United States Patent

[11] 3,633,652

[72] Inventor **Jacques Chambran**
Tarascon sur Ariege, France

[21] Appl. No. **870,741**
[22] Filed **May 7, 1969**
[45] Patented **Jan. 11, 1972**

[73] Assignee **Pechiney-Compagnie de Produits Chimiques et Electrometallurgiques**
Paris, France

[32] Priorities **Dec. 7, 1965**
[33] **France**
[31] **41149;**
Jan. 6, 1966, France, No. 45036; Aug. 11, 1966, France, No. 72779
Original application Dec. 6, 1966, Ser. No. 599,605, now Patent No. 3,498,364.
Divided and this application May 7, 1969, Ser. No. 870,741

[54] **MACHINE FOR CASTING AND STACKING INGOTS**
23 Claims, 29 Drawing Figs.

[52] **U.S. Cl.** **164/269,** 214/6, 214/8.5, 214/6.5
[51] **Int. Cl.** **B22d 45/00,** B22d 47/02, B22d 9/00
[50] **Field of Search** ..... 164/319, 348, 122, 128, 322, 326, 150, 4, 269, 270; 214/2, 6 C, 6 R, 6 A, 6 N, 6 H, 6 M, 6.2 BA, 6 F, 6 G, 6.1 FA, 6 FS, 6 DS, 6 DK, 2 X, 8.5, 6.5

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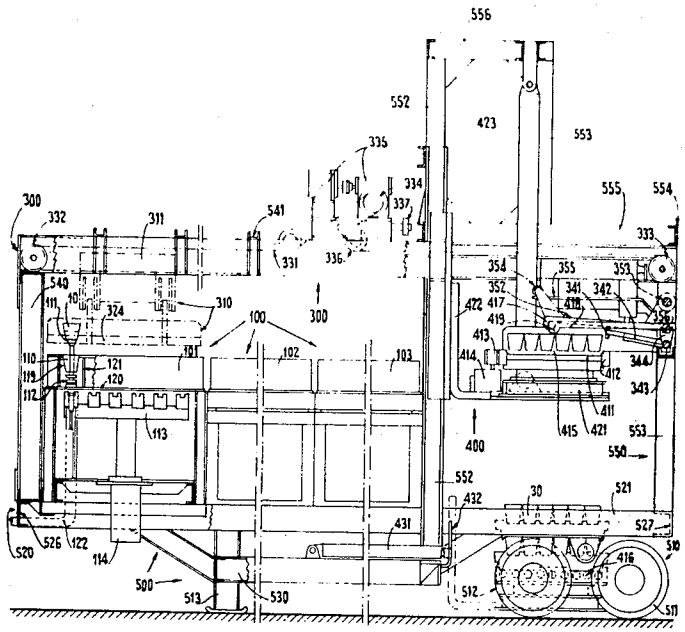
Primary Examiner—Robert D. Baldwin
Assistant Examiner—V. K. Rising
Attorney—McDougall, Hersh, Scott & Ladd

ABSTRACT: A machine for casting and stacking ingots which includes a casting zone embodying a group of ingot molds with means for pouring molten metal into the molds, means for cooling the molds and means for removal of the cast ingots from the molds; a conveyor for transportation of the ingots released from the molds to a stacking zone including a gripper capable of gripping the entire group of ingots removed from a single group of ingot molds and means which cooperates with the conveyor to displace the group of ingots into side-by-side relationship in a row; and a stacking zone which includes a table on which the ingots are stacked and in which the table is mounted for rotational movement so that the table can be turned through an angle of 90° after stacking each row of ingots.



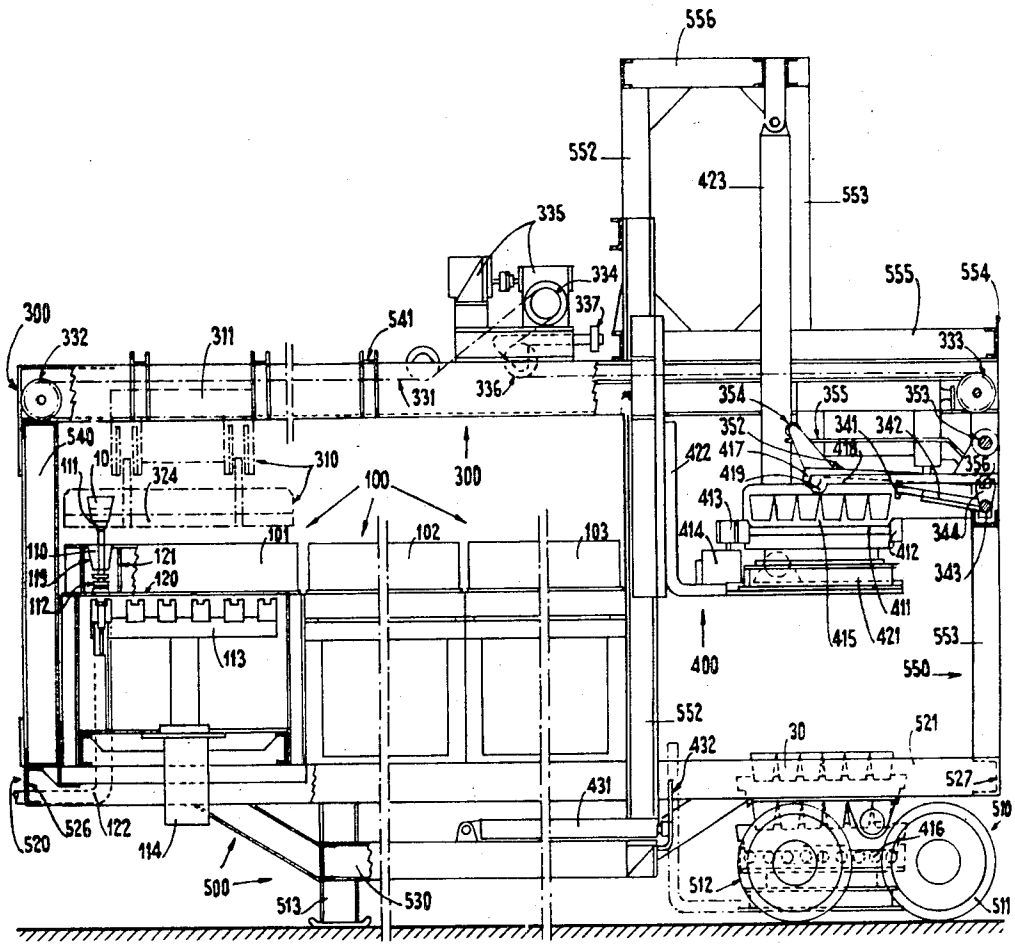


Fig. 1

INVENTOR
JACQUES CHAMBRAN

McDougall, Hersh & Scott ATTYS.

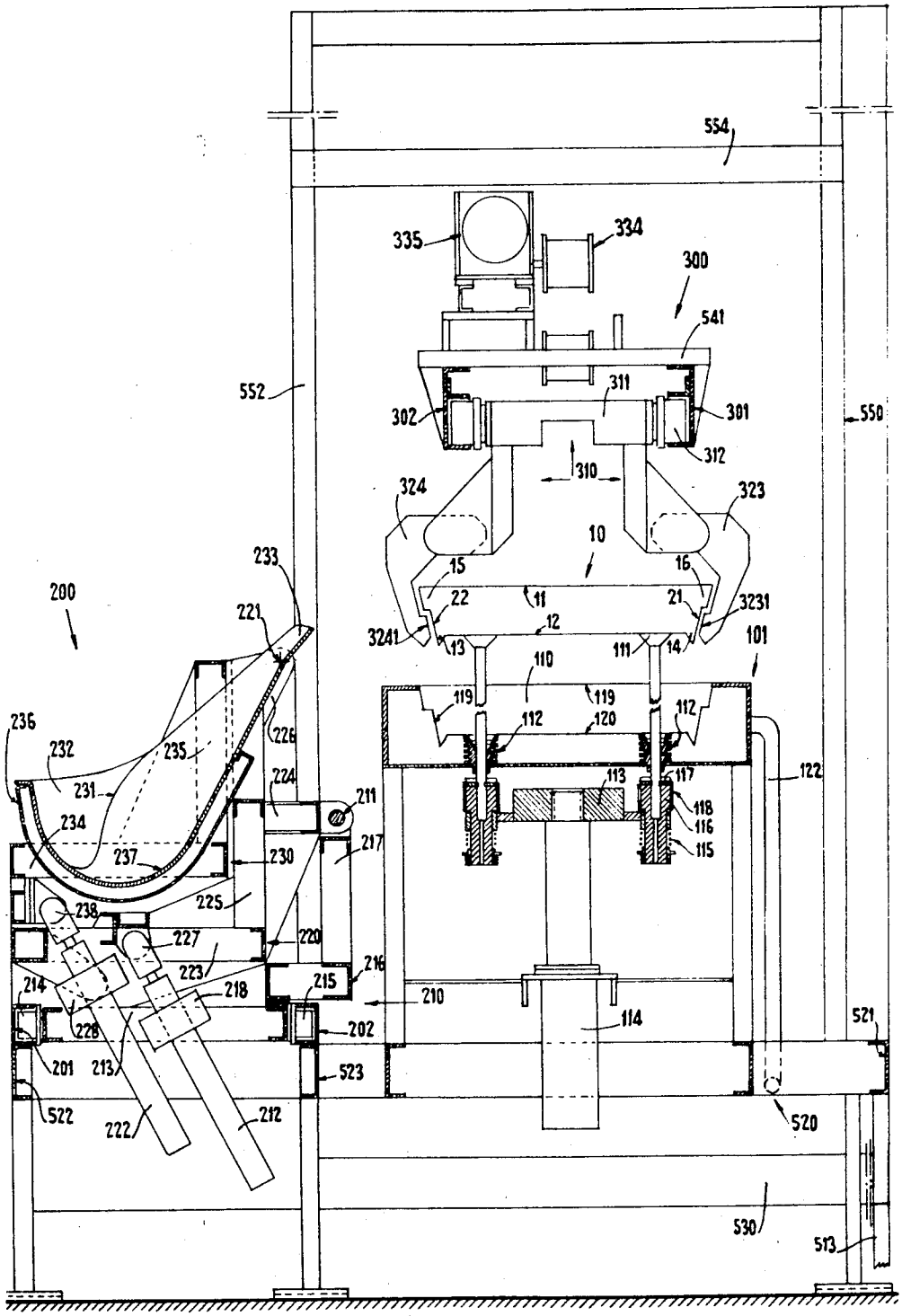

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Fig. 2

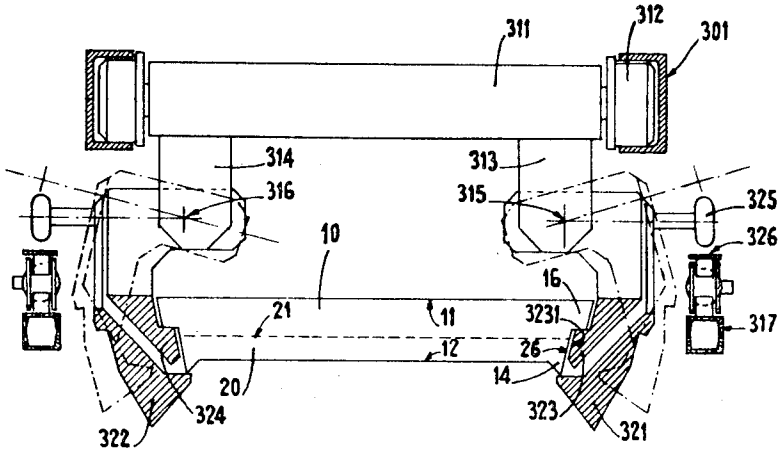
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Fig. 3

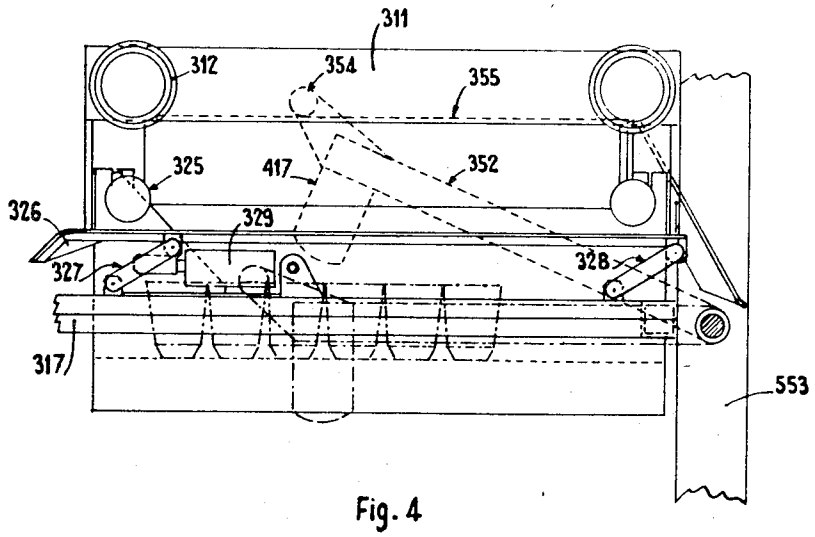
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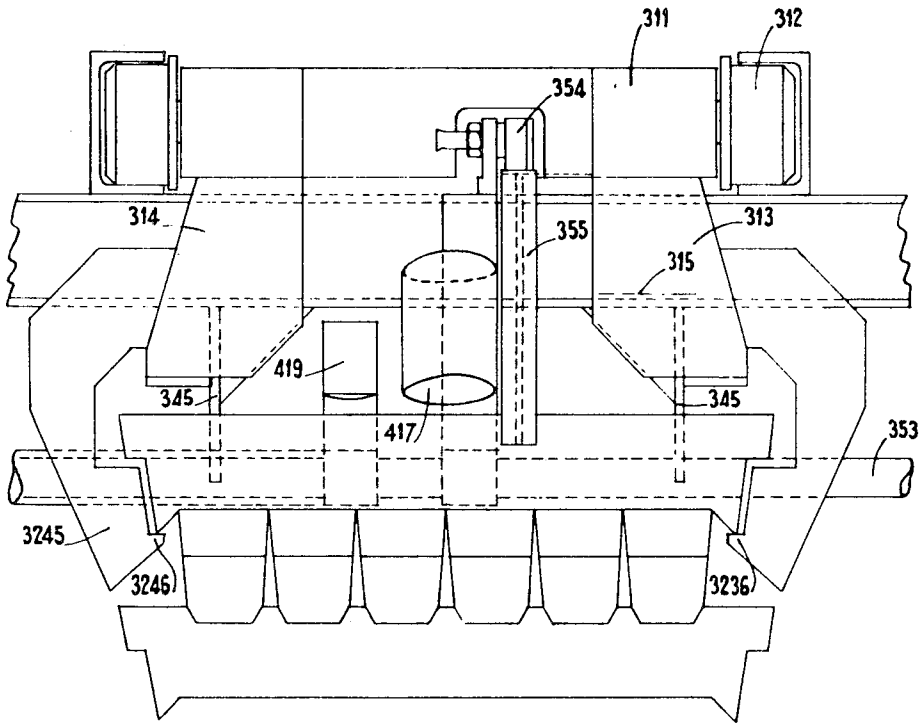
Fig. 4



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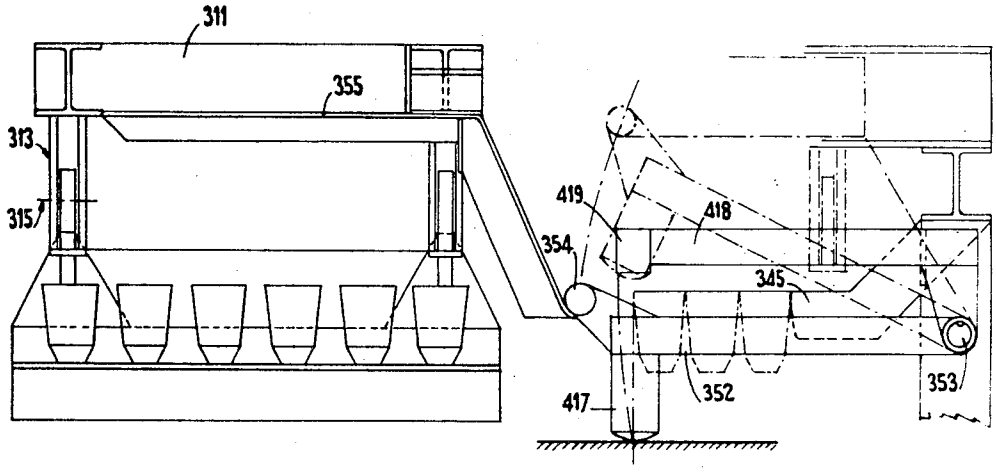

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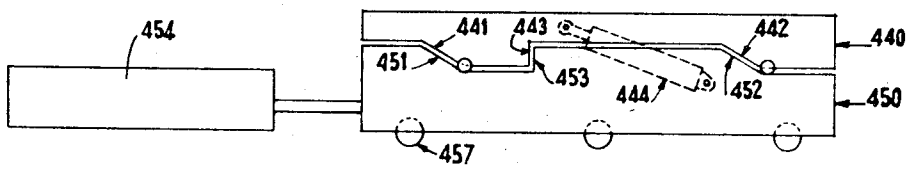
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Fig. 7

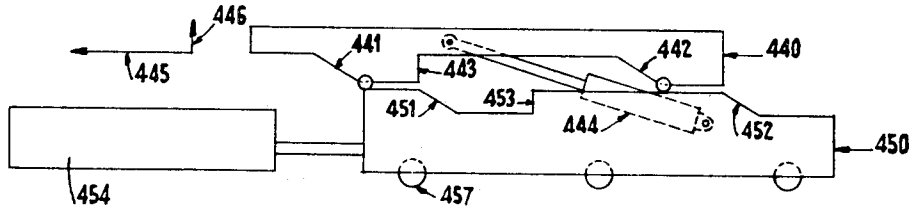
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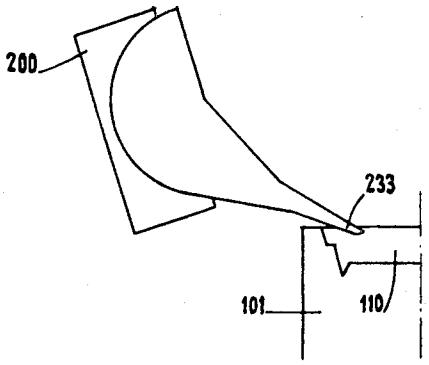
Fig. 8



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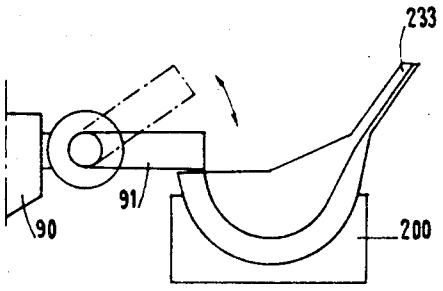

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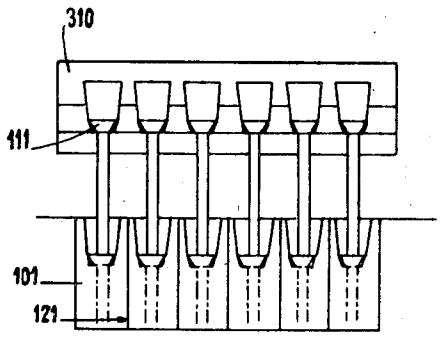
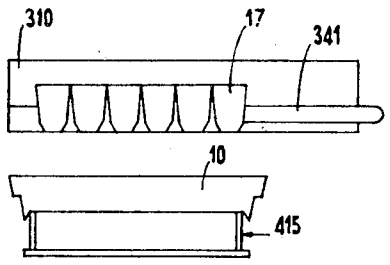


Fig. 11



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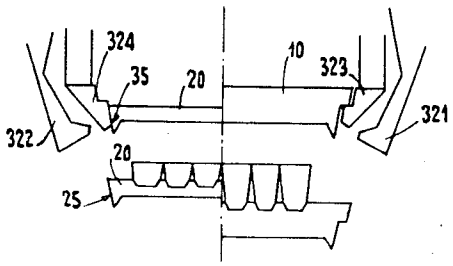

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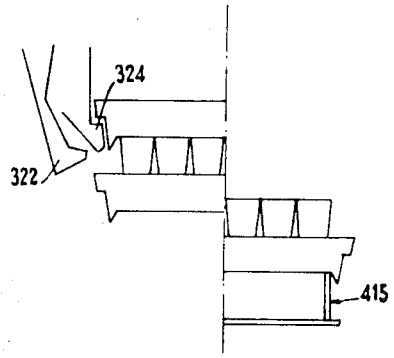

