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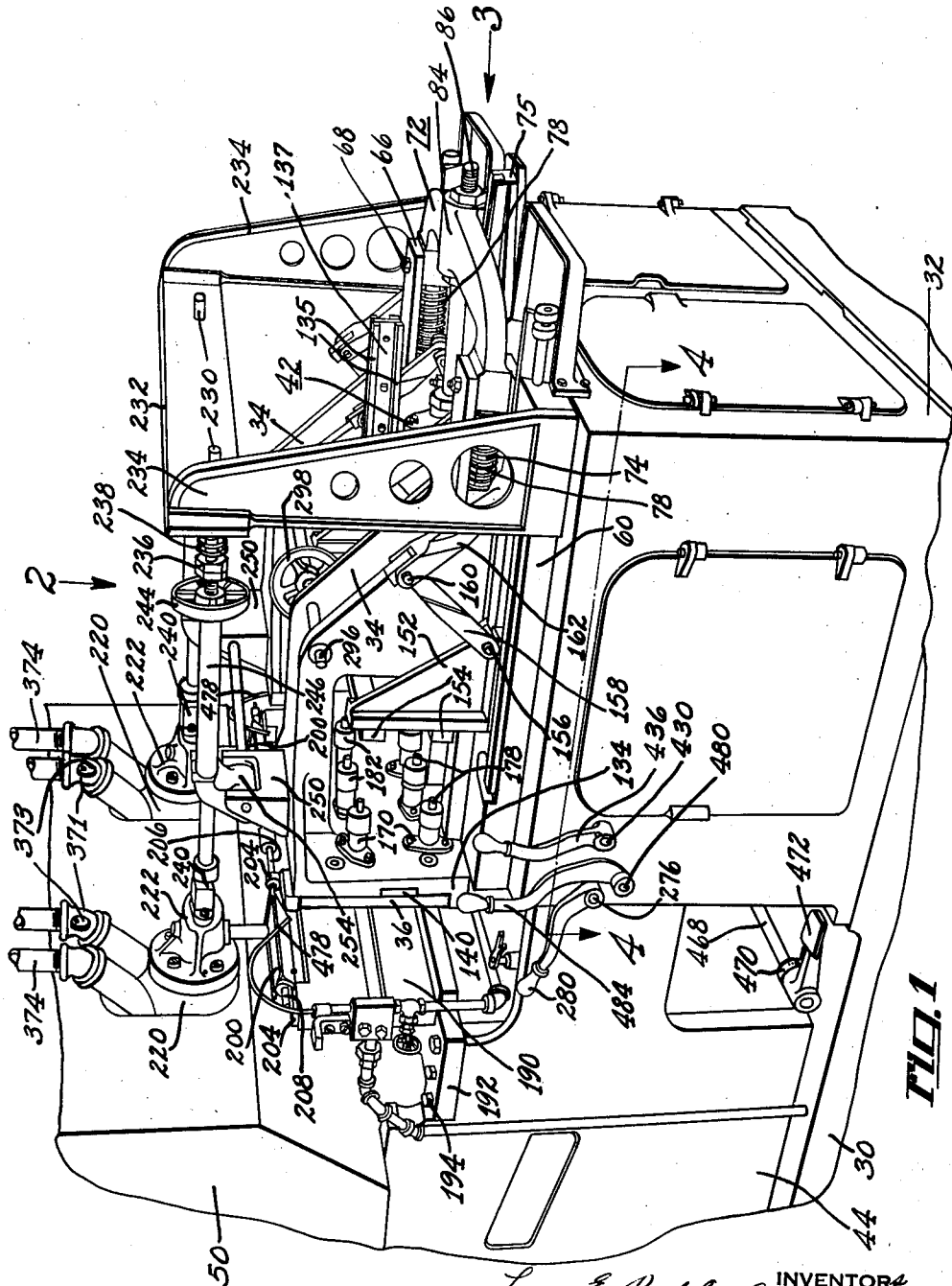
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2,113,033

GRID CASTING MACHINE

Filed May 31, 1934

10 Sheets-Sheet 1



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April 5, 1938.

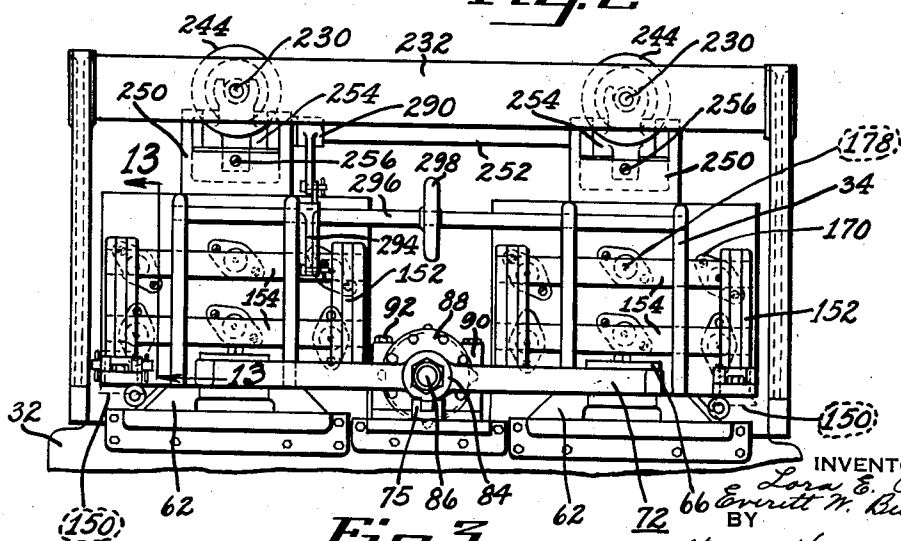
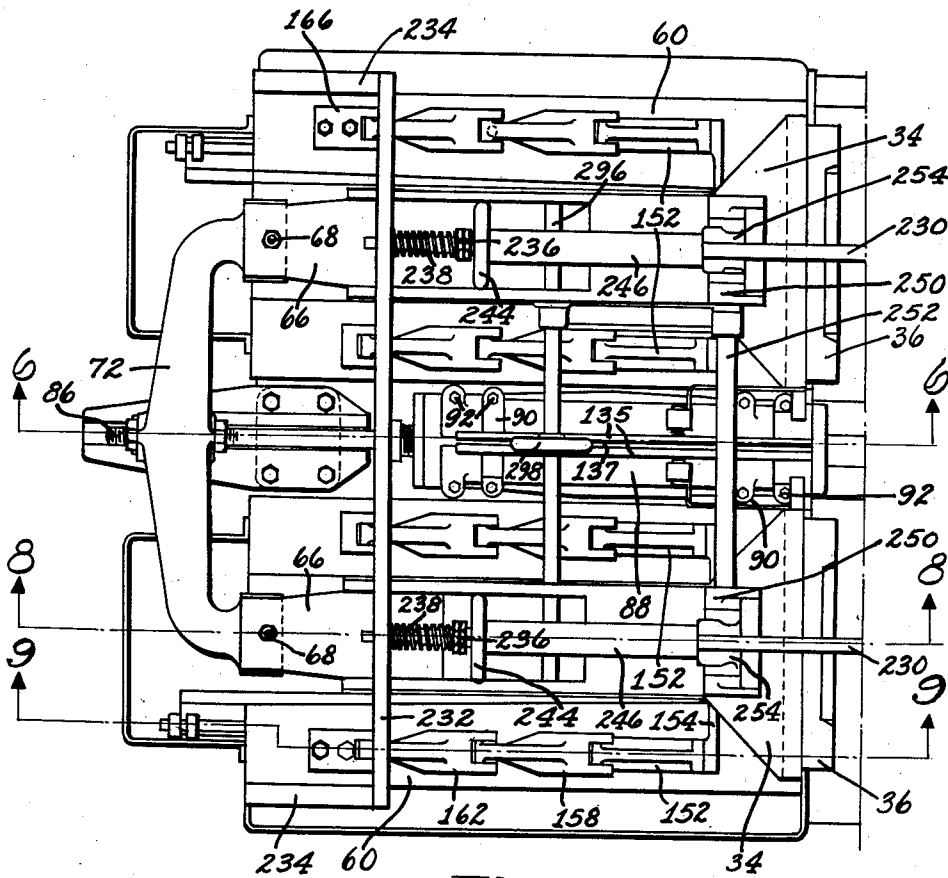
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2,113,033

GRID CASTING MACHINE

Filed May 31, 1934

10 Sheets-Sheet 2

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GRID CASTING MACHINE

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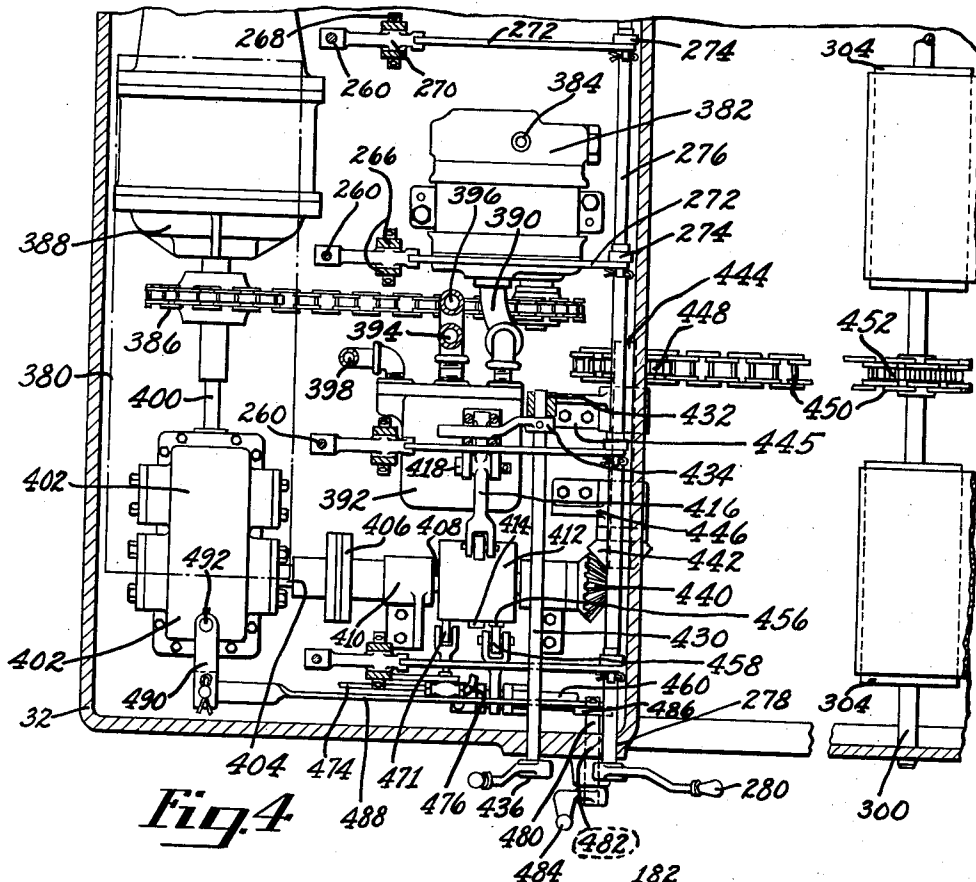


