July 9, 1957 E. H. RUBOVITZ ET AL 2,798,265

APPARATUS FOR MAKING SHELL MOLDS

Filed Aug. 7, 1952 4 Sheets-Sheet 1

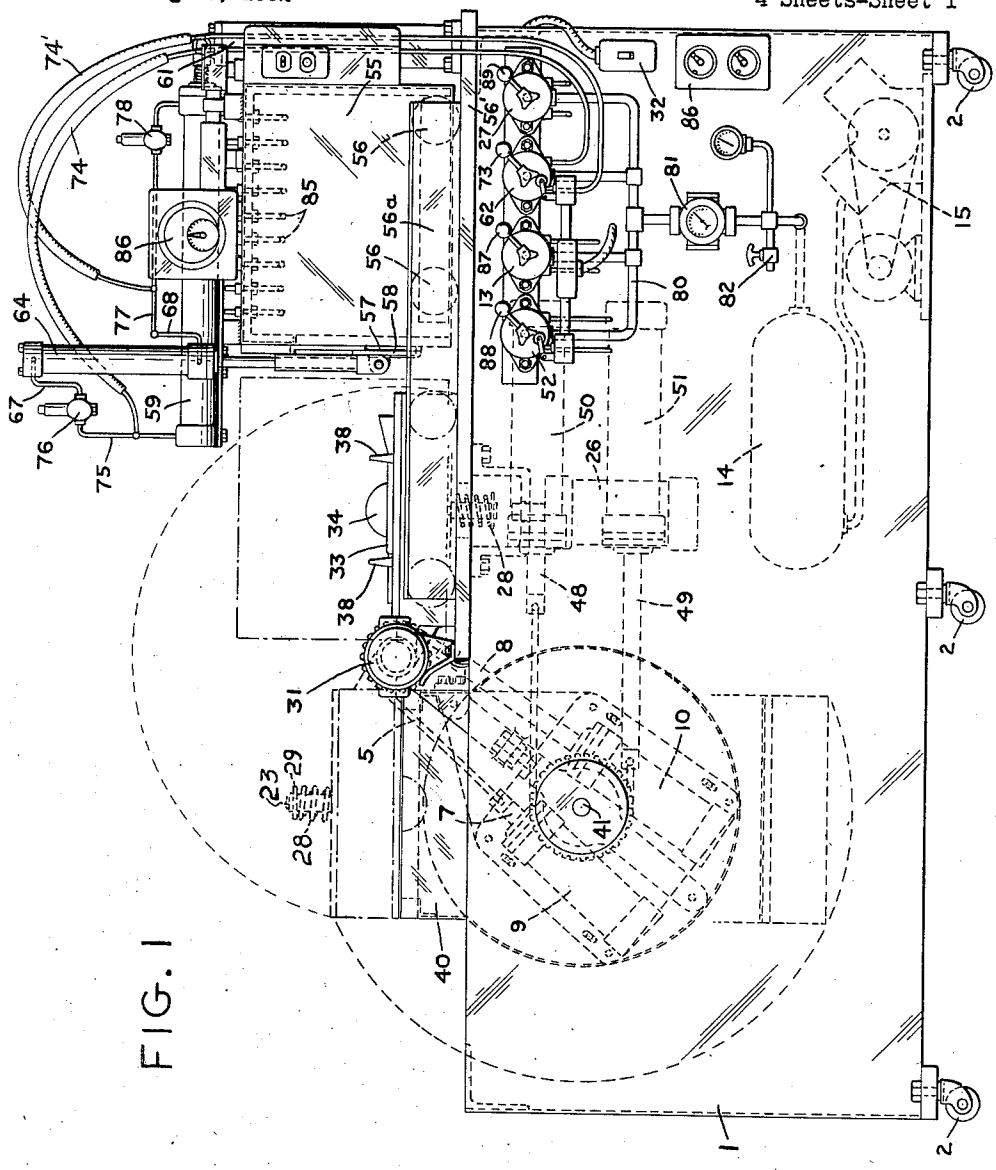


FIG. 1