Fig. 14

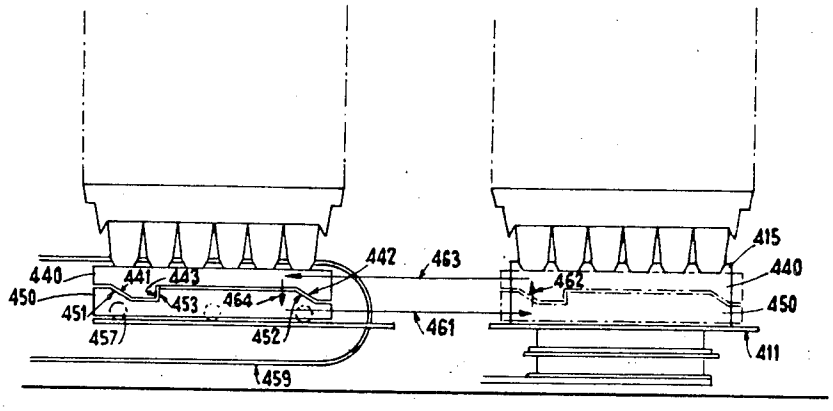

Fig. 16

Fig. 15

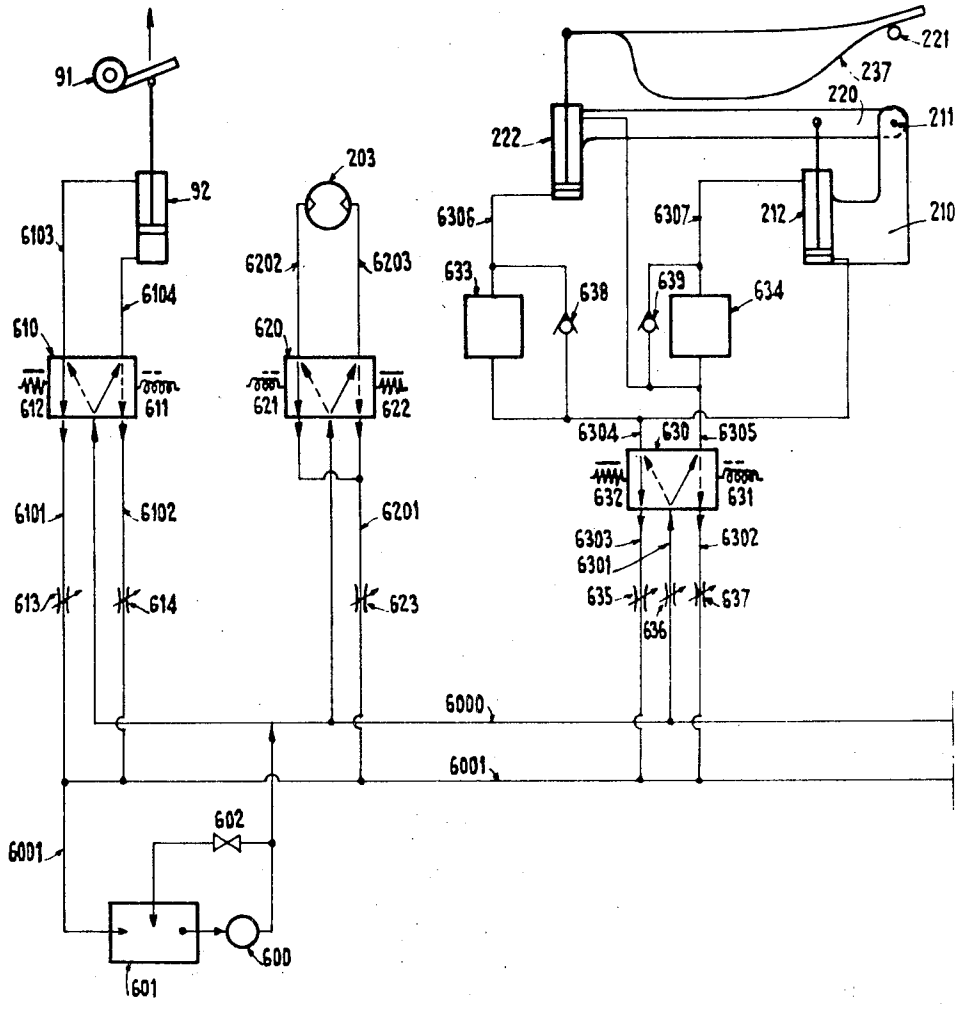
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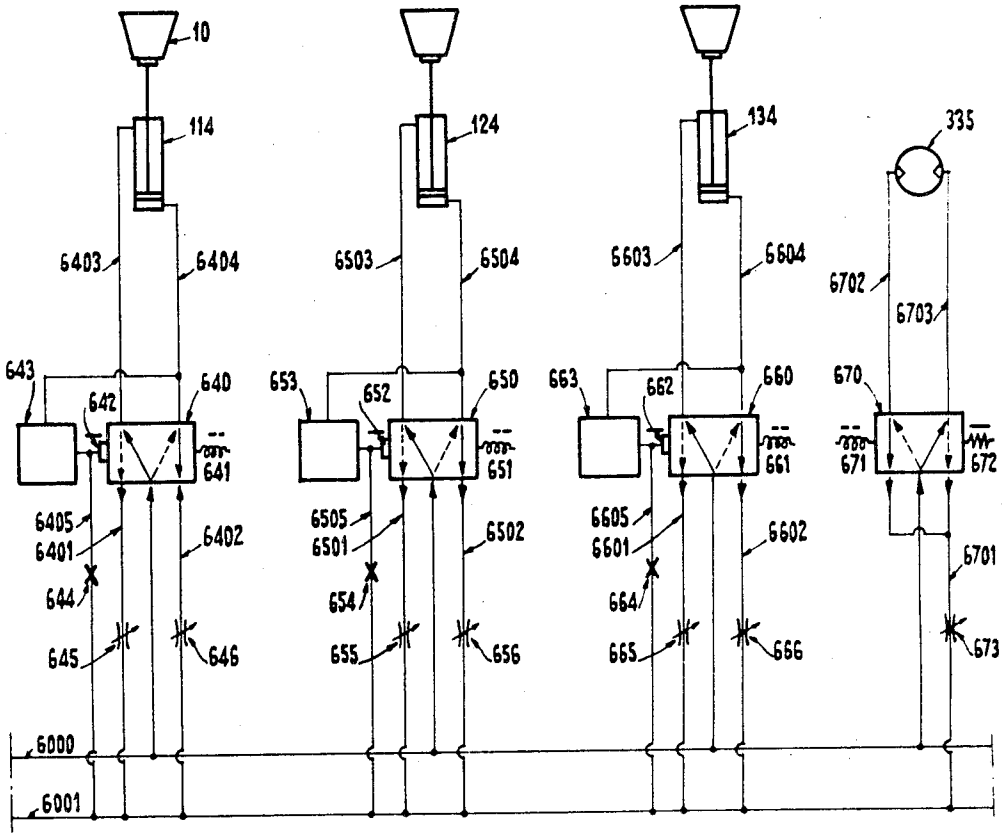
Fig. 17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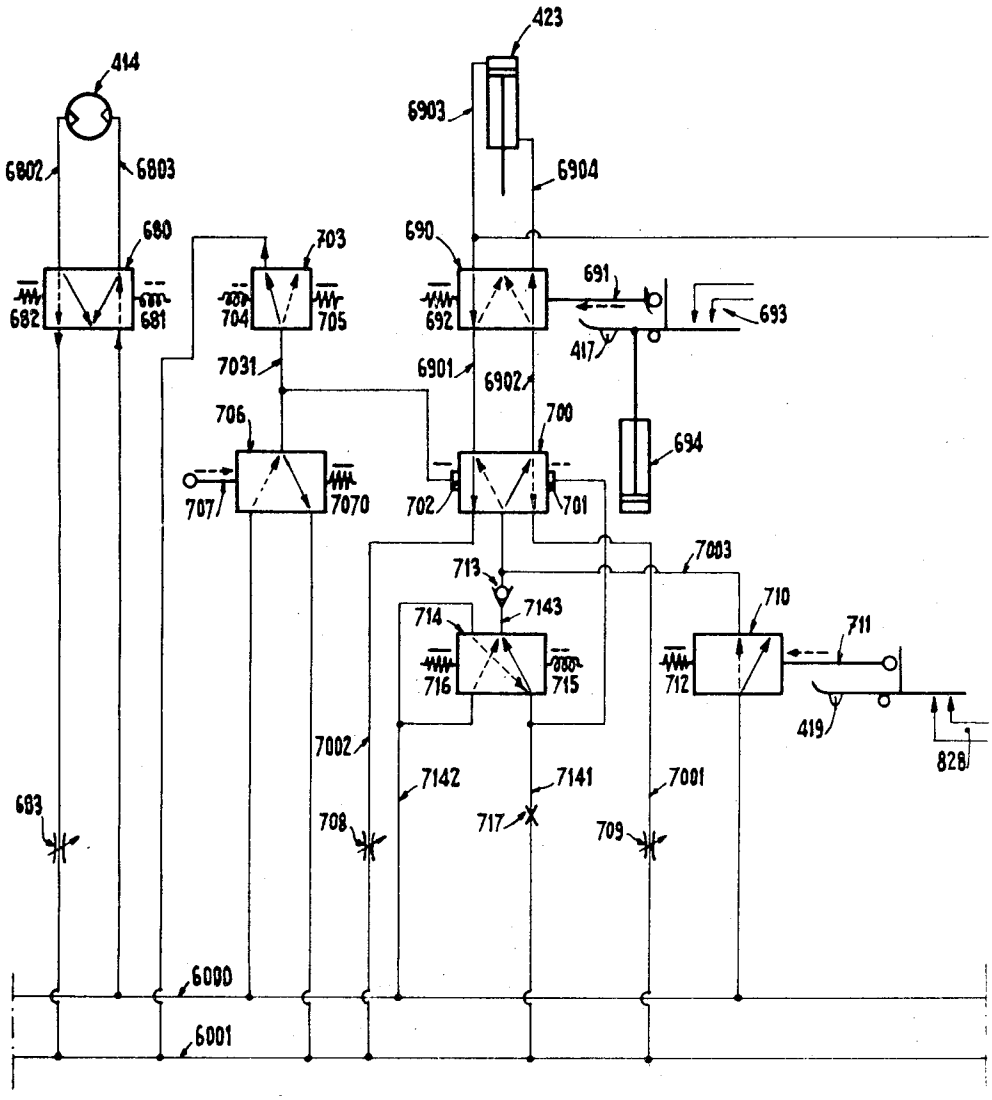
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Fig. 19

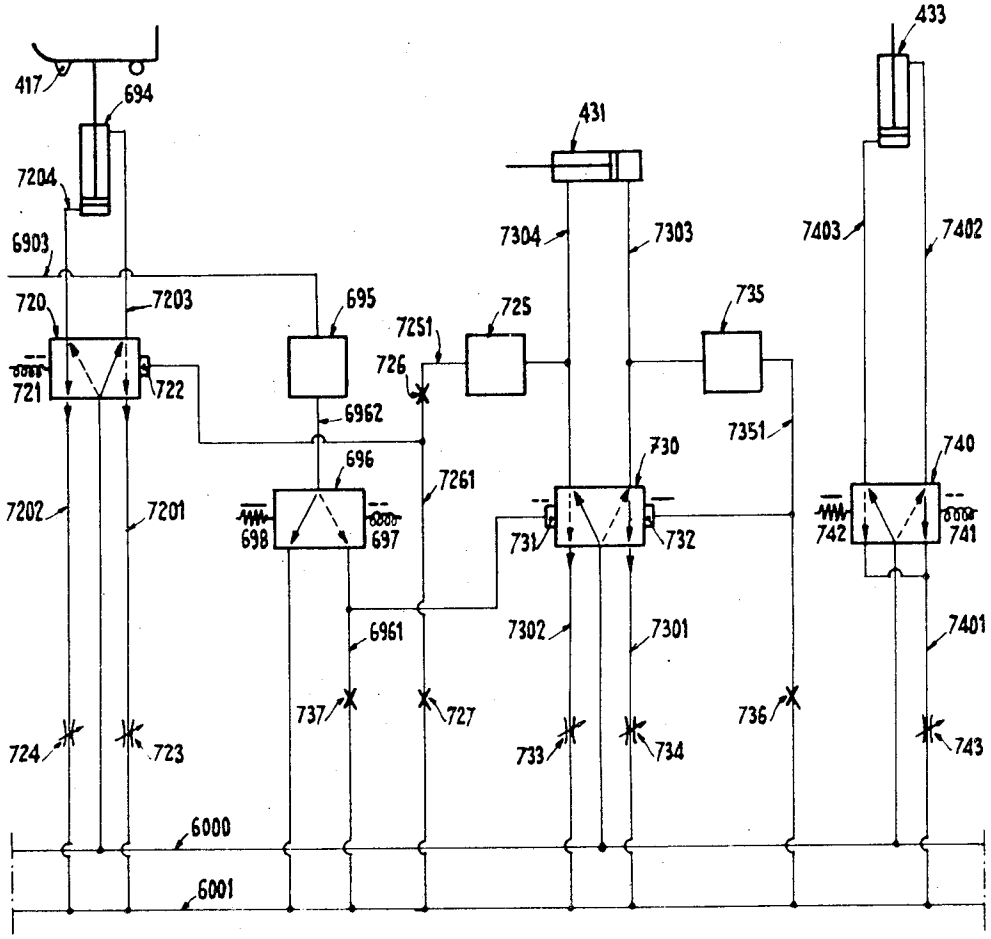
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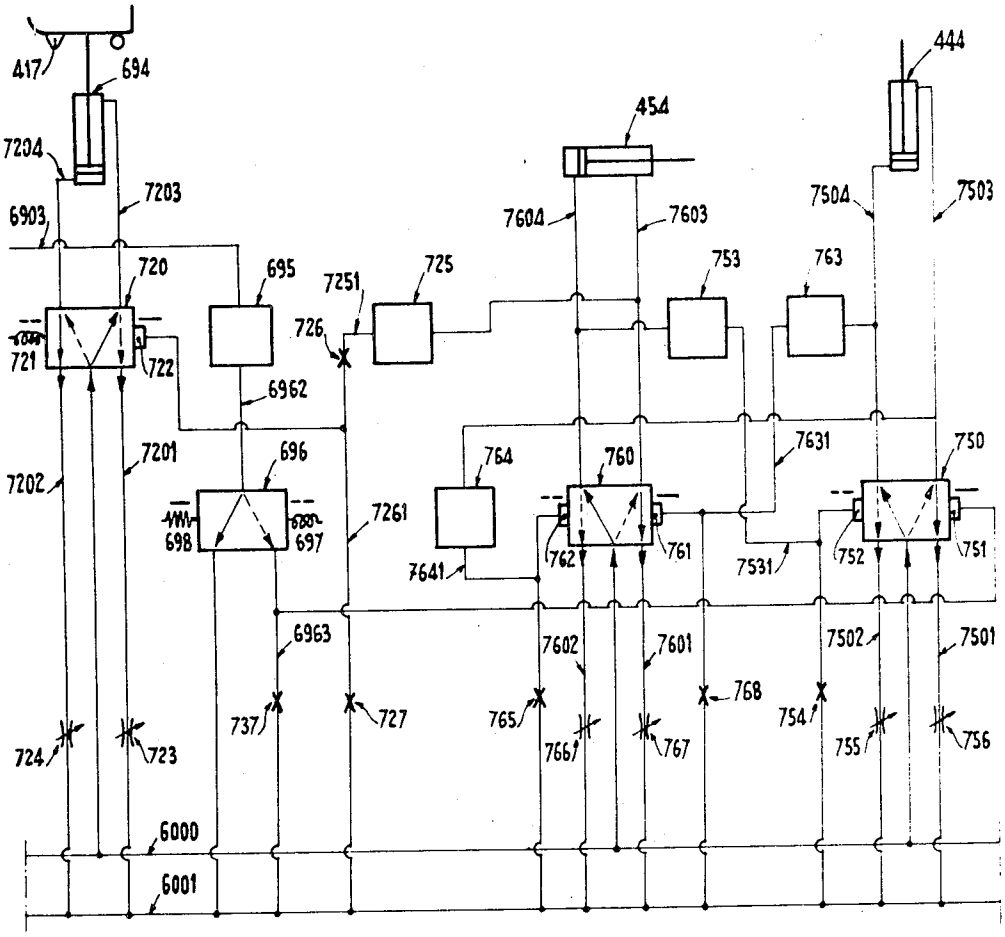
Fig. 20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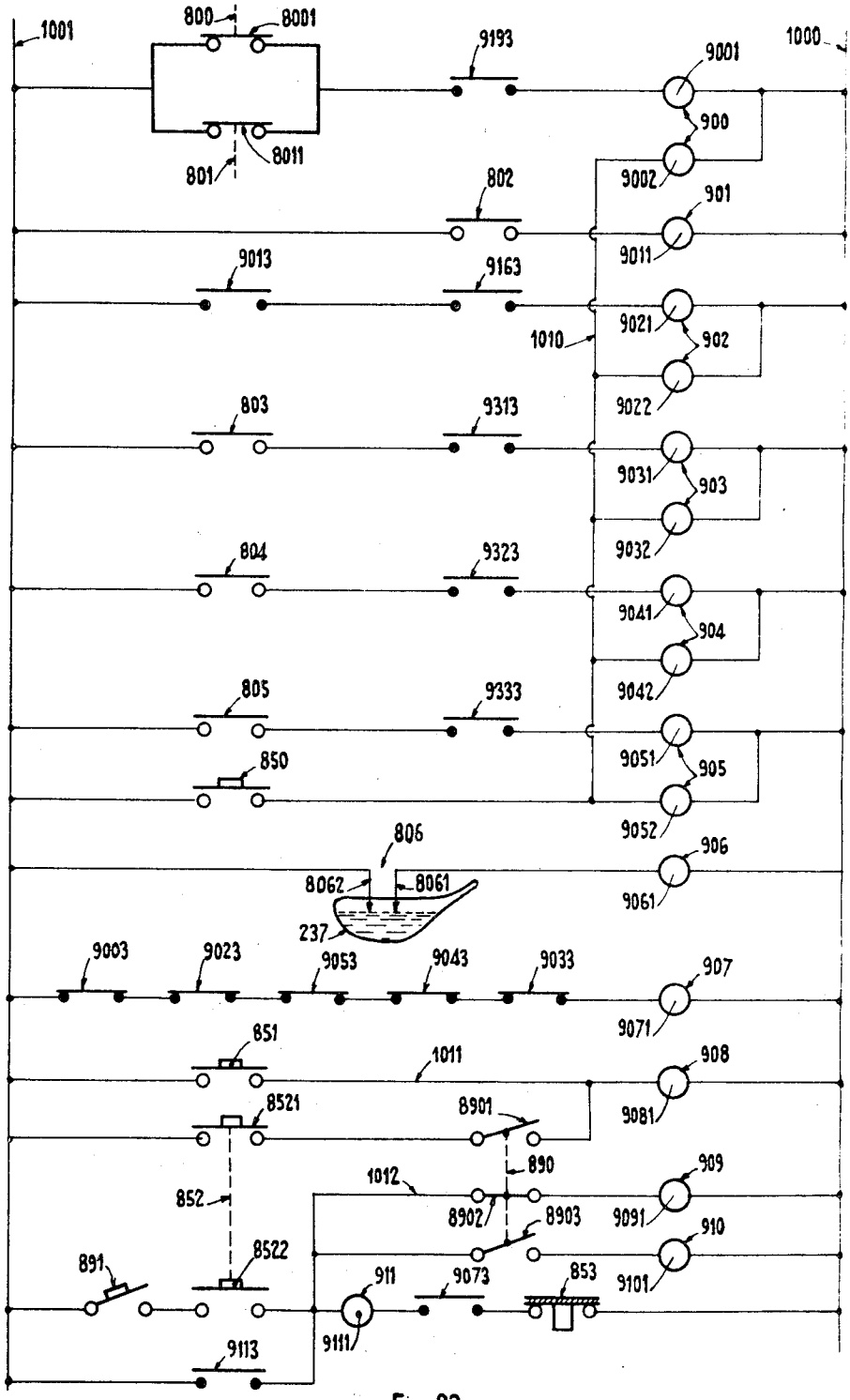
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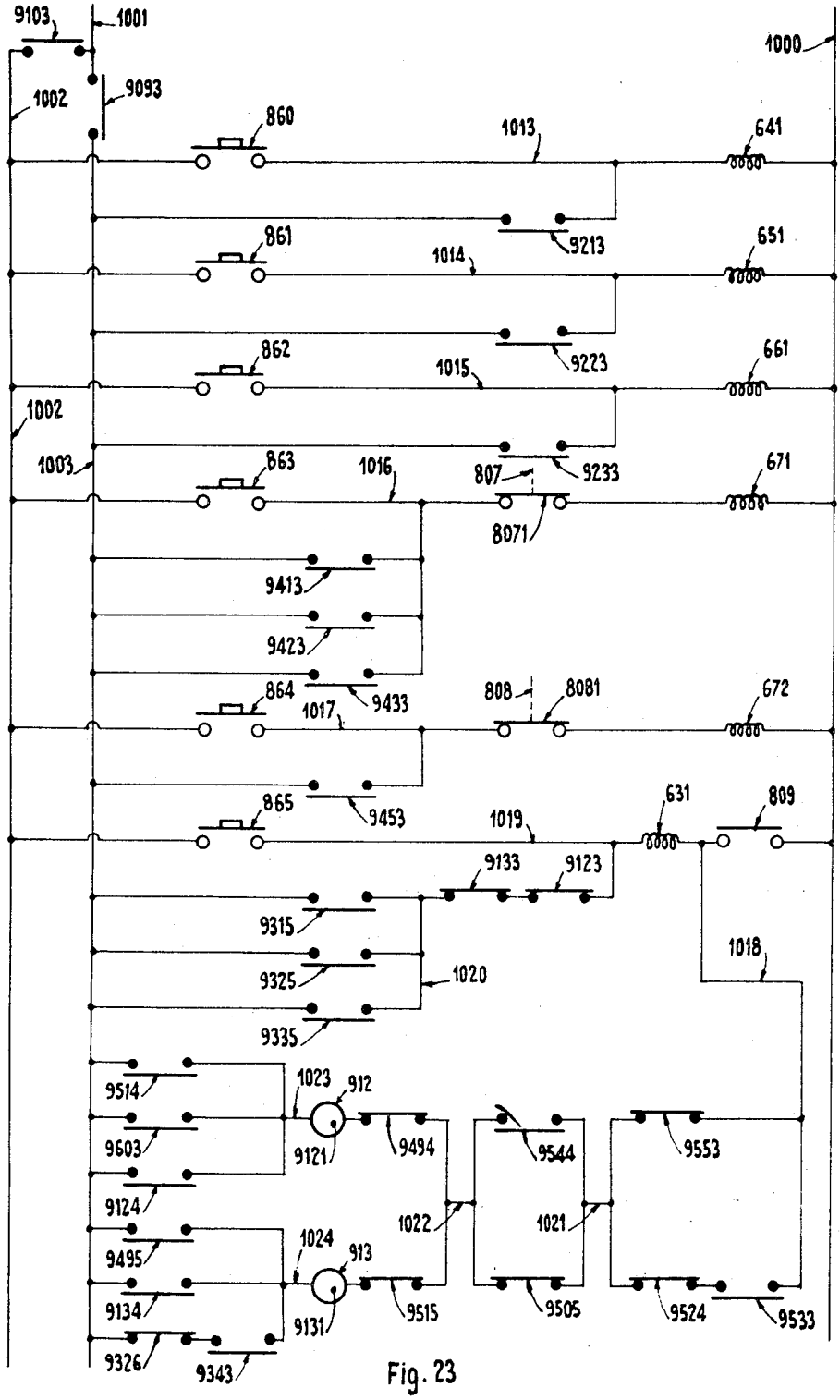
Fig. 22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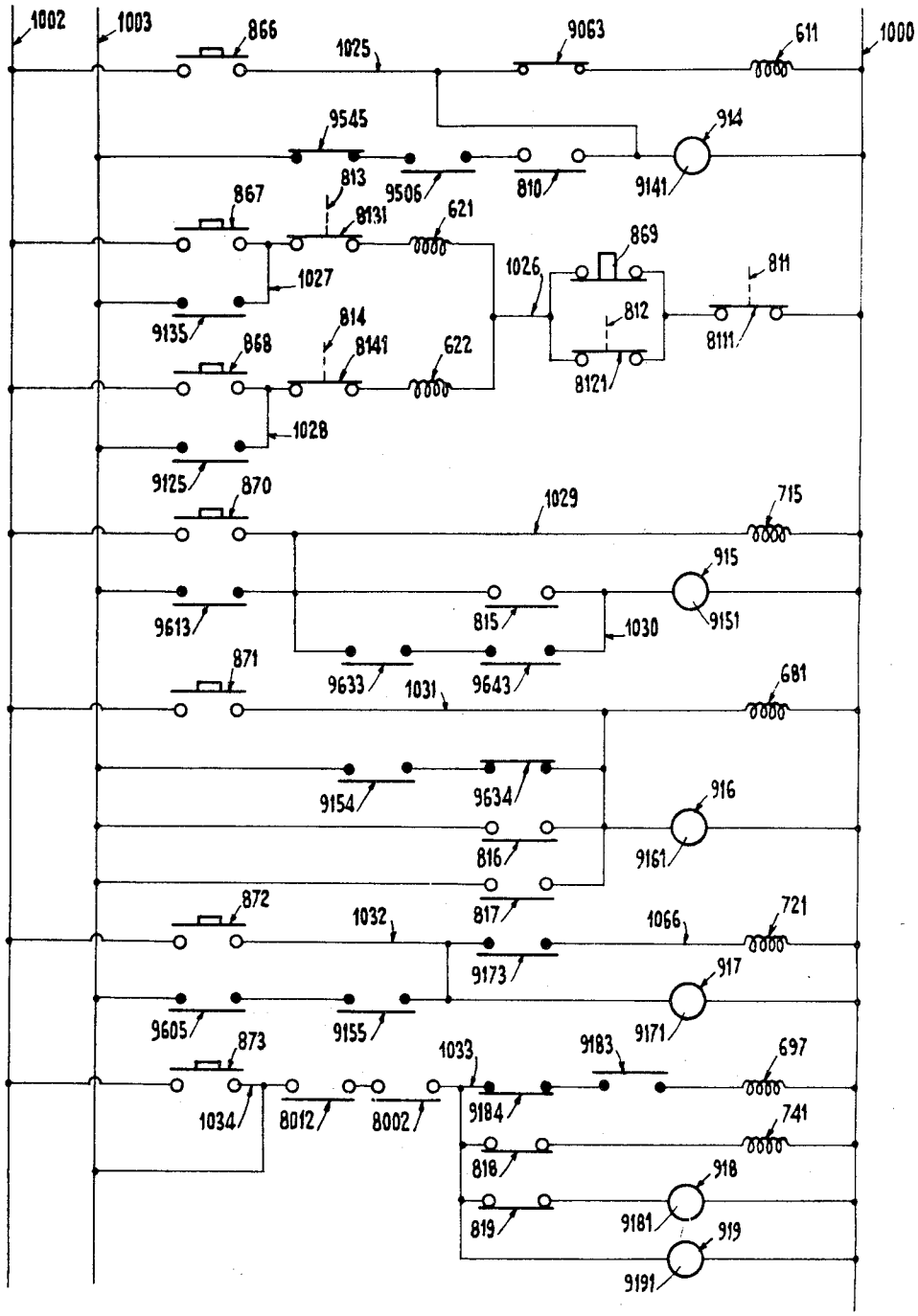
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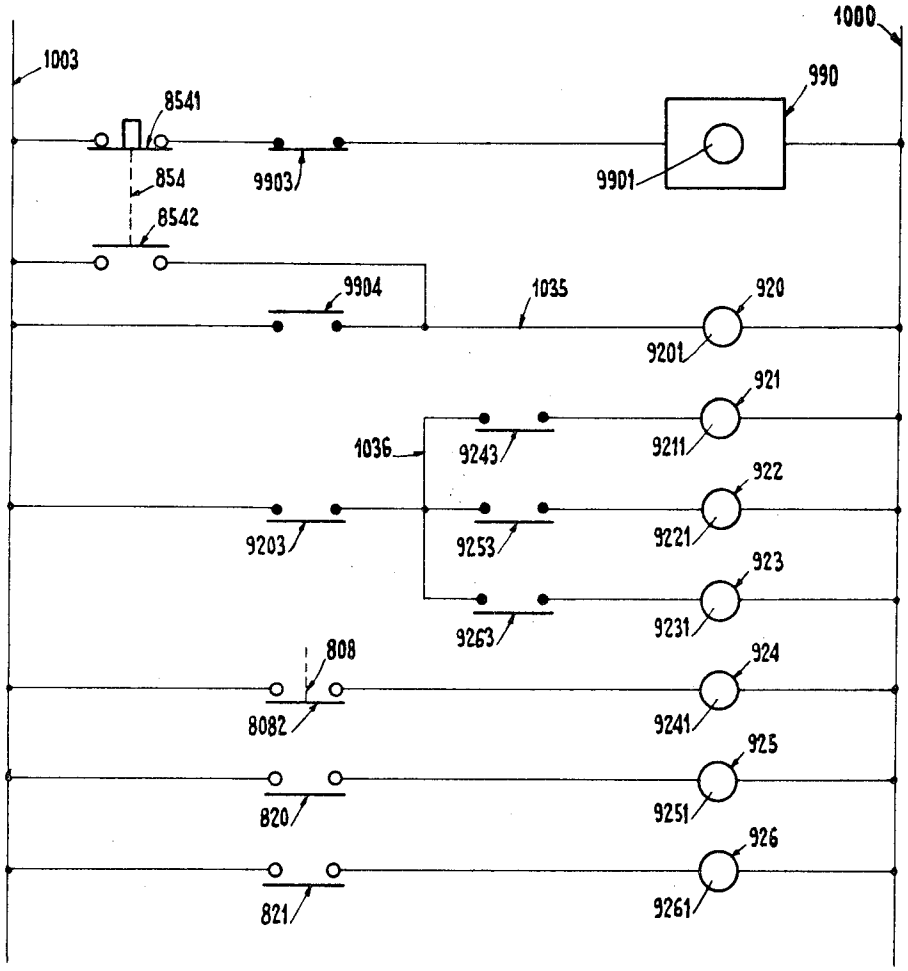
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Fig. 25