Fig. 4

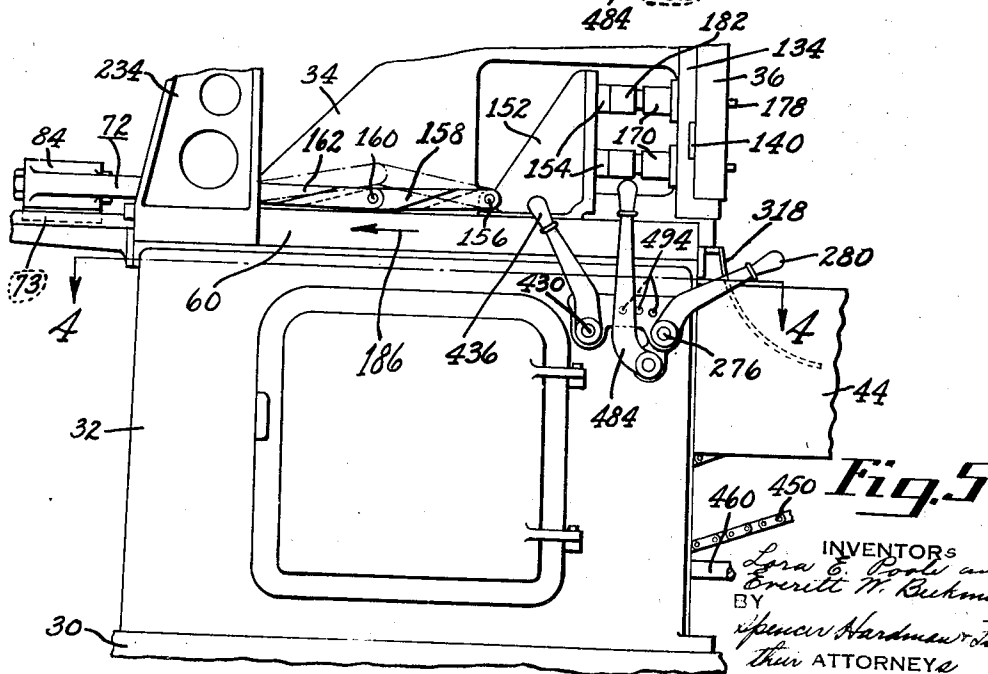


Fig. 5

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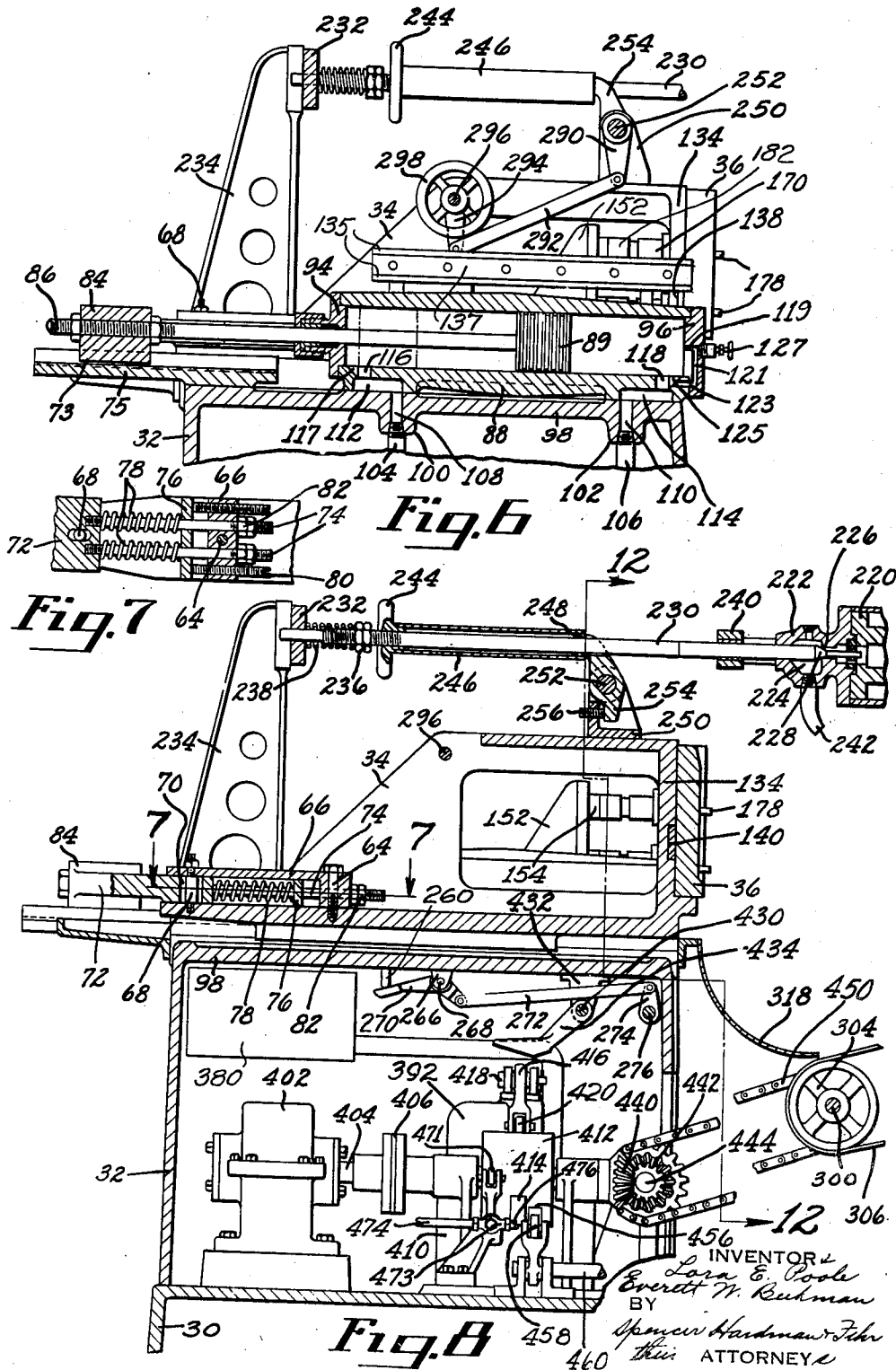
L. E. POOLE ET AL.