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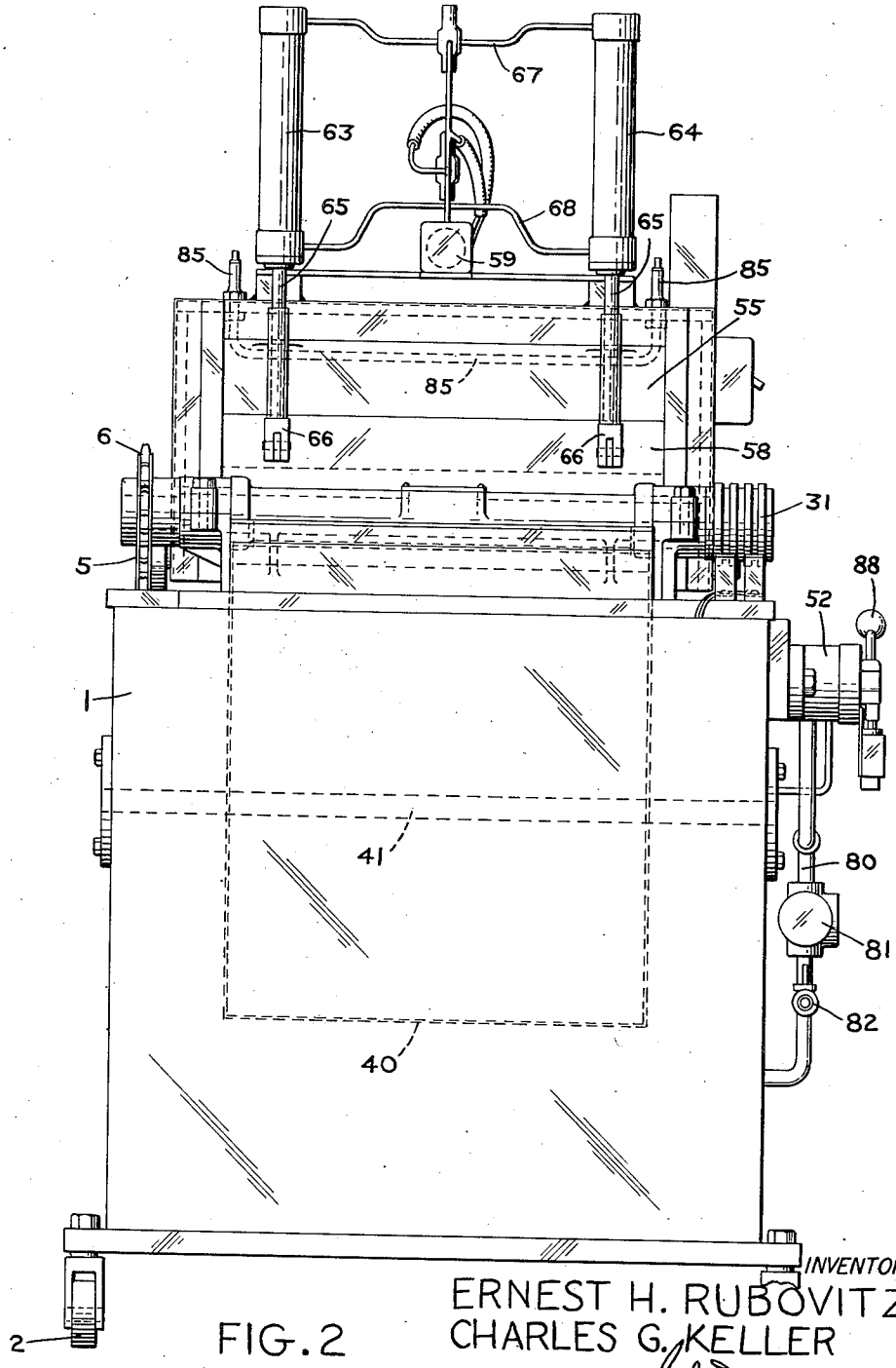


FIG. 2

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APPARATUS FOR MAKING SHELL MOLDS