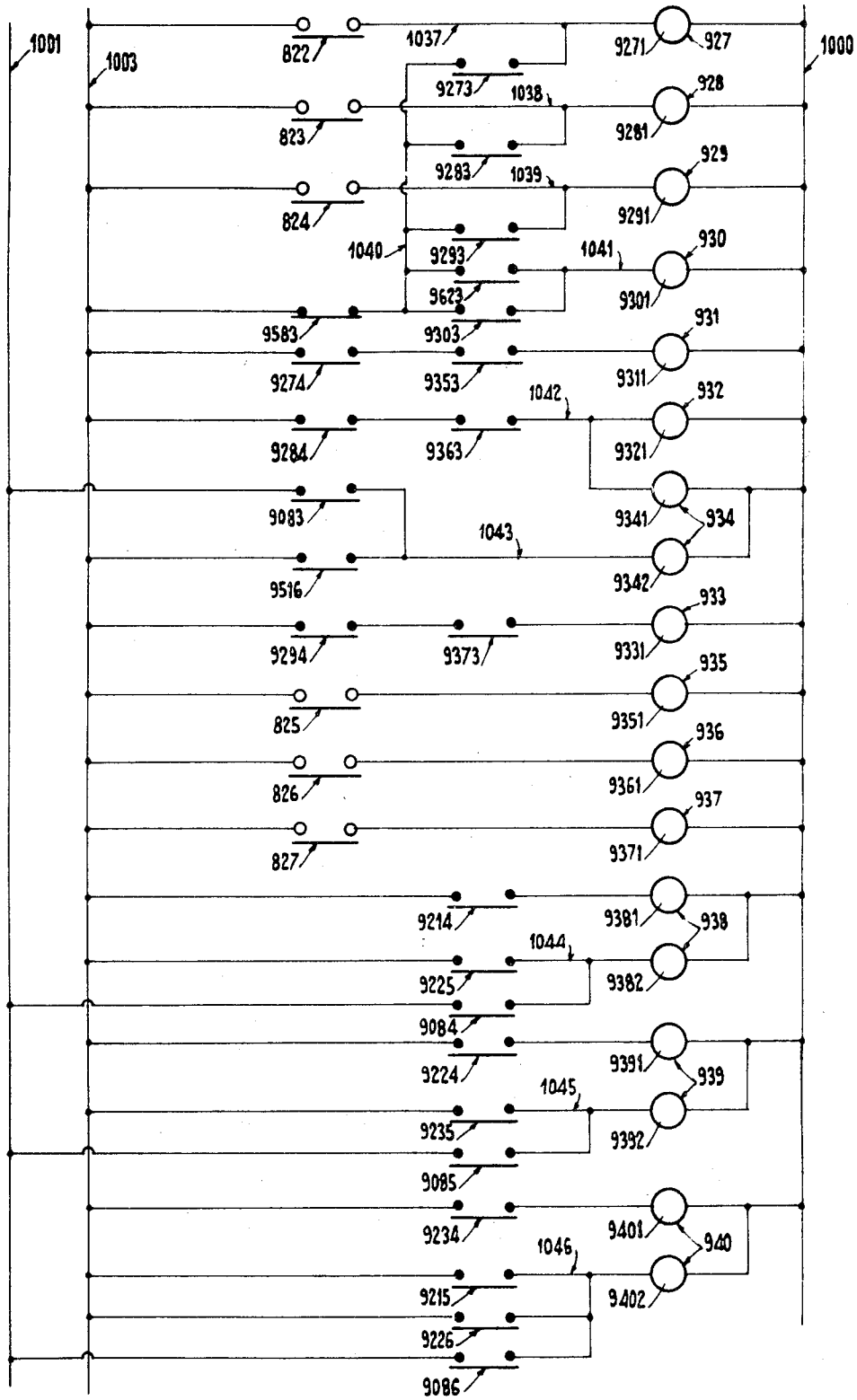
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Fig. 26

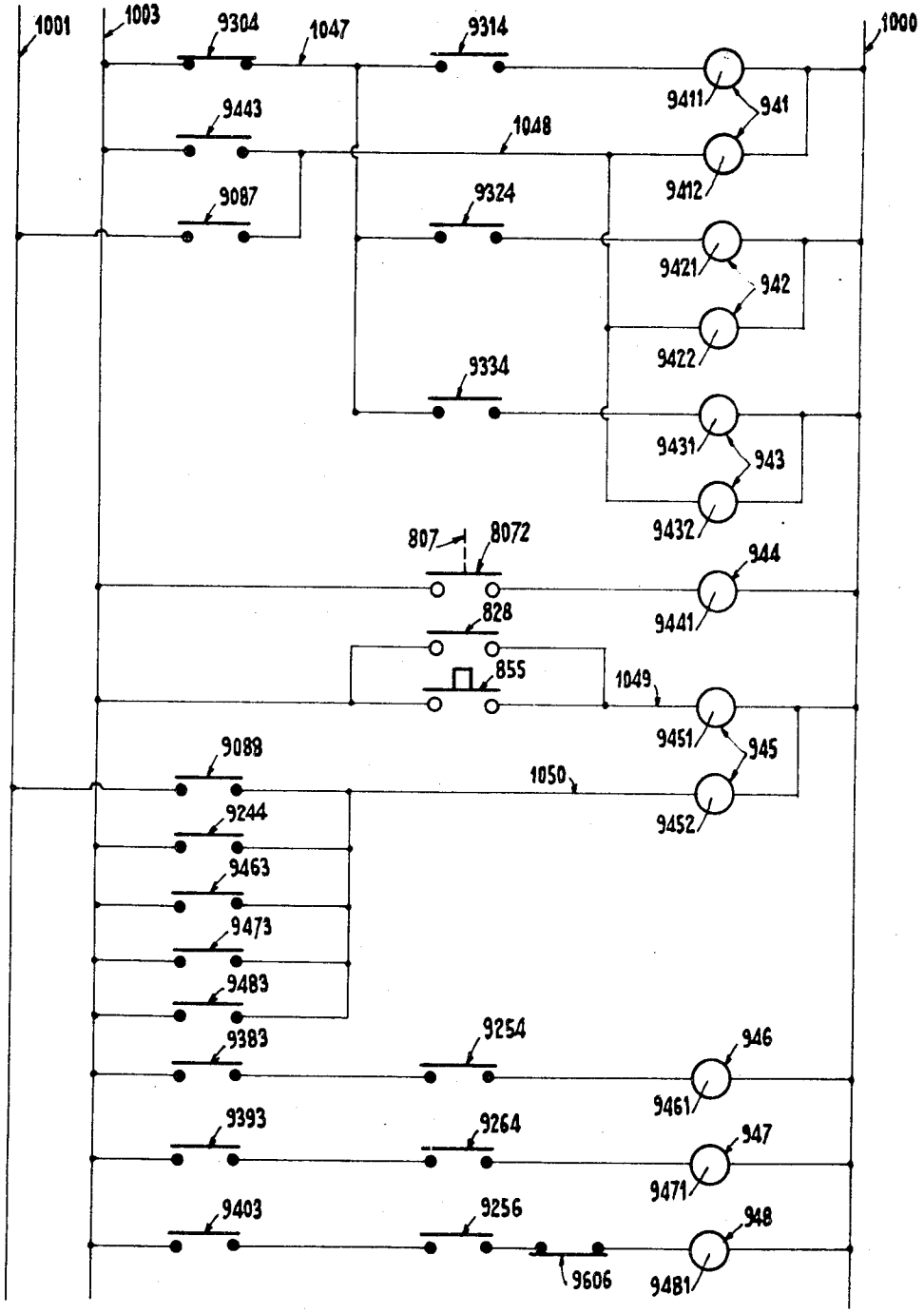
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Fig. 27

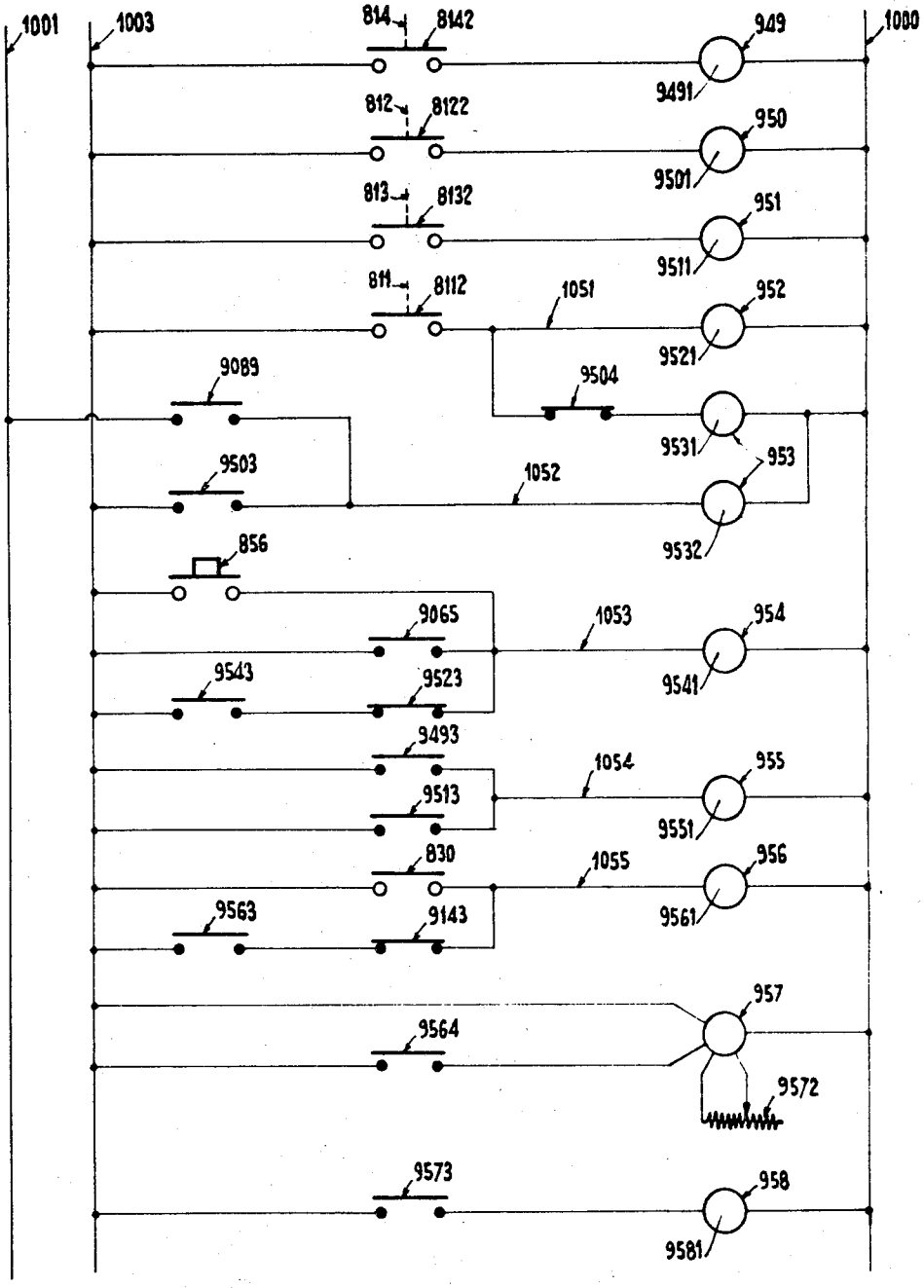
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Fig. 28

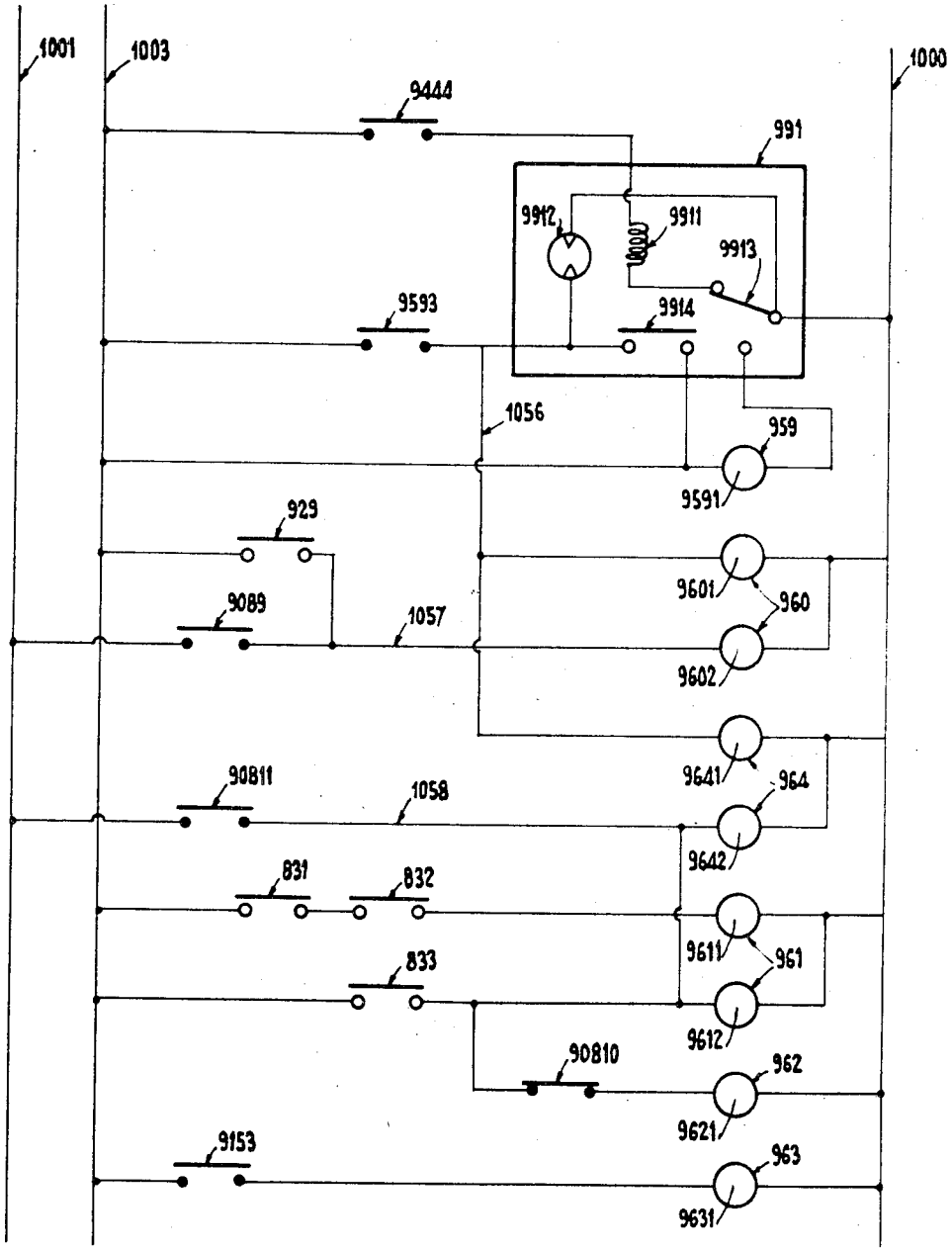
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Fig. 29

MACHINE FOR CASTING AND STACKING INGOTS

This application is a division of my copending application, Ser. No. 599,605, filed Dec. 6, 1966, now U.S. Pat. No. 3,498,364, and entitled "Machine for Casting and Stacking Ingots."

The present invention relates to a machine for casting and stacking ingots.

The known machines for casting and stacking ingots made use of ingot molds which were naturally cooled and which were mounted on endless chains. They are cumbersome, difficult to make mobile, and they are costly and delicate to maintain because the replacement of the chain is a long and laborious procedure and because the ingot molds have a relatively short useful life.

The object of the invention is in a machine for casting and stacking ingots in "*p*" layers of "*n*" ingots, which machine is less cumbersome, has high mobility and is easy to operate and to maintain.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, embodiments of the invention are shown in the accompanying drawings in which

FIG. **1** is a schematic elevational view of a stacking machine embodying the features of this invention in which the carriage has only a single pair of grippers for use with ingots having lugs;

FIG. **2** is a sectional elevational view taken transversely of the stacking machine shown in FIG. **1**;

FIG. **3** is a sectional elevational view taken transversely of a modification of the machine shown in FIGS. **1** and **2** to include a second pair of grippers for use with ingots without lugs;

FIG. **4** is a sectional elevational view taken longitudinally of the machine shown in FIG. **3**;

FIG. **5** is an elevational view of the carriage and position detectors of the machine shown in FIGS. **1** and **2**;

FIG. **6** is a transverse elevational view of the elements shown in FIG. **5**;

FIG. **7** is a schematic elevational view of an ejection device when in lowered position;

FIG. **8** is a view similar to that of FIG. **7** showing the ejection device in raised position;

FIGS. **9–16** are diagrammatic views illustrating the sequence of operations of the machine embodying the features of this invention;

FIG. **17** is a diagrammatic view of the hydraulic circuit for controlling operation of the machine for feeding the ingot molds;

FIG. **18** is a diagrammatic view of the hydraulic circuit for controlling operation of the machine for extraction and movement of the carriage;

FIG. **19** is a diagrammatic view of the hydraulic circuit for the movable table;

FIG. **20** is a diagrammatic view of the hydraulic circuit for the discharge of the completed stack by means of a jack operated ram;

FIG. **21** is a diagrammatic view of the hydraulic circuit for the discharge of the completed stack by a push-plane conveyor;

FIG. **22** is an electrical diagram for the safety and the general control circuits;

FIGS. **23** and **24** are electrical diagrams of the circuits which act on the windings of the distributors;

FIG. **25** is an electrical diagram of the pulse-switching circuits;

FIG. **26** is an electrical diagram of the automatic extraction circuits;

FIG. **27** is an electrical diagram of the circuits for automating the movement of the carriage;

FIG. **28** is an electrical diagram of the circuits for operation of the feed mechanism; and

FIG. **29** is an electrical diagram of the circuits for the movement of the stacking zone and for counting the layers of ingots deposited.

The machine embodying the features of this invention comprises a casting zone, a stacking zone and a conveyor device for ingots. The casting zone comprises at least one group of ingot molds, each comprising "*n*" chill molds provided with means for extracting the cast ingots and means for the forced cooling thereof and at least one means for feeding the ingot molds with molten metal. The ingot conveyor comprises a carriage for transporting the ingots in which the carriage is mounted for displacement on a roller track from the casting zone to the stacking zone and carries at least one ingot gripper device capable of simultaneously gripping the "*n*" ingots which issue from a single group of ingot molds, driving means for displacement of the carriage, and an abutment or stop which cooperates with the movement of the carriage towards the stacking zone to close the gap between the ingots in the same layer for alignment of the ingots in side-by-side relation; the stacking zone comprises a movable table on which the "*p*" layers of ingots are successively deposited to form a stack, driving means capable of rotating the table through an angle of 90° about a vertical axis which passes through the center of the stack, a movable table support on which the table and the driving means are carried, driving means capable of driving the movable table support in a vertical translatory movement and a discharge means for the completed stack.

In accordance with a preferred concept of this invention, the ingot transporting carriage comprises two independent grippers, one of which is fixed and capable of carrying the ingot by its two end ears or lugs, while the other is movable and capable of carrying the ingot by the extreme zones of its small base thereby to permit ingots of different weights and cast in the same ingot mold to be stacked.

The known machines for casting and stacking ingots comprise a chain of ingot molds with natural cooling, in which cooling is generally accelerated by a water spray. This spraying with water has the advantage of permitting a reduction in the length of the chain, but the result thereof is frequent cracking of ingot molds. These machines are mounted either at a fixed position or on rails, but in this latter case, only movements along straight rails are possible, on account of the considerable length of the machine.

The machine developed by applicants obviates these disadvantages: the use of ingot molds with forced cooling makes it possible to avoid the fragility of the ingot molds and to reduce the ground space occupied to the point that the machine can be easily made mobile, either on a railway or even on a roadway. In this latter case, the machine can advantageously rest at its rear end on a wheel train comprising at least two and preferably four wheels, with its front end on blocks or jacks. This front part can in addition comprise a coupling and tractioned unit permitting a road semitrailer to be formed.

The machine comprises a general frame or bedplate **500**, resting at the front end on a wheel train **510** comprising four wheels in the example illustrated, of which two wheels **511** and **512** are visible in FIG. **1**, and at the rear end on blocks, such as **513**, or on jacks.

The bedplate **500** comprises a horizontal frame **520**, formed by longitudinal iron bars such as **521**, **522**, **523** and transverse bars, such as **526**, **527**. This frame is reinforced by a structure **530** which is also horizontal.

The front region of this bedplate, which forms the casting zone, carries a gantry **540**, while its rear end, which forms the stacking zone, carries a stacking frame **550**, which comprises four vertical posts, of which three, **551** to **553**, can be seen in FIGS. **1** or **2**. These posts are braced in their upper part by an intermediate frame formed of four bars such as **554** and **555**. The front posts, such as **552**, are extended upwardly and support, with two other vertical posts such as **553**, an upper horizontal frame **556** which serves as a support for a jack.

In the casting zone, at the front of the bedplate, there is arranged the ingot mold assembly **100** and the feed arrangement **200** for such molds.

The ingot mold assembly comprises at least one group **101** of "*n*" ingot molds. Each ingot mold comprises a chill mold

such as 110 and it is equipped with extraction means, such as the valve 111.

The ingots, such as 10, comprise a large base 11 and a small base 12 connected by two lateral faces which are preferably slightly inclined relative to the vertical so as to give a slight tapering to the ingot, this enabling the maximum amount of material to be arranged in a stack of given dimensions. All the ingots are stacked in the same way with the large base facing upwardly, the ingots of each layer, considered in the length direction, being perpendicular to the ingots of the two adjacent layers. In order to permit a reciprocal and efficient locking of adjacent layers, it is desirable to provide the small base with locking projections 13 and 14 in the vicinity of their two small sides. Finally, the ingots can be formed with lugs 15 and 16 which facilitate the handling thereof.

Each ingot mold comprises a double-walled box, of which an internal wall 119 carries the impression which represents the shape of the ingot 10 to be cast, and an external wall, the free space which is between the two walls being occupied by a cooling fluid such as water, of which the rate of flow is sufficient for it to produce a throttling of the fluid stream, thus avoiding formation of points at which heat is generated. In the example illustrated, the assembly of the external walls of the group of ingot molds forms a common external element 120 provided with internal separations, such as 121, so as to give individual character to the space occupied around each impression by the cooling fluid. Each external wall is formed with an opening which permits the cooling fluid to flow successively through the free spaces of the "n" ingot molds of the group, the entry of this fluid being by way of a pipe 122.

Arranged at the bottom of each impression is at least one valve seat 122—two are shown—cooperating with a valve 111 which assures in the raised position the ejection of the cast ingot and in the lowered position the continuity of the chill mold. The valve seats can be either screwed or welded on the internal and external walls. If they are welded, it is necessary for the weld beads to be contained inside the volume through which the cooling fluid flows. These seats are preferably provided with fins which are in contact with the cooling fluid.

All the valves of the same group are controlled by a single jack 114, by means of a valve-carrying plate 113. This latter acts on each of the valves 111, directly in the direction corresponding to the return of the valve to its seat, this making the separation of the valves from the small base of the cooled ingot less severe. Each valve is mounted on a valve carrier 116 and is locked therein by keys 117 which are held by resilient plates 118. This arrangement permits easy replacement of the valves, which are the members of the apparatus which are subject to the quickest wear.

The internal wall 119 may be in one piece. It is then obtained by a known means, such as pressing or stamping. It is preferable for it to be provided with fins serving for cooling and reinforcing purposes. This internal wall may thus be formed of several parts welded together. It is then necessary for the weld heads to be inside the box in contact with the cooling fluid.

It is desirable to provide each weld with one or more fins, which can be formed by the plate of one of the elements to be welded being extended beyond the weld inside the box.

The machine may comprise only a single group of "n" ingot molds, but it is preferable for the best possible use thereof to install several groups. The figure shows three of such groups, bearing references 101 to 103. One of these groups can be designed for the casting of special ingots which comprise in their large bases a recess permitting the stack to be engaged by means of a fork, such as that of a conveyor carriage. The ingots intended to form the bottom layer of each stack are called "pallet ingots."