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GRID CASTING MACHINE

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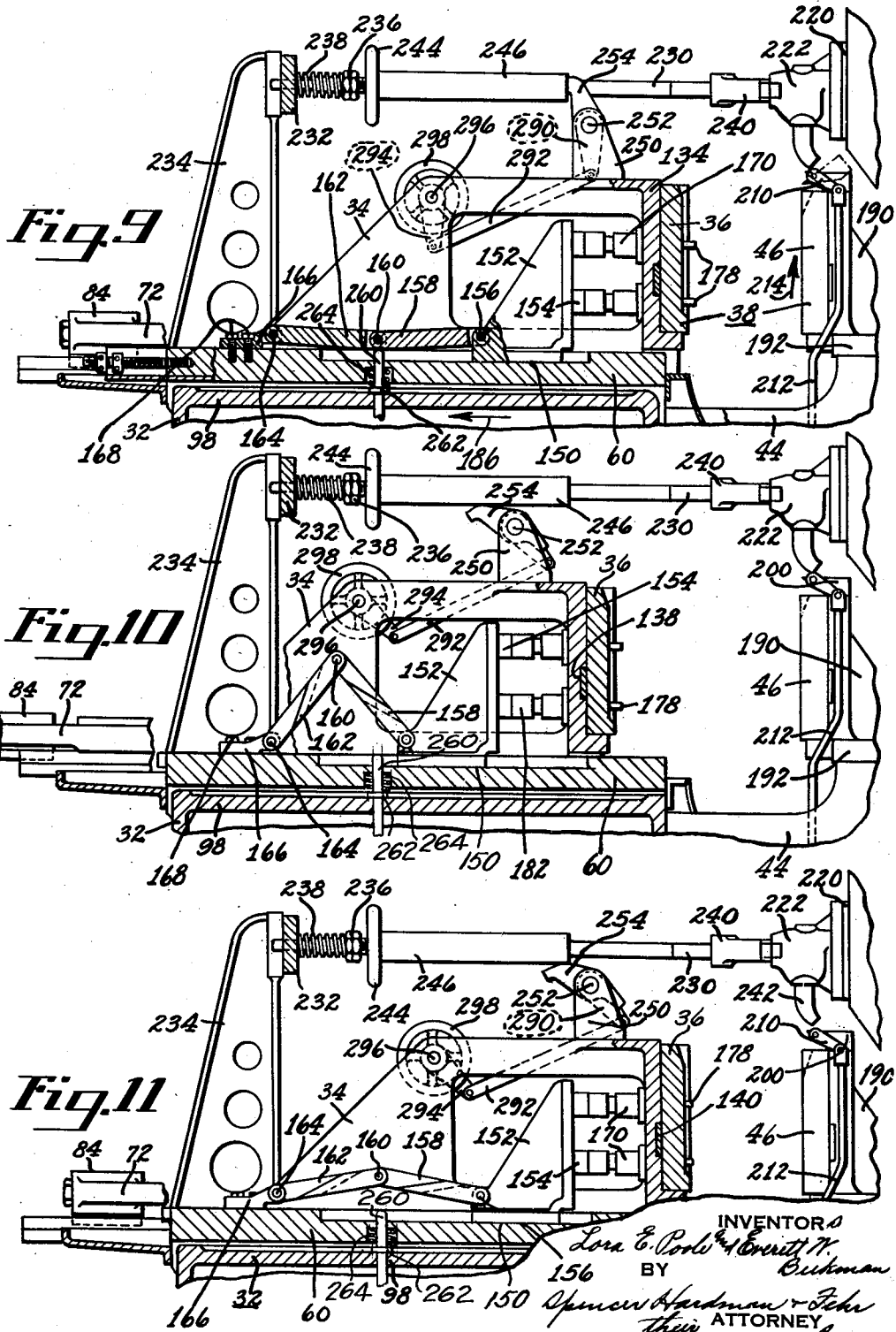
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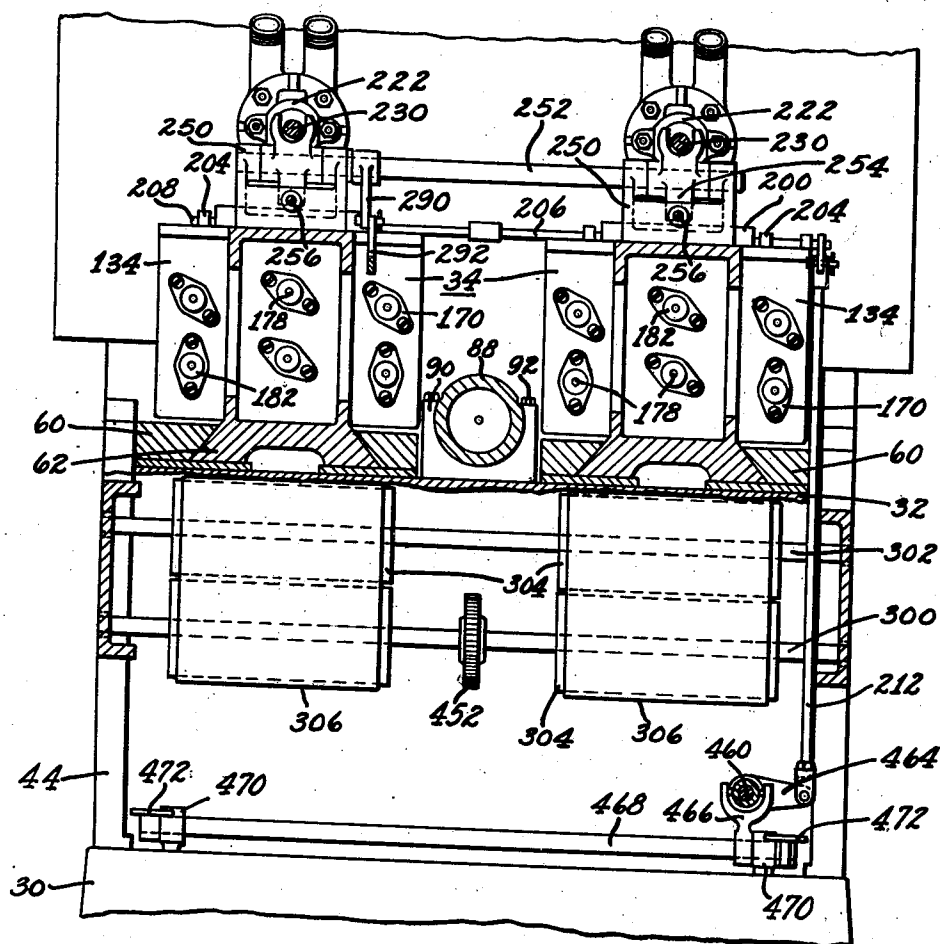


Fig. 12

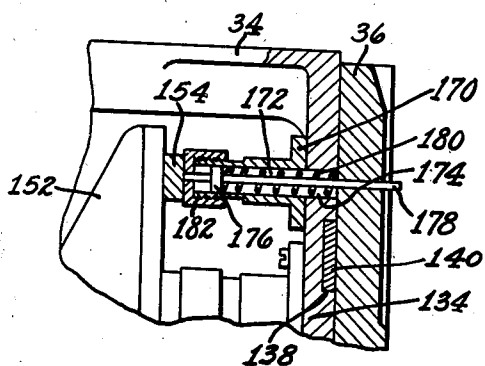


Fig. 13a

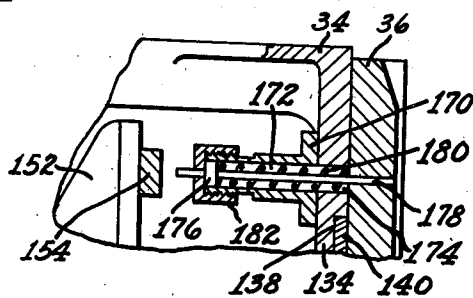


Fig. 13

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GRID CASTING MACHINE

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Filed May 31, 1934

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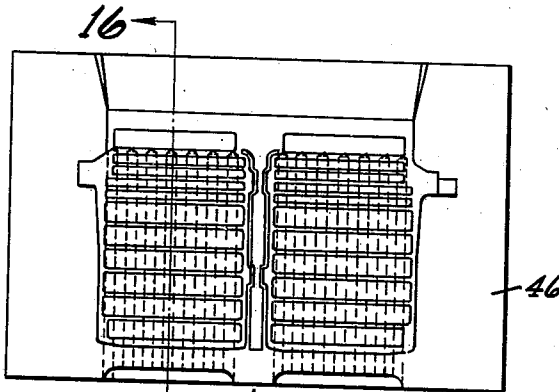