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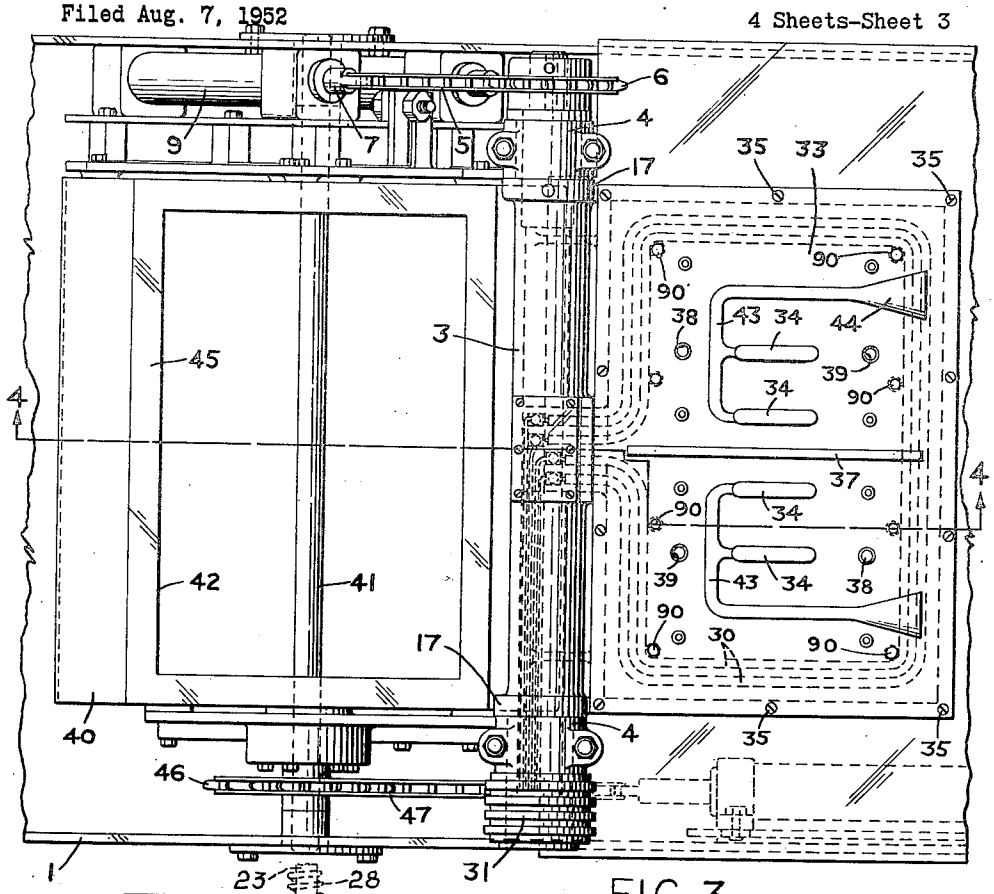


FIG. 3

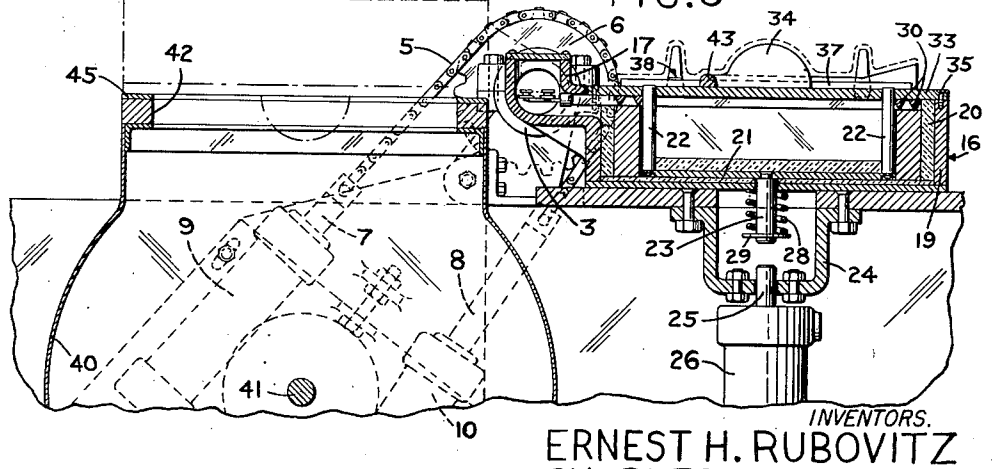


FIG. 4

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APPARATUS FOR MAKING SHELL MOLDS