The groups of ingot molds are supplied with molten metal by a melting furnace 90, preferably of the type having a rotary nose 91, by means of an ingot feeding arrangement, which is indicated at 200.

This installation comprises a distributor frame 210 carrying at least one horizontal shaft 211, on which is articulated a movable intermediate support 220. This latter carries a trough comprising a tank 232 divided by (n−1) screens such as 231 into "n" equal volumes, each of which ends at a pouring spout 233. Driving means, such as the jack 212, make it possible for the intermediate support to pivot about the shaft 211 with which the distributor frame 210 is provided, so that the "n" pouring spouts, such as 233, simultaneously pour "n" equal batches of liquid metal into the "n" chill molds of a group of ingot molds.

In the example shown in FIG. 2, the trough is mounted on a trough-supporting frame 230 which is capable of pivoting about a horizontal shaft 221, fast with the intermediate support 220, under the action of a second jack 222.

This pouring arrangement can be fixedly mounted in front of the ingot mold group which it supplies with liquid metal. In this case, as many arrangements as there are groups of ingot molds are then provided, that is to say, three in the example illustrated. It is then necessary for the nose of the pouring furnace to be movable and to permit the different pouring devices to be fed, one after the other.

In the example illustrated, it is preferred to use only one pouring arrangement, but this latter is movable, so as to permit it to be successively positioned:

- under the nose of the pouring furnace, with a view to being refilled,
- in front of one of the ingot mold groups in order to pour the molten metal into these latter, this operation being repeated as many times as there are groups of ingot molds, each pouring into a group of molds being preceded by a station beneath the furnace nose for refilling purposes.

The distributor frame or box 210 then comprises a horizontal frame 213 provided with rollers such as 214 and 215, capable of being displaced on rails 218 and 219. The rollers can have vertical or horizontal shafts. FIG. 2 shows this latter case, the rails being horizontal and fixed on bars 522 and 523 of the main bedplate of the casting and stacking machine.

At least one and preferably two shaft supports 217, each supporting a shaft 211, are fixed on this horizontal frame, either directly or, as shown, with interposition of an intermediate frame 216.

The movable intermediate support 220 comprises two horizontal frames 223 and 224 which are staggered in height and are connected by a vertical frame 225 which, extended upwardly beyond the upper horizontal frame 224, carries at least one and preferably two shaft supports 226, which each carry a shaft 221. The horizontal frame 224 carries the bearings articulated on the shafts 221.

The jack 212, which controls the movement of the movable intermediate support is fixed on the one hand by the swivel joint 218 to the horizontal frame 213 of the main support and on the other hand by the articulated joint 227 to the lower horizontal frame 223 of the intermediate support.

The trough-supporting box 230 comprises a horizontal frame 234 joined to a vertical frame 235 on which are mounted the bearings articulated on the shafts 221.

The box 230 supports the trough 237 by means of a sheet of heat-insulating material 236, the tank 232 of said trough being divided by (n−1) screens, such as 231, into "n" equal volumes which each end at a pouring spout 233. The trough is made of steel lined internally with a refractory lining, such as a lining of corundum. The screens can be held by this lining.

A cooling effect can be assured by circulation of a cooling fluid, such as compressed air or water, in the space contained between the trough and the thermally insulating sheet.

The jack 222, which controls the movement of the trough-supporting box with respect to the movable intermediate support is fixed on the one hand by a swivel joint 228 to the lower horizontal frame 223 of the intermediate support 220, and on the other hand by an articulated joint 238 to the horizontal frame 234 of the trough-supporting box.

The travel and the operating speed of the jacks are chosen in such a way that, for the largest ingot to be cast, the jack **212** brings the trough into a position such that the liquid metal is flush in the vicinity of the pouring spouts without, however, leaving the trough, this first movement being rapid, while the jack **222** inclines the trough still further, thus causing the progressive pouring of the liquid metal until complete emptying is obtained, this second movement being as slow as required for the regularity of the pouring.

The replenishing of the feeding arrangement can be stopped automatically by bringing the rotary nose of the furnace under the control of the circuit controlled by a device for completing the feeding, which device is formed for example by two contact pins which are positioned above the trough and which are short-circuited by the molten metal when the required level is reached.

It is possible to cast ingots of different weights in the same ingot mold. It is sufficient to provide either a pair of contact pins at each of the corresponding levels, or a single pair of movable pins, of which the height position is adjustable and calibrated once and for all.

However, it is pointed out that if the weight difference between the heaviest ingot and the lightest ingot is considerable, the lightest ingot can no longer have the lugs **15** and **16**, and this, as is explained below, complicates the ingot conveyor, FIG. **3** shows at the same time the heaviest ingot **10** with a large base **11**, and the lightest ingot **20** with the large base **21**, the two ingots having the same small base **12**.

The movement of the feeding arrangement is controlled by any known means, such as a jack, a cable or a chain controlled by a motor and reduction gear assembly, or even by a motor mounted on the frame and acting on rollers.

As soon as the ingots cast in one group of ingot molds are ejected, they are gripped and transported from the casting zone to the stacking zone of the machine by a conveyor device **300**.

This arrangement comprises a conveyor carriage **310** capable of being displaced on a roller track extending substantially over the entire length of the machine. This roller track can be formed, for example, by a monorail on which roll at least two rollers from which the carriage is suspended.

In the example illustrated, the said carriage rolls on two rails **301** and **302** which are carried and braced by bars such as **541**, the assembly being fixed on the one hand on the gantry **540** at the front and on the other hand on the rear vertical posts, such as **553**, of the stacker-supporting frame.

The carriage **310** comprises a chassis **311** fitted with rollers **312** engaging on the rails and carrying supports, such as **313** and **314**, on which is fixed at least one ingot gripper device **323** to **324**, capable of being engaged under the lugs or under the projections of the ingot.

The movement of the carriage is assured by a cable or an endless chain **331** which extends around two end pulleys **332** and **333** and over a driving toothed wheel or pulley **334** which is under the action of a motor and reduction gear group **335**. The correct tension of the cable or of the chain is ensured by the tensioning pulley **336** and by its counterweight **337**. The motor can be an electric, hydraulic or pneumatic motor. This arrangement can be replaced by any equivalent arrangement, such as a jack, or even a motor and reduction gear assembly mounted on the carriage and driving at least one of the rollers.

This arrangement with a single gripper device, which is fixed, is suitable in all cases where the ingots to be cast and stacked comprise the lugs **15** and **16**. When the carriage reaches the casting zone and when it is immobilized underneath one of the groups of ingot molds, the cast ingots are raised, resting on the ejection valves **111**. The lugs of the ingots move the two halves **323** and **324** of the gripper device apart, pass perpendicularly of these latter, then move slightly higher, this enabling the gripper device to close again. When the ejection valves descend again towards their seats, the ingots are deposited, with their lugs resting on the gripper device, and then the carriage reassumes its movement, being directed towards the stacking zone. When the carriage is near the end of its travel and the leading ingot occupies the correct position for the stacking operation, this ingot bears against a stop abutment **341** which, as will be explained, can be fixed or movable, but as the carriage continues to be displaced, the following ingots continue to advance until all the ingots are touching one another. The stack thus formed is then raised, so that the ingots come out of contact with the gripper device or devices, this enabling the carriage to reassume its movement towards the casting zone, while the ingots remain on the stack.

When the ingots to be stacked comprise ingots **20** without lugs, the lateral faces **3231** and **3241** of the gripper device **323–324** are given profiles which are exactly parallel to the oblique small faces **25** and **26** of the ingot, so that the ingot remains positioned on the gripper device, but by means of its lateral small faces. In order to steady the ingots while they are being conveyed, it is preferable also to support them by a large gripper device **321–322** engaging underneath the projections **13** and **14** of the ingot. This large gripper must, however, be moved away at the time of depositing the ingots on the stack.

For this purpose, the halves of the gripper device are pivoted on shafts **315** and **316**, which are fast with supports **313** and **314**. These shafts are placed in such a way that the gripper device, loaded with ingots, remains in the locked position. At least one of the halves of the large gripper device, for example **321**, carries a roller **325** capable of coming into contact with a rail **326** fixed on a bar **317** fast with the supporting chassis of the stacker device **550**, by means of two rods **327** and **328**. A jack **329** fixed on the one hand to the bar **317** and on the other hand to one of the rods (rod **327**) permits the rail **326** to assume two positions, a lower position in which it does not touch the roller **325**, so that the half of the gripper device remains in the locked position, and an upper position in which it touches and lifts the roller **325**, so that the half gripper is brought to the open position.

The second half-gripper **322** of the same pair can either carry an identical device or be controlled by the half gripper **321**, for example, by means of a system of rods and levers, so that it carries out the same movement.

Thus, when the jack **329** is in the "gripper locked" position, the ingot **10** or **20** rests by means of its projections **13** and **14** on the flat portions of the gripper device **321–322**, whereas when this jack is in the "gripper open" position, the two halves of the gripper are moved apart, so that the ingots are no longer held by the gripper **323–324** which, with the carriage remaining stationary, offers them a sufficient support permitting them to be deposited on the stack.

When the cast ingots always have exactly the same dimensions, except as regards height, that is to say, when it is desired to cast only alloys having sufficiently identical shrinkage coefficients, it is possible, in accordance with FIG. **5**, to use only a single gripper **3235–3245**, provided with horizontal projections **3236** and **3246**, on which the ingot rests by means of its projections. It is then necessary, so that the presence of the gripper does not in any way interfere with the ingots being deposited on the stack, for the lateral faces of the gripper device to match strictly the corresponding faces of the ingot and for the horizontal projections to be very short. As a result, there are very small tolerances as regards the ingot dimensions.

The stacking takes place on a movable table **411**, on which are successively deposited the "*p*" layers of "*n*" ingots forming a stack. This table can be rotated about a vertical arc passing substantially through its center by means of a known arrangement, such as a motor **414** driving a pinion **413** which, in its turn, drives a toothed ring **412**. The movable table is carried by a support **421** fur such table, the support carrying the motor and being adapted to be vertically displaced. To this end, the support **421** is fixed on a fork **422** capable of sliding or rolling on a slideway or a vertical rail, it being possible for this latter to be simply formed, as shown, by the flanges of a bar or section iron **552** of the stacker supporting frame. The vertical movement is assured by a jack **423** or by any equivalent means.

The table **411** can be provided on its surface occupied by the ingots either with rollers such as **416** or more simply with rails, such as **415**, on which the ingots are capable of sliding.

During the formation of a stack, the movable table must be maneuvered so that the upper surface of the last layer to be stacked successively occupies two positions:

a lower position or stacking position, leaving above the stack already formed a free space permitting the arrival of the carriage loaded with the following layer,

an upper position or depositing position, corresponding to the level of the upper surface of this following layer, when this latter is raised relative to the grippers so as to permit the departure of the empty carriage towards the casting zone.

The first position is thus defined in relation to a layer "*j*," while the second is defined with respect to the following layer "*j*+1."

It is possible to obtain these two positions by a simple manual action on the control member of the jack **423** or equivalent means, which ensures the sliding vertical movement of the movable table, but these operations require great attention on the part of the operator, which it is difficult to apply continuously. It is thus preferable to indicate the two levels by position detectors acting on the control member of the jack **423**, even if in other respects the machine remains under manual control. Since in certain cases the stop abutment **341** has a strict relationship with these position detectors, this abutment is described with these latter.

The formation of the abutment **341** depends essentially on the method of operation of the movable table. This latter, after depositing a layer of ingots, carries out two movements:

a downward movement towards the lower position,

a rotation through a right angle.

If the second movement is executed after the first, the abutment can be fixed, that is to say, constantly occupy its operative position. On the contrary, if the second movement takes place simultaneously with the first, it is necessary for the abutment to be retracted before these two simultaneous movements commence.

The position detectors can act with or without material contact with the stack.

A detector without material contact with the stack may be formed by a radiation source acting on a photosensitive cell, i.e., a photoelectric or photoresistant cell. The lower position cell stops the movement when it is subjected to a radiation from the source, while the upper position cell on the contrary stops this movement when the last layer deposited interrupts the radiation.

It is also possible to make use of the action exerted by the metallic mass which forms the upper layer of the stack on the resistance of the coefficient of self-induction of a winding of open flux traversed by a high-frequency current. A high sensitivity can be obtained by matching the winding, by means of a condenser disposed in series or in parallel with it, to the frequency of the current. The intensity variation of this current is then at the same time considerable and severe. The low position detector then stops the movement when the intensity of the high-frequency current passing through the winding increases, while the upper position detector stops it when the intensity of this current decreases.

A detector with material contact can be formed by two feelers or sensing members, one for the lower position indicated at **417** and the other for the upper position indicated at **419**. This detector is described in connection with a retractable stop abutment **341**, but it can also be suitably used with a fixed stop abutment, as shown in FIG. **6**.

Pivoted on the shaft **343** fast with the stacker supporting chassis **550** is an arm **342** carrying the stop abutment **341**. The lower position feeler **417** is mounted on a second arm **352** pivoted on a second shaft **353**, which is also fast with the said stacker supporting chassis. The arm **352** carries a contact roller **354** capable of rolling on a rail **355** fixed on the carriage, and which comprises an upper horizontal part and a downwardly cranked part. The arm **352** of the lower position feeler carries a finger **356** engaged in a fork **344** fast with the arm **342** of the abutment. The two arms, the finger and the fork are keyed in such a way that the arm **352** of the feeler is lifted when the arm **342** of the abutment is lowered, and vice versa.

A third arm **418** carries the upper position feeler **419**. The arm, pivoted on a shaft fast with the stacker supporting chassis, which can be the shaft **353** which already carries the arm **352**, is independent of the other two arms. An abutment prevents it from descending as far as the upper surface of the ingots resting on their grippers.

The feelers act on a control element, such as a hydraulic or pneumatic distributor, an electric contact or any other element.

When the rotational movement of the movable table is only effected in the lowered position, after stopping the translatory movement, the stop abutment can be made fixed.

The fork **344**, the finger **356** and the shaft **343** are then omitted, according to FIG. **6**.

The discharge arrangement **430** can comprise simply a discharge jack **431** equipped with a ram **432**. When the stack is completed and when the movable table has assumed, perhaps by rotation through a quarter of a revolution, the position corresponding to the discharge, the jack **431** is actuated and it pushes the stack out of the stacking zone of the apparatus, for example, on to a runway formed by rollers or on to a conveyor belt.

Another discharge arrangement (FIGS. **7** and **8**) can be used. It comprises a push-plate conveyor comprising firstly an upper plate **440** provided with two inclined planes **441** and **442**, and an abutment stop **433**, and secondly a lower plate **450** provided with two inclined planes **451** and **452** and an abutment **453** adapted to cooperate with the respective corresponding elements of the upper plate. The upper plate can be given a horizontal translatory movement in relation to the lower plate by means of a jack **444**. The sliding of the inclined planes **441** and **442** of the upper plate on the corresponding inclined planes **451** and **452** of the lower plate, according to the arrow **445**, causes the lifting of the upper plate relative to the lower plate, in accordance with the arrow **446**. One or other of the plates is preferably provided with rollers **447** and **448** for facilitating the movement. A jack **454** permits the whole conveyor assembly to be displaced, this conveyor rolling on rollers, such as **457**.

The full operation of the machine is described by reference to FIGS. **9** to **15**.

On starting operations, the arrangement **200** for feeding the ingot molds is moved on the rails **201–202** and is brought into position in front of the furnace **90**. The rotary nose of this latter is lowered (FIG. **9**) and the trough **237** is filled with molten metal until the device for ending the feeding operation becomes operative, this causing the rotary nose **91** to be raised again.

The arrangement **200** is once again displaced and it is brought in front of the first group **101** of ingot molds. The jacks **212** and **222** operate in succession, so that the trough **237** rocks, first of all quickly, until the start of the pouring operation, and then more slowly (FIG. **10**) during the pouring of the liquid metal. The cycle is continued. The arrangement **200** returns in front of the furnace **90** to be provided with liquid metal, then it is displaced for pouring the metal into the second group **102** of ingot molds, in order then to return for a third time to be supplied by the furnace and finally to pour the molten metal into the third group **103** of ingot molds. A second cycle, identical with the first, then commences. In general, one of the ingot mold groups, for example the group **102**, is positioned exactly in front of the rotary nose of the furnace, so that the number of displacements of the arrangement **200** is reduced to two per cycle.

When the ingots **10** cast in the group **101** are sufficiently solidified and when the conveyor carriage **310** is in position above this group, the jack **114** is operated and causes (FIG. **11**) the ejection of the extraction valves **111**. The cast ingots

are lifted and their lugs move the two gripper halves **323** and **324** apart and possible the gripper halves **321** and **322**, then pass perpendicularly of these grippers, and continue their ascending movement, this enabling the grippers to close again and to slide beneath the lugs and possibly beneath the projections of the ingots. The jack **114** is again operated, but in the opposite direction (it can also return under the action of a spring, if it is a single-action jack), so that the valves return to their seats. The motor **335** is supplied with power and the carriage is displaced towards the stacking zone. When the ingots extracted from the group **101** have been deposited, the carriage returns towards the casting zone, and the same process recommences, first of all for the group **102** and then for the group **103**.

When power is supplied to the motor **335** after the extraction of the ingots of group **101**, the carriage **310**, carrying the extracted "*n*" ingots, is displaced towards the stacking zone. The roller **354** is reached by the cranked part of the rail **355** and then, with the movement continuing, by the horizontal part of this rail, this causing the lifting of the arm **352** and of the lower position feeler **417**. By the action of the finger **356** on the fork **344**, the abutment **341** is lowered, so that the leading ingot **17** abuts against it and stops its movement. As the carriage continues its own movement, the second ingot continues to be driven until it abuts against the first ingot, and then the third ingot until it abuts against the second ingot, and so on, until all the "*n*" ingots are in contact with one another (FIG. **12**).

If the carriage carries two gripper devices, according to FIG. **3**, the jack **329**, after the locking of the ingots, is actuated, causing the raising of the rail **326** and hence of the roller **325**, this causing the opening of the movable gripper **321–322**. The position is then that which is shown in FIG. **13** The halves of the movable gripper are moved apart and the ingots, if they have lugs, rest by means of these lugs on the fixed gripper **323–324**, according to the right half of the figure, but they remain wedged between the oblique faces of this gripper device, if they are not formed with lugs, as shown in the left half of the figure. The carriage is stopped under the action of a travel-limiting contact.

Pending the completion of these operations, the movable table **411** is waiting. The upper surface of the stack—or that of the empty table when it is the first layer which is going to be deposited—is in the lower position. As soon as the carriage is stopped, the jack **423** is operated and communicates an ascending movement to the movable table. This latter, or the empty movable table, comes into contact with the ingots (on the left in FIG. **14**), lifts them until the large bases reach the upper position feeler **419**, and this stops the feeding of the jack.

The carriage is set in motion again towards the casting zone, the raised ingots are no longer in contact with the grippers and remain positioned on the stack, the rail **355** is displaced beneath the roller **354**, which causes the downward movement of the arm **352** and, by the action of the finger **356** on the fork **344**, the raising of the abutment **341**. If the carriage is provided with the movable gripper device, the jack **329** is fed and causes the descent of the rail **326** and this, by the action of the roller **325**, causes the closing of the gripper device **321–322** when the carriage has left the stacking zone.

Under the action of the feeler **417**, the jack **423** is actuated in the direction for the descent of the movable table until the surface of the stack reaches its lower or stacking position. Simultaneously, if the abutment **341** is movable or even if this abutment is fixed, the movable table (FIG. **14**, on the right) carries out a turning movement through a quarter of a revolution under the action of the motor **413**.

There is thus again reached the position existing before the stacking of the ingots of the group **101**. The carriage returns into the casting zone to take up the ingots of the group **102** and then, after stacking these "*n*" ingots, those of the group **103**, and so on.

When the "*p*" layers of ingots are stacked, a stack **30** is completed. The jack **423** is fed in the direction for its descent and the movable table, if necessary after turning through 90°, assumes the extraction position (FIG. **15**). The conveyor device **440–450** is in the closed position, and the jack **454** is actuated so that it is positioned beneath the stack (arrow **461**). The jack **444** is then fed with power so that the conveyor assumes it raised position (arrow **462**). The stack is thus separated from the movable table and a fresh action in the opposite direction on the jack **454** transports the pallet in the stack on to the roller-type conveyor **459** according to the arrow **463** in FIG. **16**. The jack **444** then reassumes its initial position, returning the conveyor pallet to the lower position (arrow **465**) so that the stack is placed on the conveyor.

When the stack is resting on a device, such as rollers, which do not permit a perfect immobilization, it is expedient to provide a stopping means, such as a retractable roller or wedge which becomes wedged between two adjacent ingots.

It is possible for the machine to be manually controlled, by causing the succession of the operations as described by actions on valves, distributors, electric switches, but such a machine is only of great interest if it is entirely automatic.

The arrangement described below by way of example combines circuits which are controlled by a fluid under pressure, that is to say, pneumatic and/or hydraulic circuits, and electric circuits.

The movement of the rotary nose **91** of the melting furnace **90** is controlled by a jack **92**. On the other hand, the extraction arrangement for each of the groups of ingot molds **101**, **102** and **103** is controlled by a jack acting on the valve-carrying plate. This jack, indicated by the reference **114** for the group **101** is respectively indicated by the references **124** and **134** for the groups **102** and **103**. The motor which causes the displacement of the feeding arrangement **200** in front of the three ingot mold groups bears the reference **203**.

The circuit controlled by a fluid under pressure is hereinafter described, for purposes of simplicity of language, as a hydraulic circuit, but the adoption of an equivalent pneumatic circuit is evident.

The circuit is supplied with liquid under pressure by means of a pump assembly **600** forcing the liquid into a reservoir **601**. The assembly is protected by a valve **602** calibrated to the general supply pressure "P." This assembly supplies the liquid under a pressure "P" in a general supply conduit or pressure conduit **6000** and it receives the liquid returned through the circuits by way of a general return conduit **6001**.

The jack **92** of the rotary nose of the furnace **90** is fed through a distributor **610** controlled by the electric winding **611**, the energization of which causes the distributor to be placed in the working position, represented by arrows in broken lines, the distributor being returned to its rest position, represented by arrows in full lines and corresponding to the raised position of the nose **91** by the return of spring **612**. This distributor has three inputs, of which one is connected to the pressure conduit **6000**. Two other inputs are connected to the return conduit **6001**, the first by means of a pipe **6101** and a throttle valve **613** and the second by means of a pipe **6102** and a throttle valve **614**. It has two outlets which are respectively connected by the pipes **6103** and **6104** to the rod side and the base side of the jack **92**.

When the winding **611** is energized by an electric signal, the distributor **610** assumes the position indicated by the arrows in broken lines and maintains this position as long as the signal lasts. The pipe **6103** is connected to the pressure conduit **6000**, so that jack **92** drives its rod, this causing the downward movement of the rotary nose **91** and the supply of molten metal to the trough **237**. The liquid forced by the piston of the jack passes through the pipe **6104**, the distributor and the pipe **6102** and, by means of the throttle valve **614**, which permits the speed of movement of the rod to be regulated, that is to say, the speed of downward movement of the nose, returns to the return conduit **6001**. When there is no longer a signal on the winding **611**, the distributor is rocked again by the action

of the spring **612** into its rest position, represented by the arrows in full lines. The pipe **6104** is brought into communication with the pressure conduit **6000** and the liquid under pressure forces back the piston of the jack **92**, which causes the upward movement of the nose **91** and the interruption of the supply to the trough. The liquid on the rod side of the jack is forced through the pipe **6103**, the distributor, the pipe **6101** and the throttle valve **613**, which permits the regulation of the outlet speed of the rod of the jack, that is to say, the speed of ascent of the nose, towards the return conduit **6001**.

The motor **203** which ensures the displacement of the entire feed arrangement **200** of the ingot molds is hydraulic. It is supplied with liquid under pressure by means of a three-position distributor **620**, comprising two energizing windings **621** and **622**. This distributor comprises three inlet pipes, one of which is connected to the main supply conduit **6000**, while the other two are both connected by a pipe **6201** to a throttle valve **623** which is on the other side connected to the main return conduit **6001**. The two outlet pipes of the distributor are respectively connected by the pipes **6202** and **6203** to the two inlet pipes of the motor **203**.

When the none of the windings **621** and **622** is energized, the distributor shuts off the supply to the motor (position not shown). The motor remains stationary and the supply arrangement does not move. The energizing of the winding **622** brings the distributor into the position illustrated by the arrows in full lines. The pipe **6203** is supplied under pressure, while the pipe **6202** is connected to the return conduit **6001** by means of the throttle valve **623** which permits the speed of the motor to be regulated. The motor, supplied with liquid under pressure, turns in a predetermined direction. The energization of the winding **621** causes the distributor to be brought to the reverse position, represented by the arrows in broke lines. The pipe **6202** is fed under pressure, while the pipe **6203** is connected by the valve **623** to the return conduit. The motor turns in a direction opposite to that previously referred to.