Fig. 14

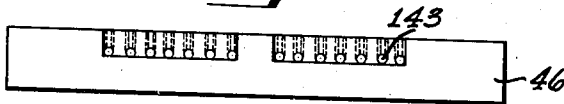


Fig. 15

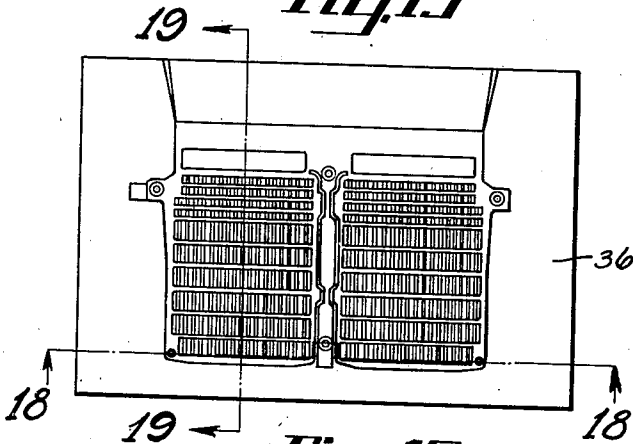


Fig. 17

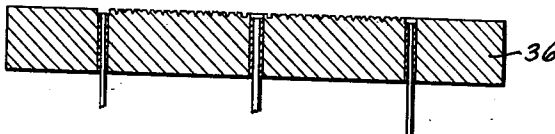


Fig. 18

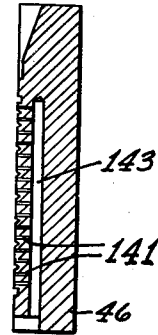


Fig. 16

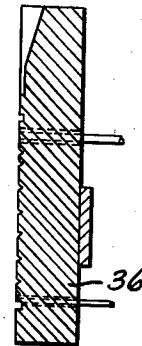


Fig. 19

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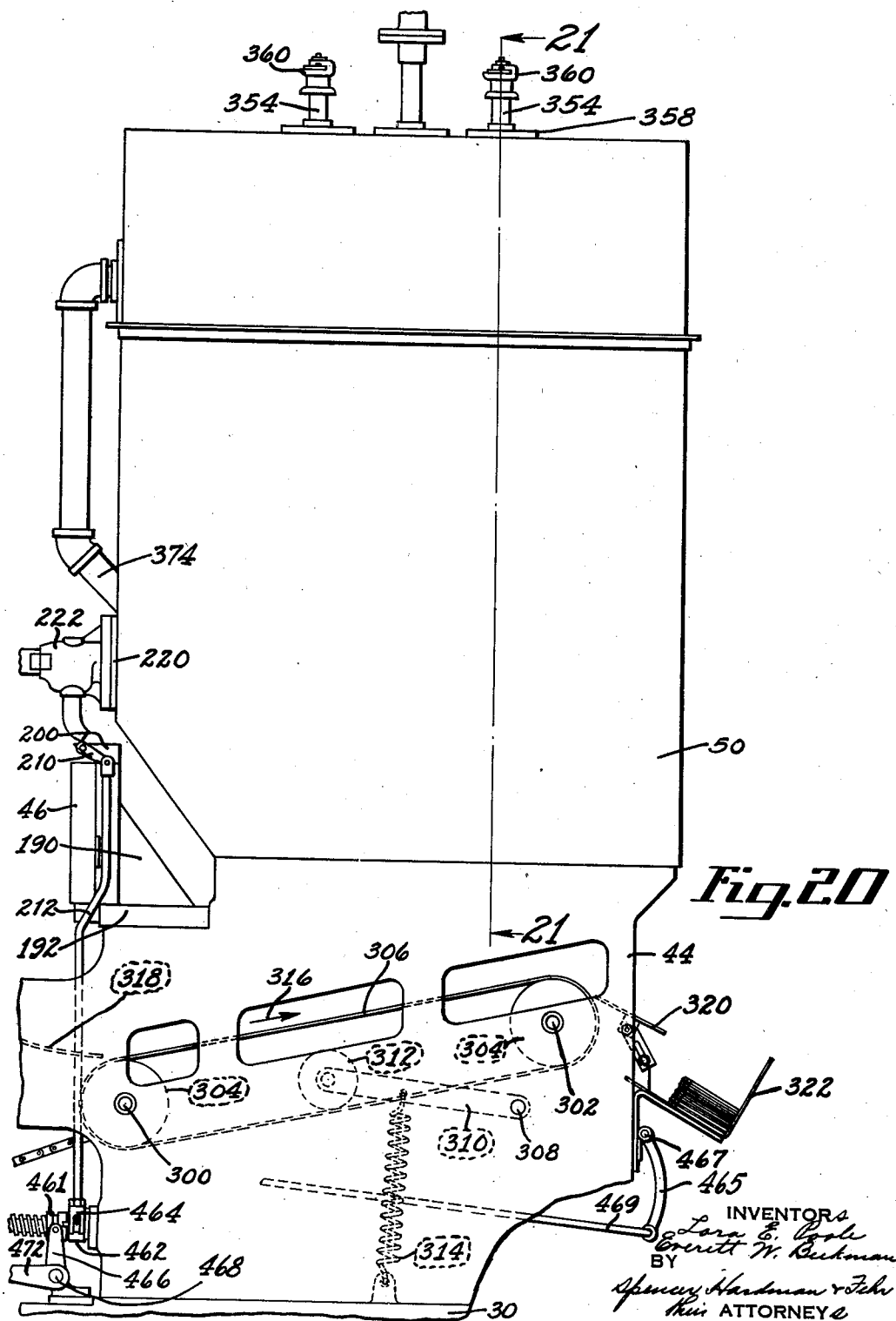
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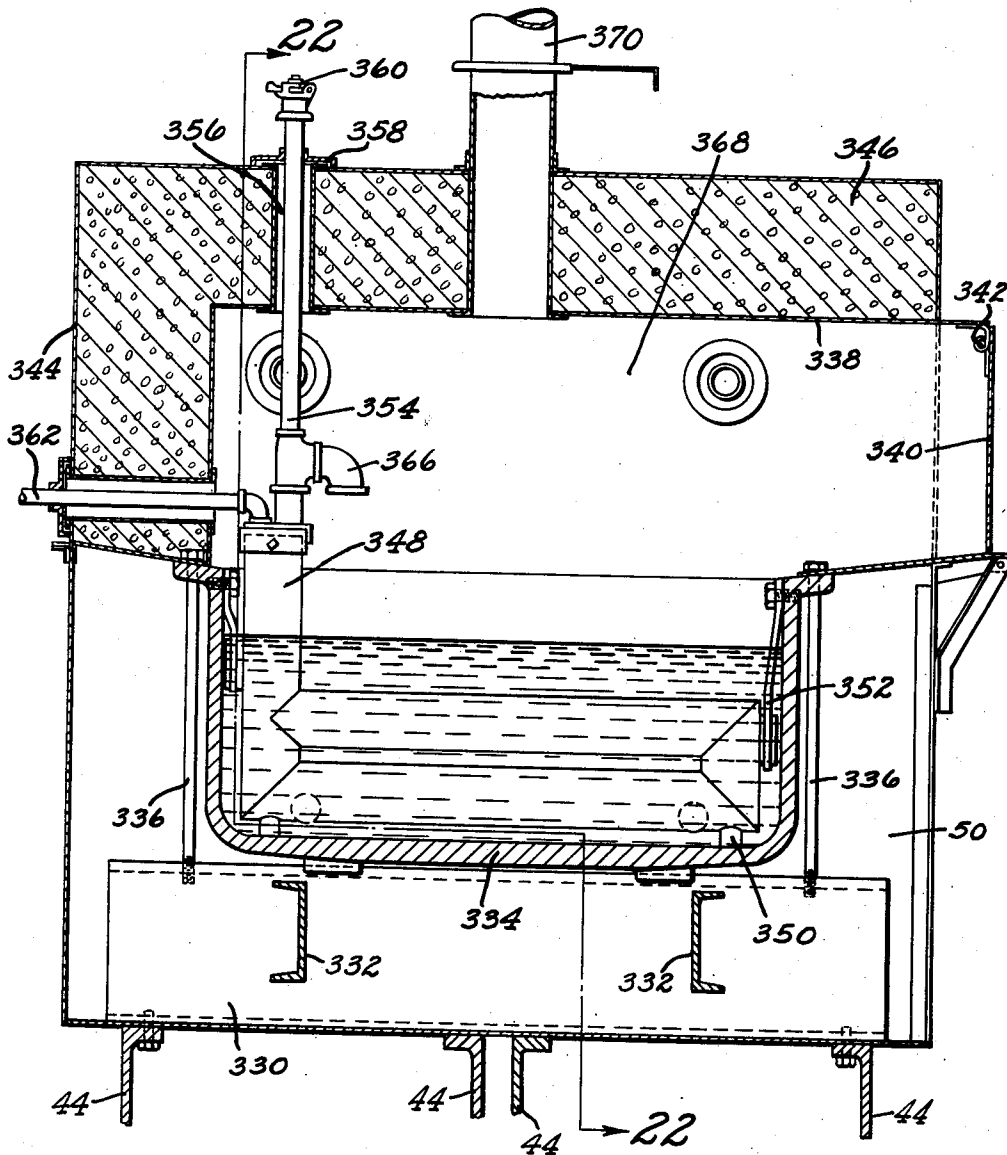


Fig. 21

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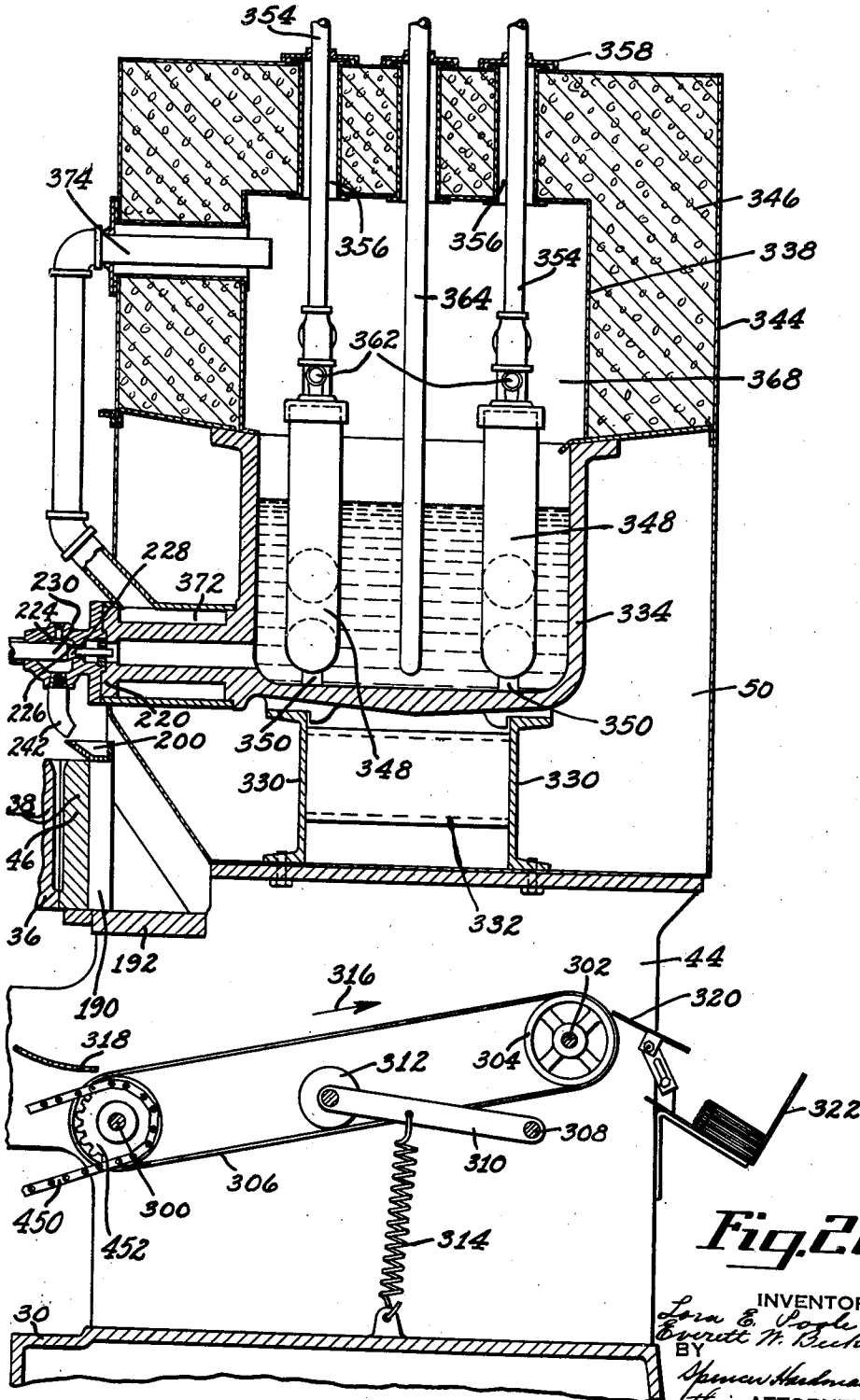


Fig. 22

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UNITED STATES PATENT OFFICE

2,113,033

GRID CASTING MACHINE

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Application May 31, 1934, Serial No. 728,318

20 Claims. (Cl. 22—57)

This invention relates to casting machines and more particularly to machines for casting storage battery grids.

It is the general object of the present invention to provide for automatic and continuous casting of battery grids without any manipulation whatever by an operator whose duty is confined to the supervision of the proper operation of the machine and the inspection of the cast grids which are required to be of a uniform high standard quality.

It is a further object of the present invention automatically to pour a predetermined quantity of casting material at a constant temperature and at a predetermined rate of flow into a mold of the machine.

It is another object of the present invention to cool a mold of the machine before a cast grid is automatically ejected therefrom in order to accelerate the solidification of the cast material without detriment to the mechanical properties of the same.

It is another object of the present invention to provide for a short travel of the reciprocable half of a mold of the machine while the latter is in operation, and for a greater travel of said reciprocable half for the purpose of coating or inspecting the mold.

It is another object of the present invention to provide for random withdrawal of the reciprocable half of a mold from its companion half at any time during the operation of the machine.

It is another object of the present invention automatically to convey the ejected grids from the immediate neighborhood of the mold and stack the same at a place remote therefrom where removal of a stack of grids and inspection of the same by the operator is not aggravated by heat radiating from the mold.