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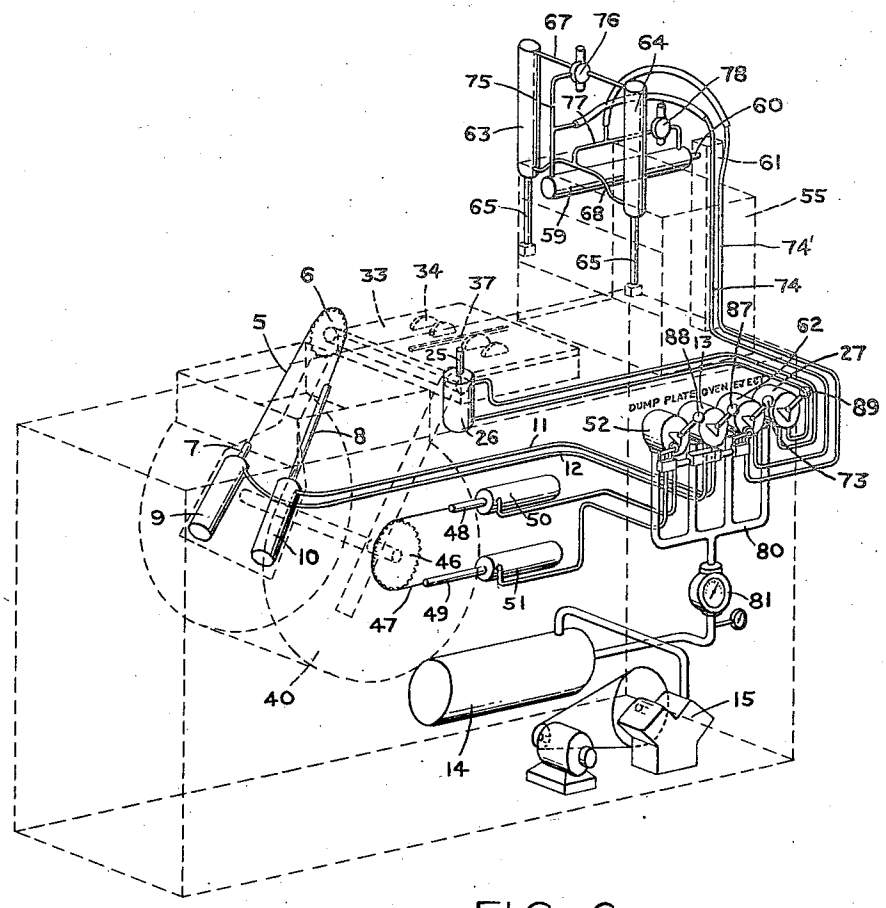


FIG. 6

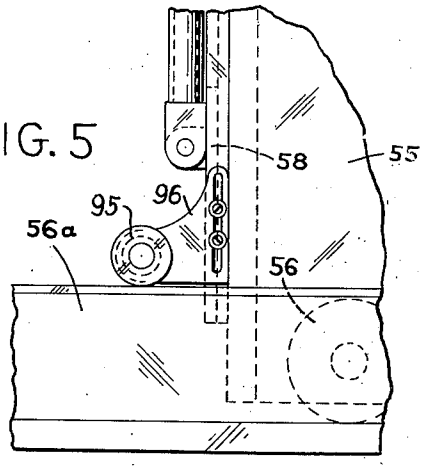


FIG. 5

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APPARATUS FOR MAKING SHELL MOLDS

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Application August 7, 1952, Serial No. 303,076

11 Claims. (Cl. 22—9)

This invention relates to a method and apparatus for making shell molds employed in making metal castings. An object of the present invention is the provision of apparatus which will provide a continuous, semi-automatic method of making such molds enabling them to be made on a production basis at economical cost.

In the foundry art, shell molds are molds of thin, lightweight structure, made of a composition of fine sand and a thermo-setting resin or plastic, which molds are formed in a green state and baked to provide firm, hard molds into which the molten metal is poured. Molds made in this manner and of such material are exceptionally sharp as to outline so that castings made therein are clean and to proper dimensions thereby reducing machining requirements of the castings.

The present invention embraces a method and apparatus for making such shell molds whereby the molds may be made accurately, quickly in a continuous operation and with a minimum of spoilage, as well as with a minimum labor requirement thereby permitting the producing of the molds at high production rates and low costs.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompany drawings, showing an apparatus for making shell molds of a preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a side elevation of the improved shell mold forming machine.

Figure 2 is an end elevation of the shell mold forming machine.