The two jacks **212** and **222** of the feed arrangement are acted upon by a distributor **630** provided with a winding **631** which causes the distributor to be brought into the operative position as shown by the arrows in broken lines, and a return spring **632**, which returns the distributor to the rest position represented by the arrows in full lines. The distributor comprises, on the supply side, a pressure inlet pipe **6301** connected to a throttle valve **636** terminating at the main supply conduit **6000** and two return pipes **6302** and **6303** respectively terminating at throttle valves **635** and **637** connected to the return conduit **6001**. The distributor has two outlet pipes **6304** and **6305**. The first is directly connected to the base side of the jack **212** and, by means of a sequence valve **633** and a conduit **6306** to the piston side of the jack **222**. The second is directly connected to the rod side of the jack **222** and by means of a sequence valve **634** and a conduit **6307**, to the rod side of the jack **212**. These two sequence valves are calibrated to a like pressure *p*1 which is smaller than P and they are shunted by nonreturn valves, **638** for **633** and **639** for **634**, which permit the free circulation in the direction going from the jacks to the distributor.

When the winding **631** is energized, the pipes **6301** and **6304** on the one hand and **6302** and **6305** on the other hand communicate with one another. The liquid under pressure thus reaches the end of the jack **212** from which the rod extends, lifting the movable intermediate support **220**. The liquid present on the rod side of this jack is forced through the nonreturn valve **639** which is only open in this direction of circulation. The liquid reaches the distributor by way of the pipe **6305** and then leaves it through **6302** in the throttle valve **637**, from whence it returns to the conduit **6001** and the reservoir **601**.

When the rod of the jack **212** reaches the end of its travel, the pressure in the pipe **6304**, until now very much smaller than *p*1 rises. As soon as it reaches the valve *p*1, the sequence valve **633** is opened and the liquid arrives beneath the piston of jack **222**, the rod of which moves and forces the liquid through the pipe **6305**, the distributor, the pipe **6302**, the throttle valve **637** and the conduit **6001** towards the reservoir **601**. The movement of the jack **212** causes the rocking of the trough and the pouring of metal into the ingot molds.

When the energization of the winding **631** ceases, the distributor **630**, under the action of the return spring **632**, reassumes its rest position (arrow in full lines). The pipes **6301** and **6305** on the one hand and **6303** and **6304** on the other hand are brought into communication. The liquid under pressure arrives by way of the throttle valve **636**; the pipe **6301**, passes through the distributor and, by way of the pipe **6305**, enters the jack **222** on the rod side. The rod is thus driven back, causing a rocking movement of the trough, which reassumes its original position in relation to the intermediate support **210**. The liquid which is beneath the piston is forced through the pipe **6306**, the nonreturn valve **638**, the pipe **6304**, the distributor, the throttle valve **635**, and the conduit **6001** towards the reservoir **601**. During the movement of the jack, the pressure in the pipe **6305** remains smaller than *p*1, but when the jack reaches the end position with the rod forced back, this pressure increases and exceeds *p*1. The liquid then passes through the sequence valve **634** and enters the jack **212** on the rod side by way of conduit **6307**. The said rod is moved back, so that the movable intermediate support **220** reassumes its initial position, while the liquid present beneath the piston of the jack is forced through the pipe **6304**, the distributor, the throttle valve **635** and the conduit **6001** to the reservoir **601**.

The delivery speed of the rods of the two jacks can be regulated as whole by an action on the throttle valve **637**, while the return speed of these rods can be regulated by acting on the valve **635**. The valve **636** in addition permits action to be taken on the general speed of operation of the arrangement. The relative speeds of operation of the two jacks depend on their respective dimensions.

The extractor of the ingot mold group **101** is controlled by the jack **114**. This latter is supplied by means of a distributor **640** which is controlled on the one hand by a winding **641**, the energization of which places the distributor in the position illustrated by the arrows in broken lines, which causes the extraction, and on the other hand by a hydraulic pilot device **642**, which when placed under pressure disposes the distributor in the position illustrated by the arrows in full lines, which causes the return of the valves to their seats. The distributor has three inlet pipes, one of which is directly connected to the main pressure conduit **6000**, while the other two **6401** and **6402** are connected to the main return conduit **6001** by way of the throttle valves **645** and **646**, respectively. The distributor has two outlet pipes, one of which is indicated at **6403** and is connected to the rod side of the jack **114**, while the other, indicated at **6404**, is connected on the one hand to the base side of the same jack and on the other hand to a sequence valve **643** calibrated to a pressure *p*2. The outlet pipe **6405** of this valve is connected firstly to the pilot device **642** of the distributor and secondly by means of a constriction **644** to the return conduit **6001**.

When the winding **641** is energized by a current pulse, the distributor **640** assumes and maintains the position shown by the arrows in broken lines. The pressure conduit **6000** is connected to the pipe **6404**, the jack **114** leaves its rod, lifts the valve-supporting plate, so that the valves of the ingot mold group **101** are lifted from their seats, and this causes the extraction of the ingots **10**. The liquid which is on the rod side of the jack **114** is forced through the pipe **6403**, the distributor **640** and its pipe **6401** towards the throttle valve **645**, which permits the regulation of the speed of outlet of the rod of the jack, and the return conduit **6001**. While the piston of the jack **114** has not reached an end position, the pressure on the base side and hence the pressure in the pipe **6404** remains very much lower than *p*2. When the piston reaches its end position with the rod out, this pressure increases and exceeds *p*2. The sequence valve **643** is opened and the liquid which leaves it by way of the pipe **6405** acts on the pilot device **642** and rocks the distributor, which assumes the position shown by the ar-

rows in full lines. The pipe **6403** is connected to the pressure conduit **6000** and the pipe **6405** is connected to the pipe **6402**, which is itself connected by means of the throttle valve **646** permitting the regulation of the speed of return of the jack rod, to the return conduit **6001**. The piston returns its rod and the valves return to their seats. The distributor **640** maintains its position until a fresh pulse excites the winding **641**. The nozzle **644** permits the slow discharge from the pipe **6405** after the operation of the pilot device.

The extraction of the group of ingot molds **102** is controlled by a jack **124** fed by means of a distributor **650**. The mounting and operation thereof are identical to that which has been explained above in respect of the group **101**. It is sufficient to replace the references, **101** by **102**, **114** by **124**, and, in all the references starting with **64**, replacing the two first digits by **65**.

Similarly, the extraction of the group of ingot molds **103** is controlled by a jack **134** fed by means of a distributor **660**. The mounting and the operation thereof are identical with that which has been set forth above in connection with group **101**. It is sufficient to replace the references, **101** by **103**, **114** by **134** and, in all the references starting with **64**, replace the first two digits by **66**.

The motor and reduction gear assembly **335** which controls the horizontal translatory movement of the conveyor carriage **310** of the ingots comprises a hydraulic motor indicated by the same reference. This motor is controlled by a three-position distributor **670**. The mounting and the operation are identical with those of the motor **203** and its distributor **620** as described above. It is sufficient to replace, in the corresponding text, the reference **203** by **335** and to add five units to the second digit of all the references starting with **62**, it being understood that the references **6000** and **6001** remain unchanged.

The motor **414** which ensures the rotation of the movable table through 90° always turns in the same direction. It is controlled by a distributor **680** which is energized by an electric winding **681** which brings it into the position illustrated by the arrows in broken lines, it being returned to its rest position, shown by the arrows in full lines, by a spring **682**. This distributor has on the delivery side two pipes **6802** and **6803** which are respectively connected to the supply pipes of the motor and, on the supply side, firstly a return pipe **6801** connected to the return conduit **6001** by way of a throttle valve **683**, and secondly a pressure pipe connected to the conduit **6000**.

While an electric signal remains applied to the winding **681**, the distributor maintains its working position indicated by the arrows in broken lines. The motor receives the liquid under pressure through the pipe **6803**, the distributor and the pressure conduit **6000**, while it discharges the liquid through the pipe **6802**, the distributor, the pipe **6801** and the throttle valve **683**, which permits the speed of rotation of the motor to be regulated, towards the return conduit **6001**.

The jack **423**, which communicates its vertical sliding movement to the support of the movable table **421**, is controlled by a mechanically controlled distributor **690** by means of a rod **691** returned by a spring **692**. The rod **691** is controlled by the lower position feeler **417**, that is to say, before stacking, which drives in the rod when it is in the lower position. A jack **694** permits the feeler to be lifted. It only becomes operative with the expelling of the completed stack. The delivery pipes **6903** and **6904** of the distributor **690** are respectively connected to the base side and the rod side of the jack **423**. The rod when extended permits the passage of the liquid in the distributor (arrow in full lines) and the stoppage thereof when retracted (arrow in broken lines).

The distributor is connected to the conduits **6000** and **6001** by means of another distributor **700** controlled by two hydraulic pilot arrangements **701** and **702**. This distributor has two delivery pipes which are respectively connected to the pipes **6901** and **6902** supplying the distributor **690**, and three supply pipes, of which two (**7001** and **7002**) are connected to the return pipe **6001** by means of throttle valves **708** and **709** respectively, while the third pipe **7003** is connected to the pressure conduit **6000** by means of a valve **710** controlled by a rod **711** which, when lowered, plates the valve in its working position, shown by the arrows in full lines, the valve being returned to the rest position indicated by the arrows in full lines by means of a spring **712**. The rod **711** is controlled by the upper position feeler **419**, which forces back the rod when it is in a higher position than its position of equilibrium.

The pilot device **701** of the distributor **700**, which, when placed under pressure, brings this latter into the position shown by the arrows in broken lines, is piloted by a distributor **714** controlled by a winding **715** which brings it into the working position (arrows in broken lines) and which is returned to the rest position (arrows in full lines) by a spring **716**. This distributor **714** has two supply pipes, one of which (**7142**) is connected to the pressure conduit and the other (**7141**) to a throttle valve terminating at the return conduit. Its delivery pipes are connected, one to the pressure conduit, and the other, by way of a pipe **7143** and a nonreturn valve **713**, to the pipe **7003** of the distributor **700**.

The pilot device **702** of the distributor **700**, which, when placed under pressure, brings this latter into the position shown by the arrows in full lines, is controlled by a circuit comprising an electromagnetic valve **703** controlled by a winding **704**, the energizing of which breaks the circuit, and which is returned by a spring **705** establishing the circuit (full lines), and also a distributor **706** controlled by a rod **707** which, when driven in, brings it into the working position shown by an arrow in broken lines and forms the travel-limiting device of the carriage in the stacking position, and is returned to the rest position (arrow in full lines), by a spring **7070**. The two supply pipes of the distributor **706** are respectively connected to the conduits **6000** and **6001**, while the delivery pipe **7031** is connected on one side to the pilot device **702** and on the other side to the valve **703**, which is connected on the other side to the conduit **6001**. Finally, the feeler **417** controls an electric contact **693** closed in the lower position, and the feeler **419** carries an electric contact **713** closed in the upper position.

The operation of this control arrangement for the jack **423** is as follows:

When the carriage **310** enters the stacking zone, the rail **355** with which it is provided lifts the roller **354** and consequently the stacking position feeler member **417**, while the feeler member **419** for the position after stacking remains in its lowest position and forces down the rod **711** of the valve **710**, which remains in its working position, arrow in broken lines. Under the action of the spring **692**, the distributor **690** assumes its rest position with the rod out, as indicated by the arrows in full lines. The pipes **6901** and **6903** on the one hand and **6902** and **6904** on the other hand are brought into communication. On the other hand, the carriage, before being stopped, drives down the rod **707** of the distributor **706**, which assumes its working position, as indicated by the arrows in broken lines. The pipe **7031** is brought into communication with the pressure conduit **6000**, which drives the control means of the pilot device **702** of the distributor **700**, because the nonenergized distributor **703** is in its rest position (arrows in broken lines) and closes the end of the pipe **7031**.

The liquid under pressure passes from the conduit **6000** into the valve **710** in the working position; with the rod withdrawn, opens into the pipe **7003**, is blocked by the nonreturn valve **713** and enters the distributor **700** piloted at **702**, which brings about the communication (arrows in full lines) of the pipes **7003** and **6902** on the one hand and **7002** and **6901** on the other hand. The liquid thus passes through the pipe **6902**, the distributor **690** in the rest position (arrows in full lines) and the pipe **6904**; the jack **423** is thus brought under pressure on the rod side and moves the said rod, this causing the upward vertical movement of the movable table **410**. The forced liquid passes through the pipe **6903**, the distributor **700**, the pipe **7002**, the throttle valve **708** which permits the regulation of the speed of ascent of the movable table and, through the

return conduit **6001**, returns to the reservoir **601**. It is noted that the section of the pipe **6903**, which leads towards FIG. **20**, is blocked, as will hereinafter be explained, by means of a sequence valve **695** (FIG. **20**).

With the upward movement of the movable table, the stack of ingots raises the ingots supplied by the carriage, then the feeler member **419** for the position after stacking, this causing, under the action of the spring **712**, the outward movement of the rod and the placing of the valve **710** in the rest position, as indicated by the arrow in full lines. On the other hand, by the electric control means hereinafter described, the carriage leaves the stacking zone, so that under the effect of the spring **7070**, the rod **707** of the distributor **706** moves out and the distributor reassumes its rest position indicated by the arrow in full lines. The pipe **7031** and consequently the pilot member **702** are connected to the return conduit **6001**.

When the carriage **310** leaves the stacking zone, the feeler member **417** is repositioned on the stack of ingots and the contact **693** is closed, thus causing the energization of the winding **715** of the distributor **714**, which assumes its working position as indicated by the arrows in broken lines. The pipes **7143** and **7142** on the one hand and **7142** and **7141** on the other hand are brought into communication, the nozzle **717** not playing any other part than to permit the elimination of the pressure of the pilot device **701** after the distributor **714** returns to its rest position.

The liquid under pressure then passes from the conduit **6000** through the pipe **7142**, the distributor and the pipe **7141** acts on the pilot device **701**, thus bringing the distributor **700** into the position indicated by the arrows in broken lines, causing communication on the one hand of the pipes **7001** and **6902** and on the other hand the pipes **7003** and **6901**. The liquid thus also passes from the pipe **7142** through the distributor **714**, the pipe **7143**, the nonreturn valve **713**, the distributor **700** (the valve **710** is closed), the pipe **6901**, the distributor **690** and the pipe **6903**, to bring the jack **423** under pressure from the bottom side. The jack pushes out its rod again, causing a downward vertical movement of the movable table. The liquid delivered by the jack passes through the pipe **6904**, the distributor **690** (in a direction opposite to the arrows), the pipe **6902**, the distributor **700**, the pipe **7001** and the throttle valve **709**, which permits the regulation of the speed of descent of the movable table, and returns to the return conduit **6001**.

The movement of the jack is stopped as soon as the feeler member **417** gives the lower position, before stacking, of the upper face of the stack of ingots. The contact **693** is only deenergized when the feeler member is lifted by the arrival of the carriage. The distributor **690** isolates the pipes, thus stopping the movement of the jack **423**.

On the other hand, after the departure of the carriage, a contact which is engaged causes the energization of the winding **681** of the distributor **680**, which assumes the position shown by the arrows in broken lines. The motor **414** is fed and causes a movable table **411** to turn through 90°. After this turning movement through 90°, the winding **681** is no longer energized (see below), the distributor **680** assumes its rest position (arrows in full lines) and the motor is stopped.

When the carriage reassumes its stacking position, the point of departure is again reached and the cycle recommences.

When the carriage is in the stacking zone and when it is desired to stop the machine, it is possible to bring the distributor **700** to a middle position by acting on the winding **704** of the valve **703**. The pipe **7031** is then brought into communication with the return pipe **6001**, so that the pilot device **702** is no longer actuated, although the rod **707** of the distributor **706** remains retracted. This valve can be omitted if it is not desired to profit from this advantage.

The control arrangement for the members ensuring the discharge of the ingots comprises a device causing the complete descent of the movable table and giving the discharge signal, and a device causing the actual discharge.

The device ensuring the descent of the table and giving the discharge signal will first be described.

It comprises the jack **694**, which permits the feeler member **417** to be raised and which is controlled by a distributor **720** piloted firstly by a winding **721**, the energization of which produces the connections indicated by the arrows in broken lines, and secondly by a hydraulic pilot device **722**, of which the placing under pressure causes the connections indicated by the arrows in full lines. The distributor comprises three inlets on the supply side, one of which is connected to the pressure conduit **6000**, while the other two are connected to the return conduit **6001**, one by way of the pipe **7201** and the throttle valve **723** and the other by way of pipe **7202** and the throttle valve **724**. On the delivery side, this distributor comprises two outlets, one of which is connected by the pipe **7203** to the rod side of the jack and the other by the pipe **7204** to the base side of said jack.

The pilot device **722** is actuated by a device comprising a sequential valve **725** calibrated at *p4* and of which the outlet is connected to a circuit comprising, arranged in series: a pipe **7251**, a nozzle **726**, which is not essential, a pipe **7261**, also connected to the pilot device **722** and a nozzle **727** ending at the return conduit **6001** and permitting, after closure of the valve **725**, the elimination of the pressure on the pilot device **722**.

The discharge signal is given by a circuit connected to the pipe **6905** and which comprises, in series, a sequence valve **695** calibrated at *p5*, a pipe **6962** and a distributor **696**, of which the single inlet is formed by the pipe **6962** and of which the two outlets are connected to the return conduit **6001**, the first directly and the second by means of a nozzle **737** connected to the distributor by a pipe **6961**. It is the pressure of the liquid in this pipe which constitutes the discharge signal.

The distributor **696** is piloted firstly by a winding **697** which brings the distributor into the position shown by an arrow in broken lines and secondly by a return spring **696** which returns the distributor to its rest position, represented by an arrow in full lines. It is noted that this distributor forms the supplementary safety device, and that it can be omitted, the pipes **6962** and **6961** the being directly connected permanently.

The arrangement effecting the discharge of the stack as described below presumes that the stack if formed on a movable table equipped with a means for immobilizing the ingots and controlled by a jack **433**, and that the discharge is effected by means of a ram controlled by a jack **431**.

This latter is fed from a distributor **730** controlled by two hydraulic pilot systems **731** which produce the connections indicated by the arrows in broken lines, and systems **732**, which produce the connections shown by the arrows in full lines.

This distributor has three inputs, one of which is directly connected to the pressure conduit **6000**, while the other two inlets are connected to the return conduit **6001**, one of them by means of the pipe **7031** and the throttle valve **734** and the other by the pipe **7302** and the throttle valve **733**. This distributor also comprises two delivery outlets which are respectively connected by the pipes **7303** and **7304** to the base side and the rod side of the jack.

The pilot unit **732** is fed from the pipe **7308** by means of a sequential valve **735** calibrated to *p3*. A nozzle **736** is interposed between the pipe **7351** connecting this valve to the pilot unit and the return conduit **6001**.

The sequential valve **725** is also connected to the pipe **7304**. The pilot unit **731** is actuated through the pipe **6961**.

The jack **433** for controlling the device for immobilizing the stack is fed through a distributor **740** piloted by the winding **741** (connections in broken lines) and returned by the spring **742** (connections in full lines). On the supply side, this distributor has two inlets, one of which is connected by the pipe **7401** and the throttle valve **743** to the return conduit, while the other is directly connected to the pressure conduit. On the delivery side, this distributor is connected by the pipe **7402** to the jack on the rod side and by the pipe **7403** to the base of the jack.

The operation of the discharge arrangement is as follows:

When the required number of layers of ingots is deposited, a pulse is sent into the winding **721** of the distributor **720**, which assumes the position indicated by the arrows in broken lines. The liquid under pressure passes through the distributor and enters the pipe **7204**, bringing under pressure the end of the jack **694** from which the rod extends, the delivered liquid passing through the pipe **7203**, the distributor, the pipe **7201**, the throttle valve **723**, which permits the speed of ascent of the jack rod to be regulated, in order to return to the return conduit **6001** and the reservoir **601**. The effect of the movement of the jack **694** is to raise the feeler member **417**, this causing the outward movement of the rod of the distributor **690**, FIG. **19**. As the feeler member is in the lower position, the rod **711** of the valve **710** is forced in, and the valve is in the working position, indicated by the arrow in broken lines. The liquid under pressure then passes through the distributor, into the pipe **7003**, where it is blocked by the nonreturn valve **713**, passes through the distributor **700** in accordance with the arrows in broken lines (the pilot unit **702** is energized, since the carriage has left the stacking zone), passes through the pipe **6901**, the distributor **690** and the pipe **6903**, and brings the base of the jack under pressure, this causing the downward movement of the movable table. The liquid delivered by the pipe **6904** passes through the distributor **690**, then by way of the pipe **6902** and the distributor **700** and, through the pipe **7001** and the throttle valve **709**, reaches the return pipe.

When the jack **423** is stopped mechanically, the pressure in the pipe **6903** rises, reaches *p*5 and opens the sequential valve **695**. The winding **697** of the distributor **696** is energized (supplementary safety arrangement), the liquid under pressure passes from the pipe **6962** to the pipe **6961** and acts on the pilot unit **731**, bringing the distributor **730** into the position according to the arrow in broken lines, after which the energization of the winding **697** is broken. During this time, the winding **741** of the distributor **740** has been energized, bringing this latter into the working position (arrows in broken lines). The liquid under pressure enters the pipe **7402** and causes the retraction of the rod of the jack **433** and hence that of the arrangement for immobilizing the stack. The liquid delivered by the pipe **7403** passes into the pipe **7401** and, through the throttle valve **7401** which permits the speed of action of the jack to be regulated, towards the return conduit. In the distributor **730**, the liquid under pressure circulates towards the pipe **7303** and brings the back of the jack **431** under pressure, because the valve **735** is closed. The rod of the jack **431** moves outwardly discharging the stack. The liquid delivered by the pipe **7304** passes by way of the distributor **730** and, by way of the throttle valve **733**, which permits the speed of movement of the rod to be regulated, returns to the conduit **6001** and the reservoir **601**.

When the jack **431** is stopped mechanically with the rod extended, the pressure increases in the pipe **7303**, reaches *p*3, so that the sequential valve **735** is opened, feeds the pipe **7351** and acts on the pilot unit **732**. The distributor **730** assumes the position indicated by the arrows in full lines. Once the valve **735** is again closed, the nozzle **735** permits the elimination of the pressure in the pipe **7351**. The liquid under pressure passes by way of the distributor **730** into the pipe **7304** and applies the pressure to the rod side of the jack, causing the return of the said rod. On the other hand, the pressure in the base is lowered, because it is at the present time connected to the return conduit, the sequential valve **735** is closed again and the pilot unit **732** is no longer energized. The delivered liquid passes from the pipe **7303** into the pipe **7301** and, by way of the throttle valve **734** permitting the speed of reentry of the rod to be regulated, returns to the return conduit.

When the jack **431** is stopped mechanically with the rod retracted, the pressure increases in the pipe **7304**. When it reaches the value *p*4, the sequential valve **725** is opened, the liquid enters the pipe **7351** and, by way of the nozzle or union **726**, which is not essential, enters the pipe **7261**. The pipe **7261** is connected by means of a nozzle **727** to the return pipe. A pressure with a value smaller than *p*4 is thus established in the pipe **7261**, this value resulting from the ratio of the diameters of the two nozzles **726** and **727**. This pressure, applied to the pilot unit **722** of the distributor **720** brings this letter to the position shown by the arrows indicated in full lines. The pressure P is thus applied through the distributor and the pipe **7203** to the rod side of the jack **692**. This rod moves inwardly again, the oil delivered by the pipe **7204** passing through the distributor and the pipe **7202** into the throttle valve **724**, which permits the speed of reentry of the jack rod to be regulated, and into the return conduit **6001**. The feeler member **417** descends again, once more driving in rod of the distributor **690**.

As soon as the carriage has taken up its position in the stacking zone and the rod **707** of the distributor **706** has been driven in, the jack **423** reassumes its ascending movement until the feeler member **417** has reached its position of equilibrium.

The end of the reentry movement of the jack **431** causes the deenergization of the winding **741** by means of a contact. The distributor rocks under the effect of the spring **742** and reassumes its rest position, indicated by the arrows in full lines. The pressure is applied through the distributor and the pipe **7403** beneath the piston of the jack **433**. The rod of this latter moves out again, once more bringing the immobilizing arrangement for the stack into position. The liquid delivered through the pipe **7402** passes through the distributor into the pipe **7401**, the valve **743** and the return conduit.

When the discharge arrangement for the stack is formed by a push-plate conveyor according to FIGS. **7** and **8**, the control means of FIG. **20** is replaced by that of FIG. **21**, which also reproduces the arrangement ensuring the complete descent of the movable table and giving the discharge signal.

The lifting jack **444** is supplier through a distributor **750** which comprises three pipes on the supply side, one of said pipes being connected to the pressure conduit **6000**, the other two pipes communicating with the return conduit **6001**, through the pipe **7502** and the throttle valve **756** for the first and the pipe **7502** and the throttle valve **755** for the second. The two delivery outlets of this distributor are respectively connected to the rod side of the jack **444** by means of the pipe **7503** and the base side of the jack by way of the pipe **7504**. This distributor is piloted by two hydraulic pilot units, of which the first (**751**) provides the communications indicated by the arrows in full lines, while the second (**752**) provides the communications indicated by the arrows in broken lines.