Another important object of the present invention is to provide a machine having a plurality of pairs of cooperating mold halves, a common means for operating the movable mold halves, a common means for operating all of the charge pouring ladles, a common driving means for the grid removing conveyors, etc.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a fragmentary perspective view of a machine embodying the present invention.

Fig. 2 is a top view of a part of the machine as viewed in the direction of arrow 2 in Fig. 1.

Fig. 3 is a fragmentary front elevation as viewed in the direction of arrow 3 in Fig. 1, and showing the movable mold halves and the common operating means.

Fig. 4 is a fragmentary section taken substantially on the line 4—4 of Figs. 1 and 5.

Fig. 5 is a fragmentary side elevation of the machine looking, however, at the machine from the side opposite the one from which Fig. 1 is viewed.

Fig. 6 is a fragmentary section taken on the line 6—6 of Fig. 2.

Fig. 7 is a fragmentary section through a detail of the common mold operating means and is taken on the line 7—7 of Fig. 8.

Figs. 8 and 9 are fragmentary sections taken on the lines 8—8 and 9—9, respectively, of Fig. 2.

Figs. 10 and 11 are sections similar to Fig. 9, showing, however, certain elements of the machine in different positions of operation.

Fig. 12 is a fragmentary section taken substantially on the line 12—12 of Fig. 8.

Fig. 13 is an enlarged fragmentary section through a movable mold half and its attached ejecting device, and is taken on the line 13—13 of Fig. 3.

Fig. 13a is a section similar to Fig. 13, showing however, certain elements in a different position of operation.

Fig. 14 is a front elevation of a stationary mold half.

Fig. 15 is a bottom view of said stationary mold half looking in the direction of arrow 15 in Fig. 14.

Fig. 16 is a section through the same mold half and is taken on the line 16—16 of Fig. 14.

Fig. 17 is a front elevation of a movable mold half.

Figs. 18 and 19 are sections through said movable mold half and are taken on the lines 18—18 and 19—19, respectively, of Fig. 17.

Fig. 20 is a side elevation of a part of the machine and is complementary to Fig. 5.

Fig. 21 is a fragmentary section through the melting furnace and is taken substantially on the line 21—21 of Fig. 20.

Fig. 22 is a fragmentary section taken on the line 22—22 of Fig. 21, and shows besides the furnace a grid conveyor.

Referring to the drawings, a machine base supports a casing on top of which are movably supported two brackets, carrying two halves of two identical molds of the machine and

a common operating device 42 for said molds. Controlling devices for the entire machine are located within the casing. Two pairs of parallel spaced frames 44 are also mounted on base 30 and carry stationary mold halves 46 which are in proper alignment with their movable companion halves 36. Intermediate each pair of frames 44 there is located a grid conveyor, and all the frames 44 support a melting furnace 50.

Reciprocation of movable mold halves

Referring more particularly to Figs. 1, 2, 3, and 12, the casing 32 is provided with two pairs of gib plates 60 each pair of which provides a swallow-tail guide, receiving the correspondingly shaped bottom 62 of the movable mold halves 36. Secured by screws 64 to each bracket 34 is an angle shaped member 66 which is connected to a cross-arm 72 by means of a screw 68, attached to the bracket 34 and member 66 and extending through an oblong slot 70 of said cross-arm. Threaded into each end of cross-arm 72 are two bolts 74 which extend through a retainer plate 76 and a member 66. Compression springs 78 are interposed between each end of the cross-arm 72 and a retainer plate 76 and surround the bolts 74. Adjusting screws 80 which are threadedly received by each member 66 provided for adjustment of the spring retainer plates 76 and thereby adjustment of the compression of the springs 78. Nuts 82, threaded over the bolts 74, provide for any desired limitation of movement of cross-arm 72 relative to the brackets 34 as can be readily understood especially from Fig. 7. The cross-arm 72 is provided with a head 84 to which is attached in any suitable manner a rod 86 of a double acting piston 89, received by a cylinder 88 which as best shown in Figs. 2 and 6 is provided with a plurality of depending lugs 90 through which extend screws 92, threadedly received by the top wall 98 of the casing 32, thus securing the cylinder 88 to said casing. Any conventional type stuffing box 94 permits the passage of piston rod 86 from the interior of the cylinder and prevents leakage of operating fluid from said cylinder along the piston rod. In case one of the molds should close slightly before the other mold the latter will also close irrespective of the earlier closing of said one mold due to the possibility of relative movement between cross-arm 72 and each bracket 34 as explained. In order to prevent bending of the piston rod 86 should one mold close prior to the other, the cross-arm 72 is guided at 73 in a guide bracket 75 which is mounted in any suitable manner on top of the casing 32. The top wall 98 of the casing 32 is provided with two spaced bosses 100 and 102, having ducts 108 and 110, threadedly receiving tubes 104, and 106, respectively, which are adapted to conduct fluid under pressure from a suitable source through said ducts 108 and 110 into chambers 112 and 114 and then through ducts 116 and 118 of cylinder 88 to either side of the piston 89 therein. It follows from the foregoing that admission of fluid pressure to the cylinder 88 results in reciprocation of the brackets 34 in their respective guides and hence in reciprocation of the movable mold halves 36. The identical reciprocable mold halves 36, one of which is shown in detail in Figs. 17 to 19 inclusive, are attached in any suitable manner to the front walls 134 of the brackets 34. These front walls 134 are provided with transverse grooves 138 in which are located immediately behind the mold halves 36 electrical heating

elements 140 of any conventional type which are adapted to maintain these mold halves at a substantially constant temperature. Current is conducted to these heating elements through contact strips 135, insulatively mounted on a bar 137 which in turn is mounted in any suitable manner on top of cylinder 88, the heating elements being provided with sliding contacts which yieldingly engage the contact strips 135.

Referring more particularly to Figs. 1, 2, 3, and 9, each gib plate 60 is provided with a swallow-tail groove 150 in which is received for lineal movement parallel to the direction of movement of the brackets 34 an upright 152, each pair of which is tied together by two parallel spaced bars 154. Pivotally mounted at 156 on each upright 152 is a link 158, pivotally connected at 160 to another link 162 which in turn is pivoted at 164 to a block 166, secured to a gib plate 60 by screws 168. Normally each pair of connected links 158, 162 is resting with its pivot connection 160 on top of a gib plate 60, thus preventing movement of the uprights 152 toward the left as viewed in Fig. 9. As best shown in Figs. 12 and 13, the front wall 134 of each movable bracket 34 supports a plurality of flanged shells 170, the opening 172 of each being in alignment with a hole 174 in said front wall and receiving the collar 176 of an ejector pin 178 and a compression spring 180 which surrounds said ejector pin and urges the collar 176 thereof into engagement with a cap 182, threadedly received by said shell 170. In the position of each ejector pin 178, shown in Fig. 13, one end thereof is flush with the mold cavity and the other end extends beyond the cap 182 and the two horizontal rows of extending ejectors pin ends of both brackets 34 are in alignment with the horizontal bars 154 of the uprights 152 as appears best from Fig. 3. During withdrawal of the mold halves 36 and brackets 34 into the position shown in Figs. 9 and 13a, the projecting ejector pin ends strike against the horizontal bars 154 of the uprights 152 and the brackets 34 with their mold halves then keep on moving a short distance relative to the ejector pins 178 which are thereby caused to project into the cavities of the mold halves 36 and eject cast grids therefrom. The brackets 34 withdraw until the caps 182 of the shells 170 move into engagement with the bars 154 of the uprights 152 as shown in Fig. 13a, due to the fact that the piston 89 has not nearly moved to the left-hand end of cylinder 88 as viewed in Fig. 6 at the time the caps 182 engage the bars 154. Although the cavities of the movable as well as the stationary mold halves are identical in every detail still the cast grids almost invariably stick to the movable mold halves due to the fact that molten metal slightly enters the unavoidable clearance between the ejector pins and the movable mold halves. The ejector pins may nevertheless be accurately fitted in their respective holes in the movable mold halves, the mere indication of clearance being sufficient to leave raised annular marks on the grids where metal sought to escape along the ejector pins. These marks, though always present, are hardly noticeable and therefore, do not require removal by grinding or otherwise. Normal retraction of the movable mold halves 36 from their stationary companion halves 46 (during normal operation of the machine) is determined by the position of the uprights 152 shown in Fig. 9, in which the links 158, 162 do not permit further movement of these uprights in the direction of arrow 186. 75

It appears further from the foregoing that the ejection of grids from the movable mold halves 36 takes place in response to engagement of the projecting ejector pin ends with the bars 154 on the uprights 152.

The identical stationary mold halves 46, one of which is shown in detail in Figs. 14 to 16 inclusive, are attached in any suitable manner to two brackets 190 which in turn are mounted on a plate 192, secured to the frames 44 by a plurality of screws 194. Located in lateral grooves of the brackets 190 and immediately behind the stationary mold halves 46 are the same type electrical heating elements 140 as applied to the movable mold halves 36. The small openings 141 leading from the cavities of the stationary molds 46 to a plurality of transverse bores 143 (see Figs. 15 and 16) permit air to escape from the cavities but no metal.

Pouring of casting material

Referring more particularly to Figs. 1, 9, and 12, two ladles 200 are pivotally supported on brackets 204 which are mounted on top of the stationary brackets 190. These ladles, when tipped into the dot-dash position shown in Fig. 9, pour casting material directly into the pouring basins of both molds which are formed by two aligned wedge shaped grooves of each pair of cooperating mold halves, communicating with the mold cavities thereof. The two ladles 200 are tipped in unison by a connecting rod 206 which is journaled in the two inner brackets 204, whereas short stubs 208, extending from the outer ends of the ladles, are journaled in the outer brackets 204. As best shown in Figs. 9 and 12, a lever 210 is secured to one of the stubs 208 and pivotally connected to a vertically reciprocable link 212 which is operated by mechanism to be described later. It is obvious from the foregoing that upward motion of the link 212 in the direction of arrow 214 in Fig. 9 causes simultaneous tipping of both ladles from the full line position into the dot-and-dash position and consequently in a pouring of the casting material therein into the pouring basins which direct the charge into the cavities of both molds.

