according to the embodiment of Figure 4. The potentiometers 110 and 105 in the embodiment according to Figure 4 respond to the embodiment according to Figure 5 of the potentiometers 134 and 135, respectively. In other respects the arrangement according to Figure 5 is similar to the arrangement according to Figure 4 and the mode of operation is the same. The bridge 103, 98 shown in Figure 4 is replaced by the differential 125 and the potentiometer 124.

The invention is not limited to the embodiment shown and described but may be varied in various respects within the scope of the basic inventive idea.

Having now described the invention, what we claim as new and desire to secure by Letters Patent, is:

1. An arrangement in machines for the substantially continuous production of elongated metal ingots by continuous casting during movement substantially in a vertical direction through a bottomless mold, said machine including pairs of positively operated feed rolls located below the mold and arranged to feed the ingot in course of casting downwardly into an ingot receiver including a platform which is movable downwardly in response to the feeding movement of the ingot by said feed rolls and control means for causing said platform to move downwardly in relation to the feeding of said ingot by said feed rolls to support said ingot with a substantially constant pressure and prevent distortion thereof during downward feeding movement, said platform having a range of movement sufficient to support said ingot after discharge from said feeding rolls.

2. An arrangement as claimed in claim 1, characterized in that the platform is movably suspended from wires in the ingot receiver, the wires being passed over pulleys or the like to a winding drum arranged outside the ingot receiver, a motor for driving said winding drum and means including at least one of the wires being arranged to actuate a switch in response to the load on said one wire, which switch operates to close and open respectively the circuit to said motor.

3. An arrangement as claimed in claim 2, characterized in that the load on said one wire is balanced by a pres-

sure medium system which maintains a continuous predetermined adjustable maximum counterforce on said one wire, in such a way that the switch is actuated to open the motor circuit when the tensile stress in the wire is less than the balancing load of said pressure system, said system including a piston and cylinder with the piston supporting the load on said one wire and with the cylinder connected to a predetermined source of fluid pressure.

4. An arrangement as claimed in claim 1, characterized in that the platform includes a resiliently mounted supporting plate for engaging the end of the ingot, the platform and supporting plate each being counter-balanced by means of a loaded wire control system, a drive motor for moving said platform and a differential potentiometer system operable in response to differences in vertical movements between the supporting plate and the platform to control said drive motor for controlling the vertical movements of said platform in response to the feeding movement of the ingot.

5. An arrangement as claimed in claim 1, characterized in that the platform includes a resiliently mounted supporting plate for engaging the end of the ingot, the platform and supporting plate each being counter-balanced by means of a loaded wire control system, a drive motor for moving said platform and a mechanical differential device including a potentiometer system operable in response to differences in vertical movements between the supporting plate and the platform to control said drive motor for controlling the vertical movements of said platform in response to the feeding movement of the ingot.

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