The jack **454** for displacing the conveyor is fed through a distributor **760** with three pipes on the supply side, one of which is directly connected to the pressure conduit **6000** and the other two are connected to the return conduit **6001** by way of the pipe **7601** and the throttle valve **767**, and the pipe **7602** and throttle valve **766**, respectively, and two delivery pipes, one of which is connected by the pipe **7603** to the jack **454** on the rod side and the other by the pipe **7604** to the jack **454** on the base side. This distributor is piloted by two hydraulic pilot units, of which the first (**761**) brings the apparatus into the position shown the arrows in full lines, while the other (**762**) brings it into the position indicated by the arrows in broken lines.

The pilot **761** is connected by the pipe **7631** on one side to a nozzle **768** ending at the return pipe and on the other side to a sequential valve **763** calibrated at *p*6 and ending at the pipe **7504**. The pilot unit **762** is also connected by the pipe **7641** on one side to a nozzle **765** ending at the return conduit and on the other side to a sequential valve **764** calibrated at *p*7 and ending at the pipe **7503**.

The pilot unit **752** of the distributor **750** is connected by the pipe **752**, on the one hand to a nozzle **754** ending at the return conduit **6001** and on the other hand to a sequential valve **753** calibrated at *p*8 and ending at the pipe **7604**.

The pilot unit **751** which causes the conveyor to be brought into operation is actuated by the arrangement already described, which gives the discharge signal. It comprises the sequential valve **695**, the distributor **696** and the nozzle **737**.

The pilot unit **751** is connected to a pipe **6963** which connects the distributor to the nozzle and which bore the reference **6961** in FIG. **20**.

The arrangement ensuring the complete descent and the reestablishment of the stacking position of the movable table has been described above. It comprises the jack **694**, the distributor **720**, the throttle valve **723** and **724**, as well as the control means of the pilot unit **722** controlling the return to the stacking position, namely, the sequential valve **725** and the two nozzles **726** and **727**, of which the first is optional. The inlet of the valve **725** is here connected to the pipe **7603**.

The operation of this arrangement is as follows:

When the stack is completed, a pulse is sent into the winding **721** of the distributor **720**, this causing the outward movement of the rod to the jack **694** and the downward translatory movement of the movable table, as already explained in connection with FIG. **20**. When the jack **423** which ensures this translatory movement is stopped mechanically, the pressure in the pipe **6903** increases, causing the opening of the sequential valve **695**. As soon as the winding **697** is energized (supplementary safety system), the pipe **6963** is placed under pressure, this causing the pilot unit **751** of the distributor **750** to become operative, the distributor taking the position indicated by the arrows in full lines. The liquid under pressure passes through the distributor and, through the pipe **7504**, places the base of the jack **444** under pressure, the rod of which moves outwardly, this causing the raising of the upper plate (**440**) of the conveyor device. In actual fact, the pressure necessary for the functioning of the jack is lower than *p6*, so that the valve **763** remains closed. The liquid on the rod side of the jack is delivered through the pipe **7503**, the distributor, the pipe **7501** and the throttle valve **756**, which permits the outward speed of the jack rod to be regulated, towards the return conduit **6001**.

When the jack **444** is stopped mechanically with the rod out, the pressure increases in the pipe **7504**. When it reaches the value *p6*, the sequential valve **763** is opened, so that the pilot unit **761** of the distributor **760** is operated. This latter assumes the position represented by the arrows in full lines, the pressure of the conduit **6000** is applied through the distributor and the pipe **7604** to the bottom of the jack **454**, which pushes out its rod, displacing the conveyor, with the stack raised, from the movable table to the roller-type conveyor **459**. The delivered liquid passes through the pipe **7603**, the distributor, the pipe **7601**, the throttle valve **767** which permits the outward speed of the rod of the jack **454** to be regulated, into the return conduit **6001**.

When the jack **454** is stopped mechanically, the pressure is increased in the pipe **7604** until it reaches *p8*, thus causing the opening of the sequential valve **753** and the action on the pilot unit **752**. In the meantime, the pressure on the pilot unit **751** is relaxed, because of the presence of the nozzle **737**. The distributor **750** takes the position indicated by the arrows in broken lines. The pressure is applied to the jack **444** on the rod side by means of the pipe **7503**, so that the jack retracts its rod, this causing the return of the upper plate of the conveyor to the lower position and the deposition of the stack on the conveyor **459**. The liquid on the base side of the jack is delivered through the pipe **7594** (the valve **763** is closed again, because the pressure is lower than *p6*), the distributor, the pipe **7502** and the throttle valve **755**, which enables the speed of withdrawal of the jack rod to be regulated, towards the return conduit **6001**.

When the jack **444** is stopped mechanically with the rod withdrawn, the pressure in the pipe **7503** increases until it exceeds *p7*, so that the sequential valve **764**, until now closed, is opened and applies the pressure to the pilot unit **762** by way of the pipe **7641**. As the action on the pilot unit **761** has disappeared, due to the action of the nozzle **768**, the distributor rocks and assumes the position shown by the arrows in broken lines. The pressure is applied to the jack **454** on the rod side, so that this jack reassumes the position with the rod withdrawn, this bringing the conveyor to the movable table. The delivered liquid passes through the pipes **7604** and **7602** and through the throttle valve **766**, which permits the speed of withdrawal of the rod of the jack **454** to be regulated, towards the return conduit **6001**.

When the jack **454** is stopped mechanically with the rod withdrawn, the pressure increases in the pipe **7603** until it reaches *p4*, resulting in the opening of the sequential valve **725**, until now closed, and the piloting of the distributor **720** by the pilot unit **722**. The distributor assumes the position indicated by the arrows in full lines, and this causes, as already explained, the ascending movement and the bringing to the stacking position of the movable table.

It is obvious that one of the throttle valves can be omitted for each of the distributors, if it is not desired separately to regulate the speed of entry and outlet of the rod of the corresponding jack. Thus, as regards the distributor **750**, the pipes **7501** and **7502** can be connected while keeping only one of the two valves **755** or **756**.

All the sequential valves are calibrated to pressure lower than P and higher than the operational pressure of the jack, of which the reaching of an abutting position causes their opening.

The different hydraulically piloted installations which have been described are controlled and coordinated by means of an electrical installation.

It is possible to employ an assembly of logic circuits, but the necessity for providing three variable parameters, namely, the number *p* of layers of ingots per stack, the rate of casting and the rate of extraction, which depends on the cooling of the metal or the alloy which is poured, the period during which the trough is kept in the pouring position as a function of the pourability of the cast product, have resulted in the development of the coordination of the automatic sequences by a set of limit switches which control the positions and the movements of the movable mechanical parts of the machine.

The limit switches are indicated by the references contained between **800** and **833**. When the switch comprises several contacts, these are indicated by the general reference of the apparatus, followed by the digit 1, 2, etc.; thus, **8001** and **8002** indicate the two contacts of the limit switch **800**. The switches are represented in the figures in the open or closed state in which they are in the absence of any action.

The relays are indicated by the references contained between **900** and **964**. The reference of the relay, followed by the digit 1 or 2, indicates respectively the pullup winding and the release winding, this latter winding only existing in the case of relays which are held magnetically. The various contacts established by a relay are indicated by the reference of the relay, followed by the digit 3 or following digits. The contacts are shown in their open or closed state in the absence of energization of the relay.

The manual operation switches are indicated by the references contained between **860** and **873**, while the various switches and the switches for initiating automatic operation bear the reference **850** to **856**. The main switches bear the references **890** and **891**.

The references contained between **1000** and **1058** indicate the conductors, the references **1000** to **1003** representing the main supply conductors. The transformers and rectifiers necessary for supplying certain circuits are not shown; they depend, in fact, on the particular characteristics of each of the components used.

The apparatus described presumes that the layer of ingots situated at the base of each stack comprises special ingots, known as "pallet" ingots, of which the small base has either a particular form for facilitating the handling of the stacks or cavities adapted to receive an immobilizing device. These pallet ingots are cast in the ingot mold group **101**, of which the chill molds have particular forms. This group is thus only used once for each stack.

There will first be described the assembly of the control and safety circuits shown in FIG. **22**.

One safety circuit for the stacking comprises a relay **900** which is held magnetically in the working position, this relay having two windings **9001** and **9002**. The two windings are connected firstly to a common main conductor **1000** which supplies all the circuits and secondly, for the release winding **9002**, to a conductor **1010**, and for the pull-on winding **9001**, to a contact **9193** of a relay **919**, in series with two contacts **8001** and **8011** of limit switches **800** and **801**, respectively, connected in parallel. The first switch provides the lowered position of the movable table ready for ejection and the second switch the correct orientation of this table for the purpose of ejection.

A "stacking zone safety" circuit comprises in a first line a relay **901**, of which the single winding **9011** is connected on one side to the conductor **1000** and on the other side to a limit switch **802**, which is itself connected to the conductor **1001**. The switch **802** shows the presence of the carriage in the stacking zone. In parallel with this line, there is a second line comprising a magnetic holding relay **902**, of which the two windings are connected firstly, for the holding winding **9022**, to the conductor **1010** and secondly, for the pullup winding **9021**, to a contact **9163** of a relay **916**, which is itself connected to a contact **9013** of the relay **901**, terminating at the conductor **1001**.

A "group **101** casting safety" circuit comprises a holding relay **903**, of which one of the ends of the two windings **9031** and **9032** is connected to the conductor **1000**, the other end of the winding **9032** being connected to the conductor **1010** and that of winding **9031** to a contact **9313** of a relay **931**, which is connected to the other hand to a limit switch **803** showing the lowered position of the extractors of the first group, this switch being itself connected to the conductor **1001**.

A "group **102** casting safety" circuit is identical. It is sufficient to replace the reference **903** of the relay by the reference **904** and to increase by one unit the reference of the switch and by **10** the reference of the contacts.

A "group **103** casting safety" circuit is also identical with the circuit described in respect of the first group. The reference of the relay becomes **905**, while that of the contact is increased by two tens and that of the switch by two units.

The conductor **1010** is connected to the conductor **1001** by means of a manual switch **850** permitting the release of the holding relays.

One circuit ensures the correction of the filling level of the trough. It comprises a relay **906**, of which the winding **9061** is connected to a switch for the end of the pouring operation, this switch being indicated at **806** and being formed by two points **8061** and **8062** of a metal which is not attacked by the poured alloy, the communication between these two points being established by the liquid metal when the desired level is reached. The assembly is connected between the conductors **1000** and **1001**. The switch **806** can also comprise a single point, the circuit of the other point being then combined with the mass of the trough.

An auxiliary safety circuit comprises a relay **907**, of which the winding **9071** has one of its terminals connected to the conductor **1000**, the other terminal being connected to the following elements, in series: contact **9033** of relay **903**, contact **9043** of relay **904**, contact **9053** of relay **905**, contact **9023** of relay **902**, and finally contact **9003** of relay **900**, connected on the other side to the main conductor **1001**.

A predisposition circuit for the magnetic holding relays comprises a relay **908** with a winding **9081**, of which one terminal is connected to the conductor **1000**, while the other terminal is connected by way of a conductor **1011**, on the one hand to a manual contact **851** joining the conductor **1001** and on the other hand to a line comprising, in series: a first contact **8901** of a "manual-automatic" switch **890**, a first contact **8251** of a double switch **852** giving the starting pulse, connected on the other hand to the conductor **1001**.

A last circuit controls the automatic or manual operation, and also the starting of the motor of the pump assembly **600**.

This circuit comprises three incomplete first lines mounted in parallel between the conductor **1000** and a conductor **1012**, and two other incomplete lines mounted in parallel between the conductors **1012** and **1001**.

The three first incomplete lines comprise: the first, a winding **9091** of an "automation" relay **909** and a second contact **8902** of the switch **890**, the second the winding **9101** of a relay **910** and the third contact **8903** of the switch **890**, and finally the third comprises a switch **853**, a second contact **9073** of the relay **907** and the winding **9111** of a relay **911** which, when energized, ensures the starting of the pump **600**.

The first of the two other incomplete lines comprises, mounted in series, a second contact **8522** of the switch **852** and a switch **891**, and the second a contact **9113** of the relay **911**.

In FIG. **22**, the switches or contacts **8001**, **8010** and **853** and the contacts of relays **9003**, **9023**, **9033**, **9043** and **9053** are closed in the absence of any action or energization. The other switches or contacts are all open in the absence of action or energization. The contacts **8901** and **8903** of the switch **890** are closed for manual operation, the contact **8902** being closed for automatic operation (position as shown).

The control circuit of the hydraulic installations (electromagnetic valves and distributors) is shown in FIGS. **23** and **24**. These figures comprise **14** switches intended for the control of the apparatus under manual operation, this control nevertheless remaining protected by the safety arrangements described in connection with FIG. **22**. Each manual control circuit is connected between the main conductor **1000** and a main conductor **1002** connected to the conductor **1001** by a contact **9103** of the relay **910**: "manual." The automatic control circuits are connected between the conductor **1000** and a conductor **1003** connected to **1001** by a contact **9093** of the relay **909**; "automatic."

The control circuits of the extractors each comprise a line comprising the pilot winding **641**, or **651**, or **661**, of the extraction distributor **640** or **650** or **660**, and the manual switch **860** or **861** or **862**, these two members being interconnected by a conductor **1013** or **1014** or **1015**. This line is connected between the conductors **1060** and **1002**. The automatic control is ensured by the contacts **9213**, or **9223** or **9233** of the relay **921**, **922** and **923**, respectively, connected between the conductor **1003** and the conductor **1013**, **1014** or **1015**, respectively.

The control circuits for the movement of the carriage **310** towards the stacking zone: "carriage advance," and towards the casting zone: "carriage in reverse," each comprise a line connected between the conductors **1000** and **1002**, and comprising the pilot winding **671**, or **672** of the distributor **670**, a contact **8071** of the limit switch **807** of the carriage in the stacking zone, or a contact **8081** of a limit switch **808** of the carriage in front of the group **101**, a conductor **1016** or **1017** and a manual switch **864**, or **865**. The automatic control is ensured, for the "carriage advance" control, by means of three contacts **9413**, **9423** and **9433** of three relays **941**, **942**, **943**, these contacts being connected in parallel between the conductors **1016** and **1003**, and for the control "carriage in reverse," by a contact **9453** of a relay **945** mounted between the conductors **1017** and **1003**.

The control circuit for the pouring, i.e., the inclination of the trough, comprises a line connected between the conductors **1000** and **1002**, and comprising, starting from **1000**: a limit switch **809**—pouring spout raised—a conductor **1018**, the pilot winding **631** of the distributor **630**, a conductor **1019** and the manual switch **865**. The automatic operation is assured firstly by a first line connected between the conductors **1019** and **1003** and which comprises: a contact **9123** of a relay **912**, a contact **9133** of a relay **913**, a conductor **1020**, and connected in parallel, three contacts **9315** of the relay **931**, **9325** of the relay **932** and **9335** of the relay **933**, and secondly by a second line connected between the conductors **1018** and **1003**, which comprises in its turn two lines: the first comprises a contact **9553** of a relay **955**, a conductor **1021**, a contact

9544 of a relay 954, a conductor 1022, a contact 9494 of a relay 949, the winding 9121 of a relay 912, a conductor 1023 and, connected in parallel, the contacts: 9514 of a relay 951, 9603 of a relay 960 and 9124 of the relay 912. The second comprises a contact 9533 of a relay 953, in series with a contact 9524 of a relay 952, the conductor 1021, a contact 9505 of a relay 950, the conductor 1022, a contact 9515 of a relay 951, the winding 9131 of a relay 913, a conductor 1024 and, connected in parallel between this conductor and the conductor 1003, the contacts: 9495 of a relay 949, 9134 of the relay 913, and the two contacts 9326 of a relay 932 and 9343 of a relay 934, connected in series. It is noted that the conductors 1021 and 1022 form bridges between the last two lines.

In FIG. 23, the limit contacts 8071 and 8081 are closed in the absence of any action; the contacts of relays 9123, 9133, 9553, 9524, 9494, 9505, 9515 and 9326 are closed when there is no energization. All the other switches or contacts are open in the absence of any action or energization.

The circuit controlling the movement of the nose 91 comprises (see FIG. 24) a manual line connected between the conductors 1000 and 1002 and composed of the pilot winding 611 of the distributor 610, a contact 9063 of the relay 906, a conductor 1025 and a manual switch 866, and an automatic line connected between the conductors 1000 and 1003 and composed of the winding 9141 of a relay 914, the conductor 1025, a limit switch 810 of the trough in the lowered position, a contact 9506 of a relay 950 and a contact 9545 of a relay 954. The conductor 1025 forms a bridge between the two lines.

The circuit for controlling the displacement of the feeding arrangement of the ingot molds comprises a contact 8111 of a limit switch 811 (trough disengaged from the journals), connected on the one hand to the conductor 1000 and on the other hand to a manual switch 869 connected in parallel with a contact 8121 of a limit switch 812, opening when the feed arrangement is stopped in front of the group 102, this corresponding to its supply position for molten metal, and ending at a conductor 1026. Starting from this conductor are two identical lines which each comprise the pilot winding 621 or 622 of the distributor 620, a contact 8131 of a limit switch 813 (trough on group 103) or 8141 of 814 (trough on group 101) and a conductor 1027 or 1028, respectively. This conductor is connected on the one hand to the conductor 1002 by way of a manual switch 867 or 868 and on the other hand to the conductor 1003 by a contact 9135 of the relay 913 or 9125 of the relay 912, these two relay contacts forming the automatic control.

The circuit controlling the descent of the movable table for the purpose of discharging the completed stack comprises a manual line connected between the conductors 1000 and 1002 and comprising the pilot winding 715 of the distributor 714 and the manual switch 870 connected in series by the conductor 1029, and an automatic line connected between the conductors 1000 and 1003 and comprising the winding 9151 of a relay 915, a conductor 1030, a limit switch 815 showing the lowered position of the feeler member for the stacking position 417, the conductor 1029 forming a bridge with the manual line, and a contact 9613 of a relay 961; between the conductors 1029 and 1030, there is also found, connected in series, the contacts 9633 and 9604 of the relays 963 and 960, respectively.

The circuit controlling the rotation of the movable table comprises firstly a manual line connected between the conductors 1000 and 1002 and composed of the winding 681 of the distributor 680, the conductor 1031 and the manual switch 871, and secondly an automatic line connected between the conductors 1000 and 1003 and comprising the winding 9161 of a relay 916, the conductor 1031 forming a bridge between the two lines and, connected in parallel, the limit contacts 816 (completion of a rotation of 90° of the movable table) and 817 (reentry movement of the ejection jack 431 or return on to the table of the push-plate conveyor 440—450); between the conductors 1031 and 1003, there is also found, connected in series, the contacts 9634 and 9154 of relays 963 and 915, respectively.

The circuit controlling the raising of the feeler member of the stacking position 417 comprises, for the manual control and connected in series between the conductors 1000 and 1002, the winding 721 of the distributor 720, a contact 9173 or a relay 917, a conductor 1032 and a manual switch 872; also mounted between the conductors 1000 and 1032 is the winding 9171 of the time relay 917. For the automatic control, a contact 9155 of the relay 915 in series with a contact 9605 of a relay 960 is arranged between the conductors 1032 and 1003.

The circuit controlling manual discharge comprises four half-lines mounted between the conductor 1000 and a conductor 1033 and a fifth half-line mounted between the conductors 1033 and 1003.

The first half-line comprises the piloting winding 697 of the distributor 696, the nontimed contact 9183 of relay 918 and the timed contact 9184 of the same relay. The second half-line comprises the winding 741 of the distributor 740 and a limit switch contact 818 actuated by the discharge device during its return. The third half-line comprises the winding 9181 of the time relay 918 and a limit switch contact 819 which opens when the device for immobilizing the stack on the movable table is removed. The fourth half-line comprises the winding 9191 of a relay 919.

The fifth half-line comprises the second contact 8002 of the limit switch 800, the second contact 8012 of the limit switch 801, and a conductor 1034 and the manual switch 873.

The automatic discharge control requires only that the conductors 1033 and 1003 are connected together.

In FIG. 24, the manual switch 869, the limit switch contacts 8111, 8121, 8131, 8141, 818, 819, the contacts of relays 9063, 9545, 9634, 9184 are closed in the absence of any action or energization. The other manual switches, contacts of limit switches and of relays are on the contrary open under the same conditions.

The automation circuits shown in FIGS. 25 to 29 are now to be described.

The automatic cycle is associated with the extraction of the ingots, which conditions the operation thereof.

The pulse emitting circuit comprises (FIG. 25) a variable timing pulse emitter 990 which comprises an electromagnet 9901 which actuates, according to the desired timing of the pulses, two contacts 9903 and 9904; corresponding to each pulse is a reciprocatory movement of the assembly of two contacts which are always in positions reversed with respect to one another. One of the terminals of the counter is connected to the conductor 1000, while the other acts on a line comprising the contact 9903, the first contact 8541 of a double switch 854 and the conductor 1003. The contact 9904 of the counter 990 is mounted between the conductor 1003 and the winding 9201 of a relay 920, to which it is connected by a conductor 1035, the winding being on the other hand connected to the conductor 1000. The second contact 8542 of the switch 854 is also situated between the conductors 1035 and 1003; this second contact is in a position in reverse to the first, that is to say, it is open in the absence of any action.

The pulse distributing circuit comprises a contact 9203 of the relay 920 mounted between the conductor 1003 and a conductor 1036. Between this latter and the conductor 1000, there are three lines connected in parallel, of which the first comprises a relay 921, the winding 9211 of which is connected to a contact 9243 of a relay 924. The other two half-lines are identical, the relays becoming respectively 922 and 923 and the contacts 9253 and 9263.

The "carriage on ingot mold group" circuit comprises three identical lines connected in parallel between the conductors 1000 and 1003. Each line comprises a relay 924, 925 and 926, respectively, of which the winding 9241, 9251 and 9261, respectively, is connected to a position contact 808, carriage at group 101, or 820, carriage at group 102 or 821, carriage at group 103.

In the circuits shown in FIG. 25, the contact 8541 is closed in the absence of any action. The other switches or relay contacts are open in the absence of any action or energization.

The method of operation of the contacts **9503** and **9504** is specific and it has been explained.

The automation circuits of the extractors are shown in FIG. **26**.

The circuit for the descent of the extractor comprises three identical lines, each connected between the conductors **1000** and **1003**.

Each line comprises a relay **927**, **928** and **929**, respectively, of which the winding **9271**, **9281** and **9291**, respectively, is connected by a conductor **1037**, **1038** and **1039**, respectively, to a limit switch contact **822**, **923** and **824**, respectively, connected on the other side to the conductor **1003**. These limit switch contacts show the descent of the corresponding extractor. They are actuated by the movement only in the direction of descent.

Between the conductor **1037**, **1038** and **1039**, respectively, and a conductor **1040** connected to the conductor **1003** by means of a contact **9583** controlled by a relay **958**, there is connected the contact **9273** of relay **927**, contact **9283** of relay **928** and contact **9293** of relay **929**, respectively.

The extractor descent circuit also comprises a memory, formed by a relay **930**, of which the winding **9301** has one of its terminals connected to the conductor **1000**, the other being connected by a conductor **1041** to two contacts mounted in parallel: **9303** of relay **930** and **9623** of relay **962**, connected on the other side to the conductor **1040**.

An extraction completed circuit comprises, for the circuits concerning the three groups, a relay **931**, **932** and **933**, respectively, of which the winding **9311** has one of its terminals connected to the conductor **1000**, the other terminal being connected to a line comprising, connected in series, the contact **9353** of a relay **935**, **9363** of a relay **936** and **9373** of a relay **937**, respectively, then a contact **9274** of the relay **927**, **9284** of the relay **928** and **9294** of the relay **929**, respectively, being connected on the other side to the conductor **1003**.

For the group **102**, there is also found a memory formed by a magnetic holding relay **934**, of which the two windings **9341** and **9342** have one of their terminals connected to the conductor **1000**, the other being connected, for **9341**, to the conductor **1042** which connects **9321** to **9363** and, for **9342**, by a conductor **1043**, to two contacts **9083** and **9516** of two relays **908** and **951**; the first of these contacts is on the other side connected to the conductor **1001**, while the second is connected to the conductor **1003**.

An "extractor in lowered position" circuit comprises three identical lines, each connected between the conductors **1000** and **1003**. Each line comprises the winding **9351** of a relay **935**, or **9361** of **936** or **9371** of **937**, connected to a limit switch contact **825**, **826** and **827**, respectively. These contacts show the lowered position of the extractors of the corresponding group.

A circuit of extraction memories comprises three identical memories. The memory relating to group **101** comprises a magnetic holding relay **938**, of which the two windings have one terminal connected to the conductor **1000**, the other terminal being connected, for **9381**, to a contact **9214** of the relay **921**, connected on the other side to the conductor **1003** and, for **9382**, by a conductor **1044** to two relay contacts: a contact **9225** of the relay **922**, connected on the other side to the conductor **1003**, and a contact **9084** of the relay **908**, connected on the other side to the conductor **1001**. The memories relating to the second and third groups of ingot molds are identical. It is sufficient, for the second group, to replace the references of the relay **938** by **939**, **9381** and **9382** by **9391** and **9392**, to replace the references of the relay contacts **9214**, **9225** and **9084** by **9224**, **9235** and **9085**, and to add one unit to the reference of the conductor. For the third group, the references **938**, **9381**, **9382**, **9214**, **9225** and **9084** are respectively replaced by **940**, **9401**, **9402**, **9234**, **9215** and **9086**, and two units are added to the reference of the conductor. The circuit relating to the group **103** comprises a contact **9226** of the relay **922** connected between the conductors **1046** and **1003**.