Projecting from the furnace, to be described later in detail, are two hollow bosses 220 which form part of a melting pot to be described later. Mounted in any suitable manner on these hollow bosses 220 are two discharge valves 222 as best shown in Figs. 1, 8, and 9. Each of these valves 222 is provided with a chamber 224 and a valve seat 226 against which bears the frusto-conical surface 228 of one end of a long rod 230 which extends through said valve, the opposite end of said rod being slidably supported by a horizontal bar 232, mounted on two pedestals 234 which in turn are mounted in any suitable manner on two of the gib plates 60. The rods 230 are partially threaded and receive nuts 236 for adjustment of the compression of springs 238 which maintain the frusto-conical surfaces 228 of said rods in engagement with the valve seats 226 of the valves 222. Suitable bearing brackets 240 are secured in any suitable manner to the valves 222 and slidably support the ends of rods 230 which are adjacent said valves. A discharge tube 242 is received by each valve 222 and is in communication with the chambers 224 thereof. Also received by the threaded portion of each rod 230 is a hand wheel 244 to which is attached a tube 246, the free end of which is journaled on the rod 230 by a spacer 248. Mounted on top of the bracket 34

are smaller brackets 250 each of which pivotally supports at 252 an element 254, one end of which is forked and straddles a rod 230, and the other end is engaged by an adjusting screw 256, threaded into a bracket 250. Toward the end of withdrawal of the movable brackets 34 in the direction of arrow 186 in Fig. 9, the forked ends of the elements 254 will engage the tubes 246 and through intermediation of the hand wheels 244 slightly withdraw the rods 230 thus permitting casting material to flow from the hollow bosses 220 of the melting pot past the valve seats 226 into the valve chambers 224 and through the discharge tubes 242 into the ladles 200. It may be stated in advance that the movable brackets 34 immediately reverse in most retracted position (see Fig. 9) so that the elements 254 immediately recede from the tubes 246 when they reach the position in Fig. 9, whereupon the frusto-conical surfaces 228 of the rods 230 are again urged against their valve seats 226 by means of the compression spring 238. It is, therefore, obvious that any desired quantity of casting material may be automatically discharged into the ladles 200 by adjusting the hand wheels 244 on the rods 230.

Extra travel of movable mold halves

In case it is desired to inspect or coat the molds, the normal maximum separation between cooperating mold halves would impair such task. Whereas inspection of the molds is infrequent, the same must, however been frequently coated preferably with sodium-silicate or like substance. Such a coat not only prevents the solidifying metal from baking to the mold cavity, but also adds to an unhindered flow of the molten metal through the cavity. Therefore, the brackets 34 may be moved from the normal retracted position in Fig. 9 to that shown in either of Figs. 10 or 11 by means to be described presently. As earlier stated, the uprights 152 with the horizontal bars 154 prevent further withdrawal of the brackets 34 beyond the position shown in Fig. 9. Therefore, in order to retract the brackets 34 beyond that position, it will be necessary first to retract the obstructing uprights 152 with their bars 154. This is accomplished by a plurality of spring urged plungers 260, each one of which is in alignment with the pivot connection 160 of each pair of links 158, 162 and movable in aligned holes of each gib plate 60 and the top wall 98 of the casing 32. Each one of these plungers, which is provided with a collar 262, normally urged against the top wall 98 of the casing 32 by a compression spring 264, projects into the interior of the casing 32 as clearly shown in Figs. 8 and 9. Suspended from the top wall 98 of the casing 32 are a plurality of lugs 266, pivotally supporting at 268 levers 270, one end of each being connected by a link 272 with a crank arm 274, mounted on a horizontal shaft 276, which is journaled in two parallel sides of the casing 32 as at 278 (see Fig. 4). The free end of each lever 270 is in alignment with a plunger 260. That end of shaft 276 which extends beyond the casing 32 is provided with a handle 280 which, when rocked by an operator counter-clockwise as viewed in Fig. 5, causes all plungers 260 to be raised against the tendency of the compression springs 264 to such an extent that all pairs of connected links 158, 162 are first moved into and then beyond dead center and into the dot-and-dash position shown in Fig. 5. While the plungers 260 hold all pairs of connected links 158,

162 in the dot-and-dash position, fluid pressure is admitted to the right-hand side of cylinder 88 as viewed in Fig. 6 so that during withdrawal of the brackets 34 in the direction of arrow 186, the caps 182 of the shells 170 engage the bars 154 of the uprights 152 in the position shown in Fig. 5 and drag the latter along whereby the pairs of connected links 158, 162 are caused to collapse as shown in Figs. 10 and 11. The brackets 34 and the uprights 152 are stopped in the extreme position shown in Fig. 10 when the piston 89 moves into engagement with the cylinder cover 94 as shown in dot-and-dash lines in Fig. 6. In order to return the brackets 34 and attached mold halves to the normal operating region by fluid pressure, the entrance duct 116 at the left-hand side of cylinder 88 (see Fig. 6) communicates with a channel 117 which, when fluid pressure is admitted, directs the same into the small space between cylinder cover 94 and piston 89 whereupon the piston moves toward the right as viewed in Fig. 6. The other cylinder cover 96 is provided with communicating ducts 119, 121, and 123, the latter being in communication with a duct 125 which leads to the entrance duct 118 of the cylinder. Any conventional needle valve 127 is received by cylinder cover 96 and restricts duct 119 so that the discharge of fluid pressure from the right-hand side of cylinder 88 through ducts 119, 121, 123, 125, 118, chamber 114 and pipe 106 is greatly delayed as compared with a discharge of the same fluid pressure directly through duct 118, chamber 114 and pipe 106, when the piston 89 moves toward the right as viewed in Fig. 6. The needle valve performs its adapted function when the piston 89 during travel toward the right closes duct 118 at which time the movable mold halves are nearly in engagement with their companion mold halves. Further advancement of piston 89 toward the right then takes place at a slow rate dependent upon the adjustment of the needle valve to any desired rate of discharge of fluid pressure between piston 89 and cylinder cover 96. In this manner the rapidly advancing movable mold halves are braked shortly before they engage their respective companion mold halves so that cooperating mold halves do not clash together and instead close slowly.

In order to withdraw the brackets 34 into the extreme end position shown in Fig. 10 it will also be necessary that the elements 254 be removed from cooperation with the tubes 246 on the valve rods 230 as can be readily understood. These elements 254, as explained earlier, are mounted on a horizontal rod 252 which is journaled in the brackets 250. Mounted on this rod 252 is a crank-arm 290 which is connected by a link 292 with another crank-arm 294, mounted on a horizontal shaft 296 which is journaled in the brackets 34 and provided with a hand wheel 298. When the operator desires to withdraw the brackets 34 into the extreme position shown in Fig. 10, he rotates the handwheel 298 counter-clockwise until the elements 254 assume the position shown in Fig. 10 in which they clear the tubes 246. The operator may do so in any position of the brackets 36 other than the one shown in Fig. 9 or close to that position, in which the elements cannot be rotated to clear the tubes 246. Incidentally the weight of the crank-arms 290, 294 and the interconnected link 292 normally urges the same into the position shown in Fig. 6, thereby also normally urging the elements into the position shown in that figure. While the brackets

34 move from the extreme end position shown in Fig. 10 to that shown in Fig. 9, the uprights 152 are caused to follow said brackets due to the tendency of the collapsed links 158, 162 to straighten out and return to the position shown in Fig. 9 by gravity.

Grid conveyors

Referring more particularly to Figs. 20 to 22 inclusive, two shafts 300 and 302 are journaled in the parallel frames 44 and carry pulleys 304 intermediate each pair of frames 44. An endless belt 306 passes over the aligned pulleys intermediate each pair of frames 44. Pivotaly mounted at 308 to the two inner frames 44 are two links 310, one end of each carrying a pulley 312 which is normally yieldingly urged into engagement with a conveyor belt 306 by a tension spring 314, thus sufficiently tightening the conveyor belts 306. The shaft 300 is continuously driven by means to be described later in such manner that the two conveyor belts 306 are continuously traveling in the direction of arrow 316 as viewed in Figs. 20 and 22. As best shown in Figs. 5 and 22, there is provided a curved track 318 in alignment with each conveyor belt 306 the receiving end of these tracks 318 being vertically below the movable mold halves 36 in ejecting position as shown in Fig. 8, and the discharging end of these tracks approaching the belt conveyors 306 substantially parallel to their direction of travel during conveyance. Two simultaneously ejected grids, therefore, descend by gravity upon the curved tracks 318 and are discharged upon the conveyor belts 306, lying flat thereon. Adjacent the end of travel of the conveyor belts 306 in the direction of arrow 316, the four frames 44 adjustably support two inclined guide-off plates 320, adapted to guide the conveyed grids off the belts and into a cradle 322 where they are stacked in the fashion shown in Fig. 22.

Melting furnace

Mounted on the frames 44 are a pair of spaced parallel channels 330 which are connected by two ties 332. These channels 330 support a melting pot 334, a plurality of through-bolts 336 firmly holding said melting pot against its supporting channels 330. A protective cover 338 of sheet metal is mounted in any suitable manner on top of the melting pot 334 and is accessible only through a door 340 which is hinged at 342 to said cover. A second protective cover 344 of sheet metal is spaced from the first mentioned cover 338 and also covers the melting pot itself and its supporting channels 330 as more particularly shown in Figs. 1, 20, and 21. The space 346 between both covers 338 and 344 is packed with any suitable heat insulating material in order to prevent radiation of heat from the melted charge in pot 334 to the outside of the furnace and also to prevent the atmosphere surrounding the furnace, from cooling the melted charge in pot 334. The metal to be melted is introduced into pot 334 through door 340. A plurality of gas burners 348 are provided with pads 350 resting on the bottom of the melting pot 334, the burners 348 being further properly located within the melting pot by a plurality of yielding retainers 352, attached to the melting pot in any suitable manner, and pipes 354 which extend from the burners and pass through cylindrical spaces 356 between the two covers 338 and 344 and through a sealing cover 358 to the outside

of the furnace. Each pipe 354 is provided with a lid 360. Connected to any suitable gas source are intake pipes 362 each of which is connected to a burner 348. Suitable provisions (not shown) provide for manually connecting or disconnecting the intake pipes 362 from the gas source. A conventional thermo-couple 364 actuates any known type automatic temperature controller (not shown) which is adapted consistently to maintain a proper combustion by controlling the quantity of fuel admitted to the burners. Elbows 366 lead the exhaust gas from the burners into the chamber 368 directly above the pot 334. An exhaust stack 370 draws exhaust gas from the burners and poisonous fumes arising from the molten charge from the chamber 368 to a place where discharge into the atmosphere does not endanger the health of working men. Additional burners 371 (see Fig. 1), receiving fuel from the same source as the first mentioned burners heat the hollow bosses 220 in order to keep the molten metal therein at the proper temperature. The exhaust gases pass through the annular chambers 372, surrounding the hollow bosses 220 and escape to the exhaust chamber 368 through a pipe line 374.