Figure 3 is a fragmentary top plan of the shell mold forming machine.

Figure 4 is a section taken on line 4—4 of Figure 3.

Figure 5 is a detail view of a part of the shell mold forming machine.

Figure 6 is a diagrammatic perspective view illustrating parts of the machine.

Referring more particularly to the drawings, the shell mold forming machine comprises a supporting housing 1 mounted on rollers 1 so that the machine may be moved to any desirable location. The housing 1 contains a hopper 40, and a rotatable hollow shaft 3 is rotatably supported by suitable bearings on said hopper. The shaft 3 is rotated through limited degrees of rotation by means of a chain 5 which passes over a sprocket 6 mounted on the hollow shaft 3 and has its ends connected to the plungers 7 and 8 of pneumatic piston or plunger and cylinder structures 9 and 10. The cylinders 9 and 10 are carried by the hopper 40 and receive their operating pressure through suitable pipes 11 and 12, under control of a manually operated four-way valve structure 13 from a compressed air reservoir 14. Compressed air is supplied to the reservoir 14 from any approved type

of compressor structure indicated at 15 in Figures 1 and 6 of the drawings.

A pattern supporting structure 16 is connected to the shaft 3 through a suitable structural connection shown at 17.

The pattern supporting or carrying structure 16 includes a box-like structure 19 having an open upper side and is lined with suitable insulation 20. A plate 21 is movably supported in the box 19. A plurality of pins 22 are carried by the vertically movable plate 21 and project through openings 90 in the metal pattern plate 33. The vertically movable plate 21 has a stud 23 carried thereby which projects downwardly out of the box into housing 24. The stud 23 is contacted by the plunger 25 of a plunger and cylinder structure 26 which is operated by air pressure from the receiver 14 to move the plate 21 upwardly and move the pins 22 upwardly through the metal pattern plate 33 for releasing a formed shell mold from the pattern and plate 33, as hereinafter more specifically described.

The delivery of pressure air to the plunger and cylinder structure 26 is under control of a four-way valve structure 27. A spring 28 is coiled around the stud 23 and engages against the bottom of the pattern carrying box or unit 16 and against a head or washer 29 on the stud for moving the plate 21 to its innermost or lowermost position after the plunger 25 has been moved out of engagement with the stud 23.

The metal pattern plate 33 is heated by a plurality of electric heating wires 30 which engage against the under surface of the pattern plate. In the drawings these wires are shown as having flat surfaces for engagement with the under surface of the pattern plate 33, but it is to be understood, of course, that any suitable electric current conducting resistance wires may be employed for this purpose. Energizing and deenergizing of the wires 30 is controlled through rings 31 of approved construction carried by the shaft 3 and which is connected to a suitable electric current supply power line (not shown) through a manually operated switch 32.

The metal pattern plate 33 carrying the pattern or a plurality of patterns as indicated at 34 is placed upon the pattern carrying unit 16 and is attached to the upper edges of the box-like structure 19 thereof by means of removable screws 35. As clearly shown in Figure 3 of the drawings the metal pattern plate is provided with a dividing central rib 37 and each of the sections carry a pattern for one-half of the casting to be made so that after a mold has been formed on the pattern plate in the manner hereinafter described the two sections of the mold are separated or broken apart on the line provided by the dividing or parting rib 37 and connected to provide a complete mold. Suitable tapered studs 38 and tapered holes 39 are provided on and in the metal pattern plate 33 to provide guiding means for the accurate connection of the two sections of a mold after it has been formed and the studs also cause protuberances to be present on the back of the mold.

A hopper 40 is located within the housing 1 being supported by a shaft 41 rotatably carried by suitable supporting bearings. The hopper 40 has an opening 42 in its top which is shaped the same as the metal pattern plate and of only slightly less cross sectional area than the area of the metal pattern plate. The opening 42, however, has a cross sectional area at least equal to the area of the metal pattern plate which carries the patterns 34, gates 43 and pouring openings 44. A cushion 45 of suitable resilient material which is not affected by heat surrounds the opening 42 in the hopper 40. The hopper 40, during the forming of molds contains a mixture of fine sand and a thermo-setting resin which is used to make the molds. A sprocket 46 is carried by the shaft

41 and a sprocket chain 47 passes about the sprocket 46. The ends of the sprocket chain 47 are connected to the plungers 48 and 49 of the cylinder structures 50 and 51. The cylinder structures 50 and 51 receive air under pressure from the receiver 14 through a four-way valve structure 52.