In the arrangements represented by FIG. **26**, only the contact **9583** of the relay **958** is closed in the absence of any energization. The other switches or contacts are all open in the absence of any action or energization.

The circuit for making automatic the movements of the carriage **310** for conveying the ingots is indicated in FIG. **27**.

The circuit ensuring the movement of the carriage between the casting zone and the stacking zone comprises, for the group **101**, **102**, and **103**, respectively, a magnetic holding relay **941**, **942** and **943**, respectively, of which the pullup winding **9411**, **9421** and **9431**, respectively, in series with a contact **9314** of relay **931**, or **9324** of relay **932** or **9334** of relay **933**, respectively, is mounted between the conductor **1000** and a conductor **1047**, itself connected to the conductor **1003** by a contact **9304** of the relay **930**, and of which the pullup winding **9412**, **9422** and **9432**, respectively, is connected by a common conductor **1048**, firstly to the conductor **1003** by a contact **9443** of a relay **944** and secondly to the conductor **1001** by a contact **9087** of the relay **908**.

The "carriage in abutment in the stacking zone" circuit comprises, connected between the conductors **1000** and **1003**: the winding **9441** of a relay **944** and a second contact **8072** of the limit switch **807**—carriage in abutment at stacking position.

The circuit ensuring the movements of the carriage from the stacking zone to the casting zone comprises a magnetic holding relay **945**, of which the pullup winding **9451** and the release winding **9452** are connected by one of their poles to the conductor **1000**. The second terminal of the first winding is connected by a conductor **1049** to the limit switch **828**, actuated when the feeler member **419** is in the raised position, and to a switch **855** which can be operated when it is desired to cause manually the return of the carriage to the casting zone, these two switches being on the other hand connected to the conductor **1003**. The second terminal of the winding **9452** is connected by a conductor **1050**, first to a contact **9088** of the relay **908**, connected to the conductor **1001**, and secondly to four contacts mounted in parallel and connected to the conductor **1003**, namely: **9244** of the relay **924**, **9463** of a relay **946**, **9473** of a relay **947** and **9483** of a relay **948**.

The circuit causing the stopping of the carriage at the group of ingot molds comprises three parallel lines corresponding respectively to the groups **101**, **102** and **103**, mounted between the conductors **1000** and **1003**, and each comprising the winding **9461** of a relay **946**, **9471** of a relay **947** and **9481** of a relay **948**, respectively, a contact **9254** of relay **925**, **9264** of **926** and **9256** of **925**, respectively, a contact **9383** of the relay **938**, **9393** of **939** and **9403** of **940**, respectively. The circuit of the relay **948** also includes a contact **9606** of a relay **960**, mounted in series.

In the circuits illustrated by FIG. **27**, the contacts **9304** of the relay **930** and **9606** of the relay **960** are closed in the absence of energization. All the other switches or contacts are open in the absence of any action or energization.

The circuits for making automatic the feeding arrangement of the ingot molds is shown in FIG. **28**.

A "trough on group **101**, **102** or **103**" circuit comprises three identical lines, connected between the conductors **1000** and **1003**. Each line comprises the winding **9491** of a relay **949**, **9501** of **950** and **9511** of **951**, respectively, connected to a contact **8142** of a limit switch—trough before the group **101**—**8122** of **812**—trough before the group **102**—and **8132** of **813**—trough before the group **103**, respectively.

A circuit ensuring the automatic movement of the trough comprises a circuit identical with the foregoing. The winding **9521** of a relay **952** is connected by a conductor **1051** to a contact **8112** of the limit switch **811**—trough disengaged from journals—the entire arrangement being connected between the conductors **1000** and **1003**. A memory of the movement order of the trough comprises a magnetic holding relay **953**, of which the two windings are connected by one of their terminals to the conductor **1000**, the other terminal being connected for the pullup winding **9531** to a contact **9504** of the

relay **950**, which itself is connected on the other side to the conductor **1051** and, for the release winding, by a conductor **1052** to two contacts, of which a first contact **9089** of the relay **908** is on the other side connected to the conductor **1001**, while the second contact **9503** of the relay **950** is connected on the other side to the conductor **1003**.

A "level in the trough" circuit is connected between the conductors **1000** and **1003**. It comprises a relay **954**, of which the winding **9541** is connected by a conductor **1053** to a switch **856** permitting the pouring to be stopped manually, to a contact **9065** of the relay **906** and finally to two contacts connected in series: a contact **9523** of the relay **952** and a contact **9543** of the relay **954**.

An auxiliary circuit known as the "trough at group **101** or **103**" circuit, mounted between the conductors **1000** and **1003**, comprises a relay **955**, of which the winding **9551** is connected by a conductor **1054** to two contacts: **9493** of relay **943** and **9513** of relay **951**, connected in parallel.

A circuit known as the "trough in the raised position" circuit, also connected between the conductors **1000** and **1003**, comprises a relay **956**, of which the winding **9561** is connected, by a conductor **1055**, firstly to a limit switch **830** providing the raised position of the trough and secondly to two contacts connected in series: a contact **9143** of the relay **914** and a contact **9563** of the relay **956**.

A circuit for timing the pouring comprises a time relay **957**, which may be of any known type and more particularly of the type in which a condenser is discharged into a variable resistance **9572**. The condenser charging circuit is connected directly between the conductors **1000** and **1003**, a rectifier (not shown) being interposed when these conductors are fed with alternating current. The discharge circuit is connected by a contact **9564** of the relay **956** to the conductor **1040**. An "end of pouring" relay **958** has its winding **9581** connected to a contact **9573** of the time relay **957**, the complete arrangement being connected between the conductors **1000** and **1003**.

In the circuits shown by FIG. **28**, only the contacts **9504** of the relay **950**, **9523** of the relay **952** and **9143** of the relay **914** are closed in the absence of energization. The other contacts or switches are open in the absence of any action or energization.

The circuits for making automatic the discharge are shown in FIG. **29**.

A circuit for counting the layers of ingots deposited comprises a layer counter **991**, which is in fact a pulse counter. It comprises an electromagnet **9911** which, with each energization, causes the advance by one tooth of a wheel (not shown) carrying a finger which, after the specified number of energizations, closes a contact **9914** and temporarily changes the position of a switch **9913**. A motor **9912** then brings the counter to the starting position.

The electromagnet **9911** is connected by one of its terminals to a contact **9444** of the relay **944** and by its other terminal to a switch contact **9913**. Between the other contact of this switch and the conductor **1003**, there is connected the winding **9591** of a relay **959**. The brush of the switch **9913** is connected to one of the poles of the motor and to the conductor **1000**. The contact **9914** is connected firstly to the conductor **1003** and secondly by a conductor **1056** to the second pole of the motor **9912** and to a contact **9593** of the relay **954**, which is connected to the conductor **1003**.

A "stack completed" circuit comprises a magnetic holding relay **960**, of which the windings are connected by one of their terminals to the conductor **1000**. The other terminal of the pullup winding **9601** is connected to the conductor **1056**, while that of the release winding **9602** is connected by a conductor **1057**, firstly to a switch **929** actuated by the extractor of the group **101** in the raised position and connected to the conductor **1003** and secondly to a contact **9089** of the relay **908**, connected to the conductor **1001**.

This circuit also comprises an auxiliary magnetic holding relay **964**, of which the two windings are connected by one of their terminals to the conductor **1000**. The other terminal of the pullup winding **9641** is connected to the conductor **1056** while that of the winding **9642** is connected by a conductor **1058** to a contact **90811** connected to the conductor **1001** and to a switch **833** connected to the conductor **1003**. This switch **833** is actuated by the carriage entering the stacking zone.

A circuit called "movements for the deposition of a layer" comprises a magnetic holding relay **961**, of which the two windings are connected by one of their terminals to the conductor **1000**; the second terminal of the pullup winding **9611** is connected to a limit switch **832** actuated when the ejection jack **431** is in the withdrawn position or when the push-plate conveyor **440–450** is in position on the movable table, the switch being on the other hand connected to another switch **831**, actuated by the carriage leaving the stacking zone, this latter switch being connected to the conductor **1003**; the second terminal of the release winding is connected to the conductor **1058**.

A "carriage in the stacking zone" circuit comprises a relay **962**, of which the winding **9621** is connected on the one hand to the conductor **1000** and on the other hand to a contact **90810** of the relay **908**. This contact is on the other hand connected to the conductor **1058**, which forms a bridge between the last three circuits described.

A "rotary displacement of movable table" circuit comprises a time relay **963** connected between the conductors **1000** and **1003**, the winding **9631** of said relay being connected to a contact **9153** of the relay **915**.

In the circuits shown in FIG. **29**, only the contact **90810** of the relay **908** is closed in the absence of energization. The other contacts of the relays and switches are open in the absence of energization or action.

The operation of the electrical control installation is explained in the following.

The machine is protected (FIG. **22**) by safety circuits which prevent any incident during operation being able to cause an accident. In actual fact, starting is only possible if the safety relay **907** is energized and closes the contact **9073**. Now the relay **907** is only energized as long as the five contacts included in its circuit remain closed, that is to say, none of the relays controlling these contacts is energized. It is assumed that the current is established between the conductors **1000** and **1001**.

The safety in discharge results from the fact that if the movable table is not in the lowered position or the orientation thereof does not permit the departure of the stack, at least one of the two contacts **8001**—movable table in lowered position—or **8011**—table in the discharge axis—is closed. If the relay **919** under these conditions sends a discharge order, the contact **9193** is closed, the relay **900** is energized and opens the contact **9003**, thus cutting off the supply to the relay **907**.

The safety measure in the stacking zone results from the fact that when the carriage is in this zone, the switch **802** energizes the relay **901**, thus closing the contact **9013**. If at the same time an order for rotation is emitted by the relay **916**, the contact **9163** is also closed, and this causes energization of the relay **902** and the breaking of the contact **9023**, and hence the release of the relay **907**.

The safety measure as regards the pouring in the three groups of ingot molds results from the fact that if one of the three contacts **803**, **804** or **805** is closed—extractors not completely descended into the group **101**, **102** or **103**—and an order for pouring is given by the relay **931**, **932** or **933**, corresponding to the same group, the relay **903**, **904** or **905** is energized, thus cutting off the supply to the relay **907**.

It is possible to introduce all the supplementary safety measures which may be desired: a too great tractive force in the translatory movement of the carriage or of the feed arrangement—a force limiting device energizes a magnetic holding relay, breaking a supplementary contact in the circuit of the relay **907**—or even the nonfunctioning of the circuit limiting the supply to the trough, by means of two points situated at a

level slightly above that of the points **8061** and **8062**, which energize a relay.

It is also possible to provide a means for signalling defects by supplying, from each of the holding relays, a light indicator (not shown).

The safety relays, being of the magnetic holding type, maintain the memory of the defect and it is expedient, before restarting, to release the relays by action on the button **850**, which feeds the assembly of the release windings, of which the reference terminates in the digit **2**.

The operation of the machine under manual control is as follows.

With the relay **907** energized, the safety devices being assumed at rest, the contact **9073** is closed. The switch **890** is brought to the "manual" position: **8901** and **8903** closed, **8902** open, then the switch **891** is closed, and thereafter the switch **852** is actuated, which is immediately released, this causing it to return to its rest position. The result thereof is a current pulse in the relay **911** and the closing of the contact **9113**: the relay remains energized. Other contacts (not shown) of this relay ensure that the motor of the motor and pump group **600** is supplied with voltage, this permitting the hydraulic control system to be brought into action.

The closing of the contact **9113** also ensures the energization of the manual control relay **910**, while the relay **909** remains at rest. The result of this (FIG. **23**) is that the contact **9103** is closed, supplying voltage to the supply conductor **1002** under manual control. On the contrary, the contact **9093** remains open, so that the supply conductor **1003** under automatic control remains broken.

The action on **852** also closes the contact **8521**, which ensures that voltage is applied to the relay **908**, this resulting in the closure for an instant of the contacts **9083** to **90811** and predisposition of the holding relays other than those of the safety circuits. This predisposition consists in bringing the release windings under voltage, of which windings the reference ends in **2**, and hence in bringing these relays to the rest position.

As the rotary nose **91** is positioned facing the group of ingot molds **102**, it is suitable first of all to bring the supply arrangement **200** into this position. For this purpose (FIG. **24**), either the manual operation switch **867** is operated, if the arrangement **200** is facing the group **101**, or the switch **868** is operated, if the arrangement **200** is facing the group **103**. Simultaneously, the switch **869** is actuated, which causes the stopping of the arrangement **200** in front of the group **102**.

In actual fact, the action on **867** directly energizes the windings **621** of the distributor **620** which feeds the motor **203**, provided only that the trough is disengaged from the journals, that is to say, it is not in the raised position: the contact **8111** of the switch **811** is then closed; the contact **8131** is also closed, because the arrangement **200** is not facing the group **103**. Similarly, the action on **868** directly energizes the winding **622** of the same distributor, provided that the trough is not in the raised position. The contact **8141** is closed, because the arrangement **200** is not facing the group **101**. On the other hand, if the switch **869** is operated, the supply to one or other winding of the distributor is broken at the moment when the contact **8121** of the switch **812** is opened, that is to say, at the moment when the arrangement **200** is facing the group **102**.

The manual switch **866** is then actuated: as the trough is empty, the contact **806** is open, the relay **906** is not energized and the contact **9063** is closed. The winding **611** of the distributor **610** is energized, and the rotary nose **91** assumes its lower position, thus supplying the trough with liquid metal. When the desired level is reached, the liquid metal touches the points **8061** and **8062**, thus causing the contact **806** to close, and hence the energization of the relay **906** and the opening of the contact **9063**. The distributor **610** rocks under the effect of the spring **612**, and the rotary nose reassumes the raised position, thus stopping the supply to the trough.

The arrangement **200** must then be returned opposite the group **101**, or opposite the group **103**, or remain facing the group **102**, in order to proceed with the pouring operation.

An action on the switch **868** alone feeds the winding **622** of the distributor **620**, setting the arrangement **200** in operation until the contact **8141** is opened, that is to say, until the arrangement **200** is facing the group **101**. Similarly, any action on **867** feeds the winding **621** of the distributor **620**, setting the arrangement **200** in operation in the direction opposite to the foregoing until the contact **8131** is opened, when the arrangement is facing the group **103**.

The pouring is effected (FIG. **23**) by acting on the switch **865**, provided that the switch **809** is open, that is to say, that the rotary nose is raised. The winding **631** of the distributor **630** is then energized, this causing the starting of the hydraulic sequence, which ensures that the trough is brought to the raised position. For returning the trough to the lowered position, once the pouring operation is completed, it is sufficient to release the switch **856**, this breaking the current in the winding **631**.

The actions as described are continued without interruption in order to ensure in succession the pouring into the group **101**, for the pallet ingot layer of the stack, then alternately the pouring into groups **102** and **103**. If a layer of pallet ingots is not required, ingot molds identical with those of the other two groups are arranged in the group **101**, and the three groups are filled in succession.

The extraction of the cast ingots is effected by acting on the switch **860** for the group **101**, **861** for the group **102** and **863** for the group **103**. Thus, in respect of the group **101**, the winding **641** of the distributor **640** is energized and this, by hydraulic sequence, causes the extraction. The corresponding windings **651** of group **102** and **661** of group **103** are energized in similar manner. The return of the extraction valves to their seats is effected by a hydraulic sequence.

It is suitable to bring the carriage above the corresponding group before the extraction. For this purpose, the switch **864** is actuated, this energizing the winding **672** of the distributor **670** feeding the motor and reducing gear group **335**, and this causes the movement of the carriage towards the casting zone. The carriage is stopped above one of the groups **103** or **102** by stopping the action on the switch at the appropriate time. As regards the group **101**, the stoppage occurs automatically by opening of the limit switch **808**.

When the extractor in question has reassumed its lower position, thus depositing the extracted ingots on the grippers which are carried by the carriage, the switch **863** is operated and this, by feeding the winding **671** of the distributor **670**, causes the movement of the carriage towards the stacking zone, until the contact **8071** of the limit switch **870** is opened, that is to say, until the carriage is in abutment. During the end of this movement, the ingots, held by the movable stop abutment **341** or the fixed stop abutment **345**, are locked one against the other.

The carriage, in entering the stacking zone, lifts the lower feeler **417** and this, as already explained, causes the ascending movement of the movable table, which raises the ingots until the feeler member **419** assumes its position of equilibrium, this causing the stopping of the ascending movement of the table.

The switch **864** is then operated, this switch energizing the winding **672** of the distributor **670**, thus causing the start of the movement of the carriage towards the casting zone, this movement being stopped either by ceasing to act on **864** or when, facing the group **101**, the carriage operates the limit switch **808**, which is opened, thereby interrupting the energization of the winding **672**.

The carriage then receives the ingots of the following group and recommences its movement.

When the carriage leaves the stacking zone, the lower feeler **417** bears against the layer of ingots which has just been deposited and, by hydraulic sequence, causes the descending movement of the movable table until said feeler member is in its position of equilibrium, which stops the movement of the

table. The switch **871** is then operated, this directly energizing (FIG. **24**) the winding **681** of the distributor **680** which controls the motor **414**. The movable table starts to turn, closing the switch **816**. The switch is then released and the movement continues until, after a rotation through 90°, a finger which is carried by the table reopens the switch **816**, this causing the stopping of the rotational movement. From this time, the stacking zone is ready to receive the carriage, provided with a fresh layer of ingots which are to be deposited.

When the number of layers of ingots to constitute a stack has been deposited, the switches **870** and **872** are simultaneously actuated. The switch **870** directly energizes the winding **715** of the distributor **714**, this latter being thus brought to the "table descent" position. However, this movement can only take place provided that the double valve which forms the distributor **690** is open, so that it is necessary to lift the feeler member **417**. This is assured by the action on the switch **872**, which energizes the time relay **917** and this, after the time period, causes the closure of the contact **9173** and the energization of the winding **721** of the distributor **720**, which feeds the jack **694**, resulting in the lifting of the feeler member and downward movement of the table.

If the position of the stack does not permit the discharge, it is appropriate to act on the switch **871** to cause a rotation of the movable table through 90°, it being possible for this action to be carried out at the same time as the previous action.

The switch **873** is then operated for causing the discharge operation. Provided that the contacts **8002** and **8012** are closed, that is to say, the plate is in the lower position and correctly oriented, and also that the contact **818** is likewise closed, that is to say, the discharge device is in its rest position, the winding **741** is energized, this causing the retraction of the locking arrangement for the stack, if such an arrangement exists. This retraction causes the closure of the contact **819**, and thus energization of the relay **918**, which results in an immediate closure of the contact **9183** and then, after a time delay, the opening of the contact **9184**. During the time delay period, the winding **697** is energized, and controls the distributor **696**, this causing the discharge of the stack, as already explained in connection with the hydraulic arrangements.

When the switches **872** and **873** are freed, the winding **721** is no longer energized, the feeler in its turn is free and by the hydraulic sequence, the movable table ascends again until the feeler member reassumes its position of equilibrium. In addition, the winding **747** is no longer energized, this bringing back into position the arrangement for immobilizing the ingots.

The operation of the automatic machine is explained below.

A manual preparation of the machine is necessary: thus, the movable table is possibly placed in the direction permitting the discharge and then the three groups of ingot molds are filled in the order: **101**, **102** and then **103**, as has just been explained, the trough is refilled and is brought on to the group **101**.

There is then carried out the regulation of the pulse emitter **991**, where the desired extraction procedure is indicated, the layer counter, where the number of layers adapted to form a stack is indicated, and finally the potentiometer **9572** of the time relay **957**, where the duration of the pouring or casting is indicated.

It only remains to operate on **850** in order to eliminate the possible defects as regards safety, to predispose the magnetic holding relays by an action on **852** and finally to bring the switch **890** to its "automatic" position, that is to say, to the position which is shown in FIG. **22**. The relay **909** is then energized, but not the relay **910**. The contact **9093** is closed, while **9103** remains open.

The conductor **1003** is thus supplied with current, to the exclusion of **1002**.

From this point (FIG. **25**), the pulse emitter **990** emits a series of pulses which give the rate of extractions. With each pulse, the contact **9904** is closed during the period of the pulse and is then reopened. It thus energizes the relay **920** during this time, and this relay in its turn closes the contact **9203** during the pulse period.

Rather than follow the ingots through the machine, the operation will be described element by element, for greater clarity.

The extraction is operated as follows:

Depending on whether the carriage is on the group **101**, **102** or **103**, it closes the contacts **8082** of the switch **808**, **820** or **821**, respectively, this causing voltage to be supplied to the relay **924**, **925** or **926**, respectively. As a result, the pulse represented by the closure of the contact **9203** is switched through one of the contacts **9243**, **9253** or **9263** of the preceding relays towards the relays **921**, **922** or **923**.

If the relay **921** is energized, the contact **9213** is closed (FIG. **23**), thus causing voltage to be applied to the winding **641** of the distributor **640**, and thence the extractor of the group **101**.

If it is the relay **922** which is energized, the contact **9223** causes voltage to be applied to the winding **651** and the extraction of the group **102**.

Finally, energization of the relay **923** causes the extraction of the group **103** via the contact **9223**.

It is noted that it is possible (FIG. **25**), by acting on the switch **854**, to energize the relay **920** and cause the manual emission of a pulse.

The extraction pulses are memorized (FIG. **26**) by the magnetic holding relays **938** to **940**. The contact **9214** of the relay **921** energizes the pullup winding **9381** of the extraction memory relay **938** of the group **101**, and likewise the contact **9224** engages the extraction memory relay **939** of the group **102** and the contact **9234** engages the extraction memory relay **940** of the group **103**.

When one of the windings **641**, **651** or **661** is energized, a hydraulic sequence causes the outlet of the extractors and then their return empty, the ingots remaining engaged in the gripper devices of the carriage.

At the time of their descent, the extractors during their movement actuate one of the switches **822** to **824** which only respond to the descending movement. The arrival of the extractors in the lower position actuates one of the switches **825** to **827**.

Thus, the extractor of the group **101** actuates the contact **822** which energizes the relay **927** which, after reopening of the contact **822**, remains automatically supplied through its own contact **9273** as long as the contact **9583** of the relay **958** remains closed. The reaching of the lower position by the extractor actuates the contact **825**, which energizes the relay **935** as long as the extractor remains in this position. The closing of the contacts **9274** of the relay **927** and **9353** of the relay **935** then energizes the relay **931**, which shows the completion of the extraction. This relay **931** then gives two orders: displacement of the carriage with the extracted ingots and filling of the ingot molds of the group **101** thus emptied.

The descent of the extractor of the group **102** likewise actuates the contact **823** which engages the relay **928** which is automatically fed at **9283** and **9583** and remains energized until voltage is applied to the relay **958**. The arrival of the extractor at the lower position actuates the contact **826**, which energizes the relay **936**; the two contacts **9284** and **9363** engage the relay **932** and also the magnetic holding relay **934** which remains energized after the relay **932** has been returned to the rest position.

Finally, the descent of the extractor of the group **103** actuates the contact **824** which engages the relay **928**, this being automatically fed on **9293** and **9583** and remaining energized until voltage is applied to the relay **958**. The arrival of the extractor at the lower position actuates the contact **827**, which energizes the relay **937**; the two contacts **9294** and **9373** engage the relay **933**.

These relays **935** and **937** cause the return of the carriage towards the stacking layer through other relays **941** to **943**, which form the actual memories.

On the other hand, these relays directly cause the pouring operation and they can only be deenergized after completion of this latter operation. It is thus the end of casting relay **958** (FIG. 29) which, by the opening of contact **9583**, deenergizes the relays.

Each extraction memory **938** to **940** is erased by the extraction pulse of the following group. Thus, the relay **938** is deenergized by the closing of the contact **9224** of the relay **922**, the relay **939** is deenergized by the closing of the contact **9235** of the relay **923**, and the relay **940** by the contact **9215** of the relay **921**. The relay **940** is moreover deenergized by the contact **9226** of the relay **922** relating to the group **102**, because after an extraction on the group **103**, the carriage and the trough may have to be returned either to the group **101** or to the group **102**.

The movements of the carriage are controlled in the manner explained below.

For the formation of a stack, the carriage must first of all transport a layer of pallet ingots of the group **101** to the stacking zone, then return to the group **102** in order to take up the second layer in order to transport it into the stacking zone, then return to the group **103** to take up and carry the third layer, then continue the operation alternately between the groups **102** and **103** until the stack is completed. As the stack comprises an odd number of layers, it is always the group **103** which supplies the last layer of ingots. After the discharge, the carriage must not return again to the group **102**, but to the group **101**, in order to take up the layer of pallet ingots for the following stack.

The extraction at the group **101** is controlled, as already indicated, by the relay **921**, of which the memory is kept by the relay **938**.