Control of machine

Referring more particularly to Fig. 4, there is shown in dot-and-dash lines a tank 380 inside the casing 32 which is more particularly located adjacent the top wall 98 of said casing. This tank contains a supply of liquid, such as oil, for the operation of the piston 89 in cylinder 88. Also mounted in casing 32 is any conventional type liquid pump 382, the low pressure side of which is connected by a pipe 384 with the tank 380. This pump is driven by an electric motor 388 through intermediation of a chain drive 386. The high pressure side of pump 382 is connected by a pipe line 390 with any conventional three-way valve 392 which is in communication with either side of cylinder 88 by pipe lines 394 and 396, respectively. A drain pipe 398 also connects said valve with tank 380. The fast shaft 400 of any conventional two speed reduction gearing 402 is connected in any suitable manner with the shaft of motor 388 and the slow shaft 404 of said reduction gearing is coupled at 406 to a shaft 408 which is journaled in bearing brackets 410 and carries a drum 412, provided with a cam 414 on its periphery. Cooperating with this cam 414 and the periphery of the drum 412 is a cam follower 416 which is pivotally mounted at 418 to the valve 392 and operatively engages the valve stem 420 of the valve 392. A spring (not shown) within the valve 392 urges the valve stem in such direction as to cause the follower 416 yieldingly to move toward the periphery of drum 412. Descent of the cam follower 416 from the cam 414 into engagement with the periphery of drum 412 results in a shifting of the valve stem 420 into such position as to permit the passage of liquid under pressure from the pump 382 and pipe line 390 through the valve and through the pipe line 394, including pipe 104, to the left-hand side of cylinder 88 in Fig. 6, thereby causing movement of the piston 89 therein toward the right and consequently advancement of the movable mold halves 36 toward their stationary companion halves 46. The liquid in the right-hand side of cylinder 88 is forced by the advancing piston 89 to flow through the pipe line 396, including pipe 106, through valve 392 and through the drain pipe 398 into the tank 380. Upon as-

cent of the follower 416 from the periphery of the drum 412 to the top of cam 414 and while riding on top of the latter, the valve stem 420 is shifted into and remains for a certain period in a position in which liquid under pressure is permitted to flow from the pump 382 and high pressure line 390 through the valve 392, through pipe line 396, including pipe 106, and to the right-hand side of the cylinder in Fig. 6, whereas the liquid in the left-hand side of the cylinder is forced by the retracting piston 89 to flow through the pipe line 394, including pipe 104, through the valve 392, through drain pipe 398 to the tank 380. It follows from the foregoing that the reciprocation of the mold halves 36 is entirely automatic and controlled by the cam 414 on the drum 412.

Referring again to Fig. 4, there is shown a shaft 430 which is journaled with one end in the casing 32 and with the other end in a bearing bracket 432. Mounted to this shaft are two levers 434 and 436, the former in alignment with the cam follower 416 and the latter on the outside of casing 32. Manual rocking of lever 436 in counterclockwise direction as viewed in Fig. 5 results in random depression of the valve stem 420 and consequently in a random withdrawal of the movable mold halves 36 from their companion halves 46 at any time during movement of said movable mold halves toward their companion halves 46.

Also mounted on shaft 408 is a bevel gear 440 which is in mesh with another bevel gear 442, mounted on a shaft 444 which is journaled in the bearing bracket 445 and another bracket 446. Mounted on one end of shaft 444 is a sprocket wheel 448 which, through a chain 450, is drivingly connected with another sprocket wheel 452, mounted on the conveyor shaft 300. Thus the grid conveyor is actuated whenever the valve 392 causes and controls reciprocation of the mold halves 36.

Also mounted on drum 412 is another cam 456 which cooperates with a cam follower 458, mounted on a shaft 460 which is journaled in suitable bearing brackets. Splined to one end of shaft 460 is a reciprocable clutch half 461, cooperating with a companion clutch half 462 which is suitably journaled and provided with a crank arm 464, connected to the earlier mentioned ladle tipping link 212. Clutch half 461 is normally yieldingly urged in engagement with the other clutch half and disconnectible from the latter by means of a clutch throw-out 466 which is mounted on a shaft 468, suitably journaled in bearing brackets 470 and provided at each end with a foot pedal 472 for operation of the clutch throw-out 466. It is obvious that every time the cam follower 458 cooperates with the cam 456 on drum 412, the two ladles 200 are tipped and caused to discharge molten metal, previously received from the valves 222, into the pouring basins of the closed molds. Disconnection of the two clutch halves 461, 462 by the operator naturally prevents such tipping of the ladles irrespective of the cooperation between the cam follower 458 and the cam 456. Such random disconnection of the clutch 461, 462 is most important when a grid sticks to a stationary mold half whereupon no ejection of the grid takes place and upon a renewed closing of the molds more molten metal would be automatically poured on top of the non-ejected grid. The operator detecting such a sticking grid may at any time before the automatic tipping of the

ladles step on either foot pedal and prevent the further discharge of metal into the molds until he stops the entire machine. The ladles are of such size that they may hold molten metal for at least 3 grids without overflowing, so that the operator has sufficient time to stop reciprocation of the movable mold halves which causes discharge of metal into the ladles as explained earlier. Since the operator is mostly in the rear of the machine inspecting the grids as they are delivered into the cradle 322, provisions are made whereby the operator may stop the entire machine when he misses a non-delivered grid. This provision consisted of a lever 465 pivotally mounted at 467 to one of the frames 44 and connected to a link 469 which is also connected with a switch controlling the operation of motor 388. If the operator desires to stop the machine, he merely rotates lever 465 counterclockwise as viewed in Fig. 20 whereupon the motor 388 and thereby the entire machine will be stopped.

With particular references to Figs. 1 and 4, the drum 412 is provided with a third cam (not shown) which operates the cam follower 471, adapted to actuate a Powell blow-gun 473, one side of which is connected to any suitable water supply by a pipe line 474, and the other side of which is connected to another pipe line 476 which terminates at 478 directly above the pouring basins formed by the closed mold halves. The Powell blow-gun 473 normally prevents the passage of water from pipe line 474 to the pipe line 476. Cooperation between cam follower 471 and its cam on drum 412 results in opening of the Powell blow-gun 473 for a short period whereupon a certain amount of water is permitted to flow through pipe line 476 and be discharged into the pouring basins of the two molds a predetermined period after casting material has been poured into the mold cavities and before the movable mold halves are separated from their companion halves. The cooling water thus splashed into the pouring basins of the molds not only cools the latter but accelerates the solidification of the grid gates which are of greater mass as the grid itself and consequently would otherwise require a longer period for solidification than the grids themselves. The amount of water discharged has been so selected that the gates solidify during the same period as the grids proper.

Referring again to Fig. 4, a stub shaft 480 is shown journaled at 482 in casing 32 and is provided at one end outside of said casing with a handle 484, and at the other end with a crank arm 486 which, by a link 488, is connected with an arm 490 which is part of the two speed reduction gearing 402. Manual rocking of arm 490 about the pivot axis 492 into registry with either one of the three depressions 494 on the casing 32, results either in complete inoperativeness of the reduction gearing or in transmission of rotation from shaft 400 to shaft 404 at two different angular speeds. More particularly, when handle 484 registers with the extreme left or extreme right depressions 494 as shown in Fig. 5, shaft 404 is rotated at one of two possible speeds, whereas registry of handle 484 with the intermediate depression 494 results in a disengagement of the transmission mechanism of the reduction gearing and consequently in idle rotation of shaft 400.

Résumé of operation

Before the present machine can produce, there

must be a supply of molten metal at the proper temperature in pot 334. The furnace is heated a considerable time prior to the operation of the machine by admitting fuel to the burners and by applying torches to the burners, the torches being introduced to burners 348 through the pipes 354, and to the burner heads 371 by removing the lids 373 thereof. Having obtained the proper charge of molten metal in the melting pot, the machine is ready for operation. The operator connects the electric motor 388 with any suitable source of electric power by manipulating the earlier mentioned control switch (not shown). The cam drum 412, which is provided with three cams the functions of which have been detailedly described earlier, commences to rotate in the proper direction as soon as the motor 388 runs. Assuming that the motor 388 was started when the movable mold halves were in normal retracted position shown in Fig. 9, rotation of the drum 412 will then cause the following operations in the order in which they shall be mentioned. First, the brackets 34 and attached movable mold halves 36 will advance toward the stationary mold halves 46 due to the admittance of fluid pressure to the left-hand side of cylinder 88 as viewed in Fig. 6. Almost immediately after the mold closes, one of the cams on drum 412 causes the ladles 200 to be tipped from the full-line position into the dot-and-dash position shown in Fig. 9, whereupon the molten metal, previously discharged into the ladles, will flow from the latter into the pouring basins of the molds. While the movable mold halves are still in engagement with their companion halves 46, another cam on drum 412 causes discharge of a certain quantity of water into the pouring basins to cool the molds, accelerate solidification of parts of the grids to such an extent that the gates solidify during approximately the same period as the grids proper. A predetermined time after the cooling water was discharged into the pouring basins, fluid pressure is admitted to the right-hand side of cylinder 88 as viewed in Fig. 6 whereupon the brackets 34 and attached movable mold halves 36 retract from the stationary mold halves 46. Shortly before the brackets 34 reach normal retracted position (see Fig. 9), the protruding ejector pin ends strike against the cross bars 154 of the uprights 152 so that the ejector pins, which are normally flush with the cavities of the movable mold halves 36 are caused to enter said cavities and eject the cast grids therefrom while the brackets 34 move relative to the ejector pins into normal retracted position. During the latter part of retraction of the brackets 34, the elements 254, movable with said brackets, withdraw the valve rods 230 from their respective valve seats 226 so that molten metal may flow from the melting pot 334 through the hollow bosses 220, through chamber 224 of valve 222 and through the discharged tubes 242 into the ladles 200. The brackets 234 immediately reverse their direction of movement upon arrival in normal retracted position (see Fig. 9) so that the valve rods 230 may return into engagement with their respective valve seats 226 under spring action as soon as a sufficient amount of molten metal is discharged into the ladles 200. The ejected grids fall upon the curved tracks 318 and are guided thereon upon the conveyor belts 306 which carry the grids to the cradle 322 as explained earlier. The machine operates continuously unless the operation of certain elements thereof is interrupted at random by the operator. Such interruptions

in the operation of certain elements are necessary partly to facilitate the periodic coating of the mold cavities or the occasional inspection of the same, and partly as safeguards against damages to the molds arising from the pouring of molten metal on top of a non-ejected grid which sticks to a stationary mold half.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

We claim:

1. In a casting machine, the combination of cooperating molds, one being movable relative to the other; means for reciprocating the movable mold; a movable stop for restricting the stroke of the movable mold away from the other mold; and collapsible links permitting the stop to be moved into and out of restricting position.