For the purpose of facilitating the heating of the metal pattern plate 33 and also for baking a mold on the pattern plate in the manner hereinafter more specifically set out, an oven structure 55 is provided. This oven structure is preferably of the electrically heated type and may have any approved type of electric energy heating means therein, the energizing and deenergizing of which is under control of the manually operated switch 32. A plurality of rollers 56 are carried by the oven structure 55 and ride over the surface of the top 56' of the housing 1. Confining guides 56*a* are carried by the housing 1 for confining and guiding movement of the rollers 56. The front of the oven structure, that is, its end facing the metal pattern plate 33 has an opening 57 therein of sufficient size to permit the oven to be moved over and entirely enclose the metal pattern plate and a mold thereon. However, for the purpose of providing even heat in the oven over the entire metal pattern plate and preventing the escape of heat from the oven a door 58 is provided which is slidably carried by the oven and is movable into open position to permit the oven to be moved over the metal pattern plate, after which the door is closed to tightly seal the pattern plate with or without the green mold thereon within the oven.

The oven structure 55 is moved over the pattern plate and removed therefrom by air pressure through the medium of a cylinder and plunger construction 59, the plunger 60 of which engages against a standard 61 rigidly carried by the housing 1 so that when air pressure is delivered to the cylinder and plunger structure from the receiver 14 through the four-way valve structure 62 the cylinder being connected to the oven, will, as pressure is exerted against the abutment or standard 61, move the oven over off the pattern plate.

A pair of cylinder and plunger structures 63 and 64 are provided, the plungers 65 of which are connected through suitable couplings 66 to the vertically movable door 58. Pressure air is supplied to the cylinders 59, 63 and 64 from the receiver 14 through the four-way valve 62. When the oven 55 is in its outer position as shown in Figures 1 and 6 of the drawings and it is desired to move it to the left or over the metal pattern plate 33 the lever 73 of the four-way valve is moved to the left. At this time, pressure air is delivered through the pipe 74 to the pipe 75 and from this pipe into the outer or lefthand end of the cylinder 59. This moves the oven 55 forward over the pattern plate 33. At the same time pressure air is delivered from the pipe 75 through a delay action valve 76 into the tops of the cylinders 63 and 64. The delay action valve 76 delays the delivery of the pressure air to the top of the cylinders 63 and 64 sufficiently to allow the oven to be moved completely over the metal pattern plate 33, at which time the air is permitted to enter the tops of the cylinders 63 and 64 and close the door 58. When it is desired to move the oven 55 off of the metal pattern plate 33 the lever 73 is moved to the right and the pressure air passes through the pipe 74' into the pipe 77 and from this pipe through the pipe 68 into the bottom of the cylinders 63 and 64 acting on the plungers therein to open the door 58. The pipe 77 also delivers the pressure air to the rear or right hand end of the cylinder 59 to move the oven 55 rearwardly off of the metal pattern plate. A delay action valve 78 is placed in the pipe 77 to provide sufficient time delay in the delivery of the pressure air to the rear end of the cylinder 59 to permit the plungers 65 to operate and open the door 58 before the oven starts movement off of the pattern plate.

The delay action valves 76 and 78 may be of any approached construction which may be purchased upon the open market.

The four-way valve structures 13, 27, 52 and 62 are of any approved type of manually operated four-way valve structure, each including a hand lever for manual operation such as the hand lever 73 of the valve 62 and they are connected to the receiver 14 by suitable piping as shown at 80. A pressure gage 81 is connected in the piping 80 and a manually operated pressure relief valve 82 may also be connected in said piping if it is so desired.