The completion of the extraction of the ingots at the group **101** is defined by the energization of the relay **931**. The contact **9314** of this relay in its turn energizes the holding relay **941** (FIG. 27), of which the contact **9413** directly feeds the winding **671** of the distributor **670**, this causing the movement of the carriage towards the stacking zone, until the contact **8071** of the limit switch **807** is broken by the arrival of the carriage in abutment therewith. It is noted that the contact **9304** is only open when the carriage is already in the stacking zone, Simultaneously, the closure of the contact **8072** of the same switch **807** causes the energization of the relay **944**, of which the contact **9443** returns the relay **941** to the rest position by energization of its release winding **9412**.

In the stacking zone, the raising of the layer of introduced ingots is assured until the upper feeler member **419** assumes its position of equilibrium and actuates the switch **828**, which energizes the relay **945**, of which the contact **9453** directly supplies voltage to the winding **672**, this causing the movement of the empty carriage towards the casting zone.

During this movement, the carriage first of all encounters the position contact **821**, placed above the group **103** of ingot molds. This contact energizes the relay **926**, but the relay **947** cannot be energized, because the contact **9393** is open.

The carriage then encounters the switch **820** of the group **102**. The relay **946** is energized, the contact **9383** being closed because, as already seen, the relay **938** which keeps the extraction memory of the group **101** is energized. The contact **9463** is closed, deenergizing the relay **945**, and this causes the opening of the contact **9453** and the stopping of the feeding of the winding **672**. The carriage is stopped at the group **102**, awaiting the following extraction pulse which, closing the contact **9203**, energizes the relay **922** causing the extraction and, by closure of the contact **9225**, deenergizes the relay **938**. Simultaneously, the closure of the contact **9224** causes the energization of the relay **939**.

The completion of extraction at the group **102** is defined by the energization of the relay **932**, of which the contact **9324** operates the relay **942** (FIG. 27) which, by its contact **9423**, supplies voltage to the winding **671**, this resulting in the movement of the carriage towards the stacking zone, the opening of the contact **8071** and immobilization of the carriage. The stacking procedure is identical with that which has been described in connection with the group **101**. The relay **945** is energized, causing the movement of the carriage towards the casting zone, but during the passage in front of the group **103**, the contact **821** energizes the relay **926**, closes the contact **9264** and, since the contact **9393** of the relay **939** is closed, the relay **947** is energized and its contact **9473** deenergizes the relay **945**, this causing the carriage to stop in front of the group **103**, awaiting the following extraction pulse. This latter closes the contact **9203**, energizes the relay **923** and causes the extraction. Simultaneously, by closing the contact **9235**, it deenergizes the relay **939** and, by closing the contact **9234**, it causes the operation of the magnetic holding relay **946**.

The completion of extraction at the group **103** is defined by the energization of the relay **933**, of which the contact **9334** energizes the relay **943** which, through its contact **9433**, energizes the winding **671** and sends the carriage towards the stacking zone, where the opening of the contact **8071** stops it. After stacking, the relay **945** is energized, feeding the winding **672**. The carriage returns towards the casting zone. As it passes in front of the group **103**, the contact **821** is closed, energizing the relay **926**, of which the contact **9264** is in its turn closed. The contact **9393** of the relay **939**, memory of the preceding pulse, is also closed, so that the relay **947** is energized. Its contact **9473** operates the relay **945**, of which the contact **9453** is opened (FIG. 23), deenergizing the winding **672**, which stops the movement of the carriage. This latter is thus stopped in front of the group **103**, awaiting the following extraction pulse. This latter closes the contact **9263** and energizes the relay **923**, of which the contact **9235** operates the relay **9393**, the extraction memory of the group **102**, and of which the contact **9234** operates the relay **940**, the extraction memory of the group **103**.

The completion of the extraction at the group **103** is defined by the energization of the relay **933**, of which the contact **9334** energizes the relay **943** which, through its contact **9433**, supplies voltage to the winding **671**. The carriage returns to the stacking zone, deposits its layer of ingots in this zone, and then returns towards the casting zone. The relay **926** is energized, but not the relay **947**, because the contact **9393** is open. The carriage thus continues its travel and reaches the group **102**. The relay **925** is energized and, through its contact **9256**, supplies voltage to the relay **948**, then the contact **9403** of the relay **940** of the extraction memory of the group **103** is closed, as well as the contact **9606**. The contact **9483** releases the relay **945** which, by breaking the contact **9453**, interrupts the supply to the winding **672** and stops the carriage at the group **102**.

The movement of the carriage then continues as in the two previous cases, alternating between the groups **102** and **103**, on the one hand, and the stacking zone, on the other hand.

However, each time the carriage, in abutment in the stacking zone, actuates the contact **8072** of the limit switch **807**, the relay **944** is energized during the stay of the carriage in this zone, and its contact **9444** sends a pulse to the counter **991**, of which the electromagnet **9911** is energized, causing the wheel to advance by one tooth. When this latter has turned the number of teeth indicated, it momentarily rocks the switch **9913** and closes the contact **9914**. The relay **959** is energized, its contact **9593** operates the holding relay **960**, of which the contact **9606** is opened. The carriage deposits its ingot layer and then it returns to the casting zone, but it is only stopped at the group **101**, because the contact **9606** in the circuit of the relay **948**, the contact **9393** in the circuit of the relay **947** and the contact **9383** in the circuit of the relay **946** are open. It is, in fact, the contact **8081** of the limit switch **808** which deenergizes the winding **672**, but nevertheless the relay **924** is energized and through its contact **9244**, releases the relay **945**.

The cycle restarts here for the formation of a new stack.

If for any reason, despite the lifting of the stack after the last layer has been deposited, the upper feeler member acted to an insufficient degree on the switch **828**, the return of the carriage can be controlled by a manual action on the switch **855**, which short-circuits the switch **828**.

The casting is carried out as follows:

On completing such extraction at one of the groups **101**, **102** or **103**, the corresponding relay **931**, **932** or **933** is energized and ensures the movement of the carriage. At the same time, the contact **9315**, **9325** or **9335**, in series with the contacts **9133** and **9123** (trough in the rest position) which are closed, causes the energization of the windings **631** of the distributor **630**, which controls the hydraulic pouring sequence, provided that the contact **809** is closed, that is to say, the rotary nose is in the raised position. As will be set out below, the trough is necessarily facing the group where the extraction has just been produced.

As soon as the trough reaches its raised pouring position, it closes the limit switch **830** and this causes (FIG. **28**) the energization of the relay **956**, which by its contact **9564**, sets in operation the time relay **957**, of which the variable resistance **9572** adjusts the timing. At the end of the indicated time, the contact **9573** is closed, supplying voltage to the end of casting relay **958**. As a result, the contact **9583** is open, deenergizing the relay **927**, **928** or **929** which is concerned (FIG. **26**), and this, by opening the corresponding contact **9274**, **9284** or **9294**, causes the relay **931**, **932** or **933** in question to be brought to rest. The result thereof is the opening of the corresponding contact **9315**, **9325** or **9335**, the only one which was closed, so that the supply of the winding **631** is interrupted and the trough reassumes its raised position by a hydraulic sequence.

It is noted that if, at the same time as a casting order is given, the extractors of the group to be cast are not in the lower position, one of the safety devices represented by the relays **903**, **904** or **905** would become operative and would cause the complete interruption of the current and possibly the signalling of the defect.

The automatic operation of the circuits for moving and filling the feeding arrangement is described by reference to FIGS. **28** and **24**.

The filling of the trough results from the fact that, if the trough is facing the group **102**, the contact **8122** of the position switch **812** being closed, the relay **950** is energized. If in addition the trough is empty, the contact **806** (FIG. **22**) is open, so that the relay **906** is at rest, and its contact **9065** is open, which also brings the relay **954** to rest. The contact **9545** (FIG. **24**) is thus closed. If in addition the trough is in the lower position, the switch **810** is closed, and the winding **611** of the distributor **610** is fed. The rotary nose **91** is lowered and fills the trough.

As soon as the two points **8061** and **8062** of the contact **806** are short-circuited by the liquid metal, the relay **906** is energized so that the contact **9063**, which until now is closed, is opened and interrupts the supply of voltage to the winding **611**, this causing the raising of the rotary nose and the shutting off of the supply. It is noted that the contact **9065** (FIG. **28**) is also closed, this causing the energization of the relay **954** and the breaking of the contact **9545** (FIG. **24**). When the rotary nose is raised, the contact **809** is closed (FIG. **23**), this authorizing the pouring or casting operation and, as will be explained, the displacement of the trough.

If it should be desired for any reason to interrupt the supply, this can be done by energizing the relay **954** by acting on the switch **856**. The contact **9545** is open, shutting off the current of the distributor **611**.

It is also possible to provide a contact similar to **806** on the trough, but at a higher level. It is then possible to cause it to energize a safety relay, preferably of the holding type, which breaks a supplementary contact interposed in the relay circuit **907**. There is thus available a supplementary safety device which stops the machine if there is any danger of the liquid metal overflowing the trough. This supplementary safety relay could also be provided with a defects signalling device.

In order to explain how the displacement of the supply arrangement is operated, the commencement of the automatic cycle will now be referred to. The trough is brought, filled by manual operation, opposite the group **101**.

As a result, the contact **8142** of the switch **814** (trough at group **101**) is closed and the relay **949** is energized. After extraction, the group is cast; on completing the casting, the trough is disengaged from the trunnions and then the switch **811** assumes its rest position. The contact **8111** (FIG. **24**) is closed, while the contact **8112** (FIG. **28**) is open, so that the relay **952** remains at rest.

The relay **913** is energized (FIG. **23**). In actual fact, the following contacts are all closed: **9495** of relay **949**, because the trough is at the group **101**; **9515**, of the relay **951**, because the trough is not at the group **103**; **9505** of the relay **950**, because the trough is not at the group **102**; **9524**, because the relay **952** is at rest, and **9533**, because the relay **953** has been engaged but not disengaged again.

The supply arrangement (FIG. **24**) is thus displaced in the direction of the group **102**, because the following contacts are closed: **9135** of the relay **913**, **8131** of the switch **813** (the trough is not at the group **103**), the switch **869** and finally **8111**; the winding **621** of the distributor **620** is thus energized.

This forward movement continues until the trough comes in front of the group **102**. Actually, the contact **9505** is then opened and deenergizes the relay **913**, of which the contact **9135** is opened, breaking the current in the winding **621**.

From then on, as already stated, the rotary nose rocks and fills the trough.

As a result, the relay **954** is energized by the closing of the contact **9065** and then is automatically fed on the contacts **9523** and **9543**.

The extraction and the casting of the group **102** then takes place in accordance with the procedure already explained. At the end of casting, the trough is empty; it is then disengaged from the trunnions, the relay **952** is energized and this, through the contact **9523**, deenergizes the relay **954**. As has been explained, the rotary nose then immediately refills the trough.

Referring to FIG. **26**, the relay **932** is energized from the end of the extraction of the group **102**, and the relay **913** is thus energized through the following chain of closed contacts: **9326** of relay **932**; **9343** of relay **934**; engaged by the energization of the relay **932**; **9515** of relay **951**, which is at rest, since the trough is not facing the group **103**; **9544** of relay **954**, which is energized, since with the trough full of metal, the contact **9065** is closed; **9553** of relay **955**, which remains at rest, because the trough is not on any of the groups **101** or **103**; **809**, since the rotary nose is raised.

The supply arrangement is displaced in the same direction as before, because the same winding **621** of the distributor **620** is supplied with voltage through the following chain of closed contacts: **9135** of relay **913**; **8131**, since the trough is still not facing the group **103** and finally **8111**, since the nose is raised.

This displacement is continued until the supply arrangement comes opposite the group **103**, because at this moment, the contact **8131** is opened, shutting off the current in the winding **621**. In addition, the contact **8132** is closed, energizing the relay **951** (FIG. **28**): the contact **9515** is opened, deenergizing the relay **913**.

The pouring spout fills the trough and meanwhile, after extraction, the group **103** is cast, as has already been explained.

On completing the casting, the relay **912** is energized through the following closed contacts: **9514** of relay **951**; **9494** of relay **949**, which remains deenergized, since the trough is not facing the group **101**; **9505** of relay **950**, which is at rest, because the trough is not at the group **102**; **9254** of the relay **952**, which is at rest since the trough is disengaged from the trunnions, and finally **9533** of the relay **953**, which has been energized when the trough moved down again.

The supply arrangement then starts again in the direction opposite to before, by energization of the winding **622** of the distributor **620**; in fact, the following contacts are closed: **9125** of the relay **912**; **8141**, since the trough is not facing the group **101**, and finally **8111**, because the trough is disengaged from the trunnions.

The supply arrangement is stopped opposite the group **102**, because the simultaneous opening of **9544** of the relay **954**, deenergized because the trough is empty, and of **9505** of the relay **950**, energized by the arrival of the trough facing the group **102**, deenergizes the relay **912**, which shuts off the current in the winding **622** of the distributor **620**.

The alternating movement of the supply arrangement between the group **102** and the group **103** is continued until a complete stack has been cast, the last layer arriving from the group **103**. Following this casting operation, the trough is positioned facing the group **102** in order to cause the refilling thereof, but the layer counter **991** energizes the holding relay **960**, resulting in the closure of the supply chain of the relay **912**, this causing the return of the trough to face the group **101** for the recommencement of the complete cycle for the formation of a new stack.

As has already been described in connection with the movements of the carriage, the decounting memory **960** permits the return of the carriage, with completion of the stack, not to the group **102**, but to the group **101** of the pallet ingots. This memory is erased by the raised position switch **829** of the extractors of group **101**, that is to say, with the following extraction. It is also this memory which, by its contact **9063**, gives the rearward movement order to the filled supply arrangement, so that it is positioned in front of the group **101**. It is still this memory, which, duplicated by the auxiliary memory **964**, released at the same time as said memory, brings the feeler member **417** out of operation by the contacts **9605** of relay **960** and **9155** of relay **915**, thus preparing for the discharge of the stack. The relay **915** is in fact energized through the contact **9643** of relay **964**.

The automatic control of the movements in the stacking zone is now set forth.

Each time that the carriage enters the stacking zone, the switch **855** is temporarily actuated, deenergizing the relay **961** and energizing the relay **962**. As a result, the contact **9623** of this relay energizes the relay **930**, which is automatically fed at its contact **9303**, through the contact **9583** (FIG. **26**). As the contact **9304** is opened at this moment, the holding windings of the relays **941** to **943** can no longer be energized (FIG. **27**). The carriage is immobilized.

The carriage, at the moment of stopping by abutment, operates the rod of the distributor **706** and lifts the feeler member **417**, this causing an ascending movement of the movable table. The ingots suspended from the grippers of the carriage are lifted until the feeler member **419** is in its turn lifted, closing the contact **8072** of the switch **807**, this causing the relay **945** to be brought to the working position and setting the carriage in motion towards the casting zone, as has been explained. In leaving the stacking zone, the carriage actuates the contact **831** and, if the discharge arrangement is at its rest position, that is to say, if the contact **832** is closed, the relay **961** (FIG. **29**) is energized and feeds through its contact **9613** (FIG. **24**) the winding **715** of the distributor **714**, which causes the downward movement of the movable table. Simultaneously, the feeler member **417** is again deposited on the layer and, when it reaches its position of equilibrium, it closes the contact **815**, thus energizing the relay **915** which, in its turn, energizes the relay **963** (FIG. **29**), and the combination of the instantaneous contact **9154** on closing and of the time contact **9364** on opening, energizes for a brief instant the winding **681** of the distributor **680**, starting the rotation of the plate. This latter closes the contact **816**, which maintains the supply of the winding **681** until the reopening of the contact **816**, when the plate has turned through 90°.

The movable table is in the stacking position for receiving the following layer.

It is noted that, when the winding **681** is under voltage, the relay **916** is also under voltage, closing its contact **9163** (FIG. **22**); if simultaneously the carriage was in the stacker, the relay **901** would be energized, closing its contact **9013** and in its turn energizing the relay **902**, which would open its contact **9023**, causing the stoppage of the machine (stacking zone safety arrangement).

The automatic control of the discharged mechanism is now explained.

After the last layer has been deposited to form the complete stack, the carriage leaves the stacking zone, as has been explained. However, in addition, the relay **960** is under voltage. The feeler member **417** is in its position of equilibrium. It thus actuates the limit switch **818**, as the relay **961** is itself under voltage, the relay **915** is energized and, by the closing of its contact **9155**, it places the time relay **917** under voltage which, at the end of a given time, closes its contact **9173** and supplies voltage to the winding **721** of the distributor **720**. The feeler member **417** is raised and now gives an order for descent of the movable table. At the same time, as has been explained in connection with the movements in the stacking zone, the movable table turns through 90°.

When the movable table reaches its lower position, the contact **8002** of the switch **800** is closed. As the table is in the discharge axis, the contact **8012** of the switch **801** is also closed. The limit switch contact **818**, which is only sensitive to the reentry of the discharge arrangement, remains closed. The winding **741** of the distributor **740** is energized, retracting the locking arrangement of the stack. This movement causes the closure of the contact **819**, which results in the time relay **9181** being supplied with voltage and this, by the movement of the instantaneous closure contact **9183** and of the opening time contact **9184**, sends a pulse into the winding **697** of the distributor **696**, thus causing the discharge by hydraulic sequence.

When the discharge arrangement reassumes its rest position, it actuates during its passage the switch **818**, which is opened, thus interrupting the current in the winding **741**, and this causes the locking arrangement of the stack to be returned to its position, and then the switch **817** which energizes the winding **681**, thus causing a rotation through 90° of the movable table.

At the same time, the two contacts **816** and **817** are released and the contact **819** is reopened. As the stack is no longer in the discharge axis, the contact **8012** is opened and the discharge procedure cannot recommence.

It is pointed out that if the locking of the stack proves to be useless, its control arrangement can either be omitted or be used for other purposes. For example, for controlling the bringing to the raised position of an inclined roller track at the moment of discharge, with a view to the removal of the discharged stacks.

A discharge safety arrangement results from the energization of the relay **900** if, with the contact **9193** closed, which corresponds to an order for discharge, the movable table does not satisfy the two conditions: lower position—contact **8001** open—and orientation in the discharge axis—**8011** open. If the relay **900** is energized, it breaks the contact **9003**, which results in the complete stoppage of the machine (FIG. **22**).

It will be understood that numerous changes may be made in the construction, arrangement and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. In a machine for the casting and stacking of multiple layers of ingots with multiple ingots per layer, comprising:

a. a casting zone including
   1. a group of ingot molds corresponding to the number of ingots per layer;
   2. means for pouring molten metal into the molds;
   3. means for cooling the ingots, and
   4. means for extraction of the cast ingots from the molds;

b. ingot conveyance means including
   1. a carriage for the ingots;
   2. means for imparting translatory movement to the carriage from the casting zone to a stacking zone;
   3. at least one gripping device capable of gripping the ingots in a row, and
   4. an abutment in the path of the carriage in position to engage the ingots to close the gap between the ingots during movement of the carriage to the stacking zone;

c. ingot stacking means including

1. a support mounted for movement in the vertical direction;
2. a platform mounted on the support for rotational movement about its vertical axis;
3. driving means on the support;
4. an operative connection between said driving means and said platform for rotation of the platform through an angle of about 90° between the deposition of adjacent layers of ingots whereby the ingots in one layer are disposed substantially perpendicularly to the ingots in adjacent layers;
5. actuating means, and
6. an operative connection between said actuating means and support for movement of the support in the vertical direction; and

d. discharge means for removal of the completed stack of ingots from the platform.

2. A machine as claimed in claim 1 in which the means for translatory movement of the ingot carriage from the casting zone to the stacking zone includes a roller track on which the carriage rides.

3. A machine as claimed in claim 1 in which the ingot molds comprise a container having a mold cavity shaped to correspond with the shape of the ingot to be cast, an interior wall surrounding the mold cavity, an exterior wall spaced outwardly from the interior wall to define an enclosed space therebetween and means for circulating a coolant through the enclosed space for cooling the molds.

4. A machine as claimed in claim 3 in which the means for extraction of the cast ingot from the mold comprises at least one opening which extends crosswise of the mold through the bottom side of the mold, a knockout pin received in fitting relationship in the opening to close the opening, and means for actuating the knockout pin between extended and retracted positions to knock out the ingot from the mold during displacement from extracted to extended position and in which the inner surface of the knockout pin is flush with the interior wall of the mold when in retracted position.

5. A machine as claimed in claim 3 in which the interior wall of the mold is of a unitary construction.

6. A machine as claimed in claim 3 in which the interior wall of the mold has fins extending outwardly into the space between the interior wall and the exterior wall.

7. A machine as claimed in claim 3 in which the interior wall is formed of a number of pieces of metal welded together with the beads of the weld extending outwardly as fins from the outer surfaces of the interior wall into the space between the interior wall and the exterior wall.

8. A machine as claimed in claim 4 in which the openings are defined by a casing extending continuously between the interior wall and the exterior wall across the open space therebetween and in which the casing has fins on the outer surface extending into the open space between the walls.

9. A machine as claimed in claim 4 in which the means for displacement of the knockout pins from retracted to extended position comprises a jack which acts on all of the knockout pins of the group of molds.

10. A machine as claimed in claim 1 in which the means for pouring molten metal into the ingot molds comprises a trough, screens subdividing the trough into equal volumes, a pouring spout at the end of each subdivision, means communicating with the trough for the supply of molten metal, an intermediate support on which the trough is carried, a distribution frame, and a horizontal shaft on the frame and means mounting the intermediate support for pivotal movement on the shaft.

11. A machine as claimed in claim 10 in which a trough supporting frame supports the trough and which includes a horizontal shaft about which the frame is pivoted, said shaft being fixed to the intermediate support.

12. A machine as claimed in claim 11 including means for causing the intermediate support to pivot about the shaft on the distributor frame and means for causing the trough supporting frame to pivot about the shaft fixed to the intermediate support, said means comprising jacks including a first jack of the quick-action type and a second jack of the slow-action type.

13. A machine as claimed in claim 10 in which the means for supplying the trough with molten metal comprises a melting furnace having a rotary nose mounted for movement in the vertical direction between a raised position for stopping the flow and a lowered position for enabling flow, and electrical contact means in position to be contacted by the rising level of metal in the trough for controlling the movement of the nose between raised and lowered positions.

14. A machine as claimed in claim 1 in which the means for feeding the ingot molds is mounted at a fixed position with one such means for each group of ingot molds.

15. A machine as claimed in claim 1 which includes means mounting the means for feeding the ingot molds for movement into position to supply several groups of ingot molds.

16. A machine as claimed in claim 1 in which two gripping devices are carried on the ingot conveyance carriage, one of which has fixed claws having lugs for gripping the ingots, said lugs having oblique surfaces for wedging the ingots and another of which has movable jaws capable of gripping the ingots beneath their projections.

17. A machine as claimed in claim 1 in which a single gripping device is carried on the conveyor carriage, said device having fixed jaws with their lateral faces corresponding to the shape of the oblique faces of the ingots and which comprise horizontal protuberances of small dimension on which the projections of the ingots can rest, said gripping device being adapted for conveying the ingots of defined dimensions.

18. A machine as claimed in claim 16 in which the movable jaws of the gripping device are articulated to remain in closed position even when loaded with ingots of maximum weight, a roller on at least one of the movable jaws, a rail mounted on the main frame of the machine, means mounting the rail for movement between a lower position, corresponding to the closed position of the gripping device, and an upper position, corresponding to the open position of the gripping device, said roller being movable into position to engage said rail.

19. A machine as claimed in claim 1 in which the discharge means comprises a jack and a ram.

20. A machine as claimed in claim 1 in which the discharge means comprises a pusher plate conveyor having an upper plate with at least one inclined surface and a stop abutment and a lower plate having at least one inclined plane and an abutment arranged to cooperate with the respective corresponding elements of the upper plate, jack means connected to impart a horizontal translatory movement with respect to the lower plate with corresponding vertical displacement of the upper plate whereby the stack of ingots is lifted responsive to relative sliding movements between the inclined planes, second jack means operatively connected to the conveyor to lift the stack from the movable platform.

21. A machine as claimed in claim 1 which includes a manual control for the actuating means.

22. A machine as claimed in claim 1 in which the control means is a sequential automation arrangement.

23. A machine as claimed in claim 12 which includes a distributor, means connecting the distributor to each of the jacks, the base of the first jack being directly connected to the distributor for movement of the intermediate support with respect to the chassis and a sequential valve shunted by a non-return valve connecting the base of the first jack to the base of the second jack for movement of the trough supporting frame with respect to the movable intermediate support, the rod end of the second jack being directly connected to the distributor and a sequential valve shunted by a return valve connecting the rod end of the second jack to the rod end of the first jack.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,633,652 Dated January 11, 1972

Inventor(s) Jacques Chambran

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

column 3, line 34, change "122" to "112";

column 10, line 8, change "it" to "its";

column 14, line 3, change "plates" to "places";

column 18, line 38, change "7502" to "7501";

column 18, line 58, after "shown" insert "by";

column 20, line 20, change "pressure" to "pressures";

column 21, line 42, correct the spelling of "tenths"

Signed and sealed this 3rd day of October 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334