2. In a casting machine, the combination of cooperating molds, one being movable relative to the other; means for reciprocating the movable mold; a stop movable in the direction of movement of the movable mold and adapted to restrict the stroke of the latter away from the other mold; and means including collapsible links permitting the stop to be moved into and out of restricting position and for locking the stop against movement from restricting position.

3. In a casting machine, the combination of a support; cooperating molds, one mold being movable on the support relative to the other mold; means for reciprocating the movable mold; a stop movable on the support in the direction of movement of the movable mold and adapted to restrict the stroke of the latter away from the other mold; and collapsible links connecting said stop with the support, said links normally resting on the support by gravity in slightly collapsed relation to each other thereby locking the stop against movement from restricting position.

4. In a casting machine, the combination of a support; pairs of cooperating molds, one mold of each pair being movable relative to its companion mold; means for simultaneously and yieldingly reciprocating all movable molds; stops movable on the support in the direction of movement of the movable molds and adapted to restrict the strokes of the latter away from their companion molds; collapsible links for each stop connecting the latter with the support, said links normally resting on the support by gravity in slightly collapsed relation to each other thereby locking all stops against movement from restricting position; and means including a single manually operable lever for simultaneously collapsing all links away from the support sufficiently to permit removal of the stops from restricting position by the reciprocating molds.

5. In a casting machine, the combination of cooperating molds, one being movable relative to the other; normally retracted ejector pins carried by the movable mold; yielding means for reciprocating the movable mold through a pre-assigned stroke; and means cooperating with the movable mold for restricting the stroke of the same, said means also actuating the ejector pins and being removable from restricting cooperation with the movable mold whereby the same is moved through said preassigned stroke.

6. In a casting machine, the combination of cooperating molds, one being movable relative to the other; fluid pressure operated means periodically reciprocating the movable mold; a stop

movable in the direction of movement of the movable mold and adapted to restrict the stroke of the latter away from the other mold; means including collapsible links permitting movement of the stop into and out of restricting position and for locking the stop against movement from restricting position; means including a manually operable lever for collapsing all links sufficiently to permit removal of the stop from restricting position by the reciprocating mold; and means including a manually operable lever adjacent the first mentioned lever for causing the fluid pressure operated means to reverse the periodic closing stroke of the movable mold at any cycle thereof.

7. In a casting machine, the combination of cooperating molds, one being movable relative to the other; means periodically opening and closing the molds; manually operable means for causing the mold opening and closing means to reverse the closing stroke of the movable mold at any cycle thereof; a pivotally mounted ladle holding a charge of casting material; means periodically tipping the ladle to pour a charge into the cavity defined by the closed molds; and manually operable means for rendering the tipping means ineffective.

8. In a casting machine, the combination of cooperating molds, one being movable relative to the other; fluid pressure operated means periodically reciprocating the movable mold; a stop movable in the direction of movement of the movable mold and adapted to restrict the stroke of the movable mold away from the other mold; means including collapsible links permitting movement of the stop into and out of restricting position and for locking the stop against movement from restricting position; a pivotally mounted ladle holding a charge of casting material; means periodically tipping the ladle to pour a charge into the cavity defined by the closed molds; means including a manually operable lever for collapsing all links sufficiently to permit removal of the stop from restricting position by the reciprocating mold; means including a manually operable lever for causing the fluid pressure operated means to reverse the closing stroke of the movable mold at any cycle thereof; and means including a foot pedal within reach of the operator when manipulating both levers for rendering the tipping means ineffective.

9. In a casting machine, the combination of pairs of cooperating molds, one mold of each pair being movable relative to its companion mold; a pivotally mounted ladle adjacent each stationary mold adapted to hold a charge of casting material; a single prime mover periodically and simultaneously reciprocating all movable molds; manually operable means for causing said prime mover to reverse the closing stroke of the movable molds at any cycle thereof; means including a single power operated element periodically tipping all ladles simultaneously; and manually operable means for rendering the tipping means inoperative.

10. In a casting machine, the combination of a mold for a flat casting; means for ejecting a casting from the mold; an endless conveyor adapted to receive and convey an ejected casting to a receiving station remote from the mold; means guiding an ejected casting flat upon the conveyor during its gravity descent from the mold; a cradle at the receiving station adapted to receive the conveyed castings; and a bodily adjustable plate above the cradle adapted to guide the castings off

the conveyor at the turning point thereof and into the cradle such that the castings are stacked therein.

11. In a casting machine, the combination of cooperating molds, one being movable relative to the other; fluid pressure operated means for reciprocating the movable mold; means for supplying fluid under pressure; means for controlling the admission of fluid pressure to the fluid pressure operated means; an endless conveyor receiving and conveying an ejected casting away from the molds; and a single prime mover for operating the fluid pressure supplying means and the conveyor.

12. In a casting machine, the combination of cooperating molds, one being movable relative to the other; fluid pressure operated means for reciprocating the movable mold; means for supplying fluid under pressure; a controller for the admission of fluid under pressure to the fluid pressure operated means; rotary means for periodically operating said controller; an endless conveyor receiving and conveying an ejected casting away from the molds; and a single prime mover for operating the fluid pressure supplying means and the conveyor, and for rotating said rotary means.

13. In a casting machine, the combination of cooperating molds, one being movable relative to the other; fluid pressure operated means for reciprocating the movable mold; means for supplying fluid under pressure; a controller for the admission of fluid under pressure to the fluid pressure operated means; rotary means for periodically operating the controller; a pivotally mounted ladle holding a charge of casting material to be poured into the cavity of the closed molds; rotary means for periodically tipping the ladle; an endless conveyor receiving and conveying an ejected casting away from the molds; and a single prime mover for operating the fluid pressure supplying means and the conveyor and for rotating all rotary means.

14. In a casting machine, the combination of cooperating molds; a pivotally mounted ladle holding a charge of casting material to be poured into the cavity of the closed molds; means for opening and closing the molds; means for tipping the ladle; a device for operating the mold opening and closing means and the ladle tipping means periodically in a predetermined sequence; and manually operable means for disabling the ladle tipping means while permitting the periodic operation of the mold opening and closing means.

15. In a casting machine, the combination of cooperating molds; a pivotally mounted ladle holding a charge of casting material to be poured into the cavity of the closed molds; means for opening and closing the molds; means for tipping the ladle; and a device for operating the mold opening and closing means and the ladle tipping means periodically in a predetermined sequence, said device including a normally connected and manually disconnectible clutch for disabling the ladle tipping means while permitting the periodic operation of the mold opening and closing means.

16. In a casting machine, the combination of cooperating molds, one being movable relative to the other; a ladle for pouring a charge of casting material into the closed molds; a container

holding a supply of casting material; a normally closed valve to discharge casting material from the container into the ladle; and means operated by the moving mold for opening the valve.

17. In a casting machine, the combination of cooperating molds, one being movable relative to the other; a ladle for pouring a charge of casting material into the closed molds; a container holding a supply of casting material; a normally closed valve to discharge casting material from the container into the ladle; means operated by the moving mold for opening the valve; and means for disabling the valve opening means.

18. In a casting machine, the combination of cooperating molds, one being movable relative to the other; a ladle for pouring a charge of casting material into the closed molds; a container holding a supply of casting material; a valve to discharge casting material from the container into the ladle, said valve including a valve head which is normally urged against the valve seat to close the valve and provided with a shoulder; and means carried by the movable mold to engage the shoulder and move the valve head away from the valve seat during movement of the movable mold away from the other mold, said means being shiftable out of cooperative alignment with the shoulder to permit opening of the molds without opening the valve.

19. In a casting machine, the combination of cooperating molds, one being movable relative to the other; a ladle for pouring a charge of casting material into the closed molds; a container holding a supply of casting material; a valve to discharge casting material from the container into the ladle, said valve including a valve head which is normally urged against the valve seat to close the valve and provided with a shoulder; a lever pivoted on the movable mold; and an abutment on the movable mold normally engaged by one end of the lever, the other end of the lever engaging the shoulder and moving the valve head away from the valve seat during movement of the movable mold away from the other mold, said lever moving out of engagement with the abutment and out of cooperative alignment with the shoulder upon rotation of the lever in a certain direction, thereby permitting opening of the molds without opening the valve.

20. In a casting machine, the combination of cooperating molds, one being movable relative to the other; a ladle for pouring a charge of casting material into the closed molds; a container holding a supply of casting material; a valve for discharging casting material from the container into the ladle, said valve including a valve head which is normally urged against the valve seat to close the valve; a sleeve threaded on the valve head and providing a shoulder; a lever pivoted to the movable mold; and a set screw on the movable mold and normally engaged by one end of the lever, the other end of the lever engaging the shoulder of the sleeve and moving the valve head away from the valve seat during movement of the movable mold away from the other mold, said lever moving out of cooperative alignment with the set screw and with the shoulder upon rotation of the lever in a certain direction, thereby permitting opening of the molds without opening the valve.

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