In operation: A metal pattern plate 33 bearing the pattern of which molds and castings are to be formed is attached to the top of the metal pattern carrying unit 16 by means of the screws 35, after which the surface of the metal pattern is sprayed with a suitable non-adhesive liquid well known in the art to prevent the material of which the mold is formed from sticking to the pattern plate. The switch 32 is then turned on and the hand lever 73 of the four-way valve 62 is moved to admit air to the cylinders 59, 63 and 64 for moving the oven over the metal pattern plate 33 and providing the proper closing of the door 58. At the same time the electric conducting resistance wires 30 are energized through the rings 31 for heating the metal pattern plate 33 from its under surface while its upper surface is heated through the medium of the electrical heating units or unit 85 in the oven 55. After the expiration of a suitable period of time indicated by the timer 86 the lever 73 is moved to the right to admit air to the cylinders 59, 63 and 64 for opening the door 58 and moving the oven 55 back off of the pattern plate 33. As soon as the oven 55 is moved off of the pattern plate 33 the lever 87 of the four-way valve structure 13 is moved to the left which admits air pressure to the cylinder 9. The admittance of the air pressure to the cylinder 9 moves the plunger 7 thereof inwardly to the position shown in the drawings and consequently rotates the shaft 3 towards the left moving the metal pattern plate 33 into a reversed position upon the hopper 40 and over the opening 42 in the hopper. During this time and while the metal pattern plate is over the mouth of the hopper its heat or temperature is maintained by means of the heating wires 30. When the pattern plate is firmly placed over the opening 42 of the hopper 40 with the pattern 34 facing the interior of the hopper the lever 88 of the four-way valve structure 52 is moved to the left which delivers air pressure to the cylinder 51 and at the same time exhausts air pressure from the cylinder 50. The delivery of the pressure air to the cylinder 50 rotates the shaft 41 by means of the sprocket chain 47 and sprocket 46 and moves the hopper into an inverted position causing the mixture of sand and resin in the hopper to be deposited upon the surface of the metal pattern plate. The heat of the plate causes a desired amount of the mold forming materials to adhere to the metal pattern plate through the softening of the contained resin in the mixture. After a predetermined time the lever 88 of the four-way valve 52 is moved to the right which delivers pressure air to the cylinder 50 and permits the exhausting of the air from the cylinder 51. The pressure air delivered to the cylinder 50 moves the sprocket chain 47 and rotates the sprocket 46 and shaft 41 to move the hopper 40 back to its normal upright position. After the hopper 40 has been moved to its normal upright position the hand lever 87 of the valve 13 is moved to the right which delivers air to the cylinder 10 and operates its plunger for moving the metal pattern plate back into its normal upright position as shown in Figures 1 and 6 of the drawings and in position for having the oven 55 moved thereover. After the metal pattern plate 33 carrying the deposit of the mold forming material is moved into its normal upright position the lever 73 of the four-way valve 62 is moved to the left so that the oven will again move over the metal pattern for baking the green mold carried by the pattern. The timing of

this baking operation is determined by means of the timer **86** and after the expiration of the proper baking time the lever **73** of the four-way valve **62** is again moved to the right opening the door **58** and moving the oven back off of the baked mold and the metal pattern plate.

The hand lever **89** of the four-way valve structure **27** is then moved to the left which delivers pressure air to the cylinder **26** causing its plunger **25** to move the plate **21** and the pins **22** carried thereby through the openings **90** in the metal pattern plate to release the baked mold from the metal pattern plate.

The baked mold is then removed from the apparatus or machine, is broken in two along the parting line provided by the rib **37** and the two sections of the mold are placed with their hollow faces together and are united or connected by any suitable means thus forming a complete shell mold.

As shown in Figure 5, a roller **95**, is mounted rotatable on bearing means **96**, adjustably attached to the oven **55**, to roll over protuberances on the back of the green mold and so produce shaped surfaces desirable in the subsequent stacking together of the cured molds.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In a shell molding machine having a pattern plate adapted to carry a mold thereon, an oven movable from a retracted position to a position over said plate, and from its position over said plate to a retracted position, respectively, a door on said oven, driving means to move said oven, means to open and close said door respectively, and time delay means cooperably connecting said driving means and said door opening and closing means to hold said door open while said oven is moving over said plate and to close said door when said oven is at rest over said plate.

2. A shell molding machine comprising a pattern adapted to have a mold thereon, an oven, heating means in said oven, means to move said oven from a first position of rest in retracted relation to said pattern to a second position of rest over said pattern, respectively, a door on said oven, means to hold said door open while said oven is moving over said pattern, means to automatically close said door when said oven comes to rest over said pattern whereby said pattern becomes enclosed in the oven, and means to move said door clear of said pattern in anticipation of movement of said oven from its second to its first position.

3. A shell molding machine comprising a pattern adapted to have a mold thereon, an oven, heating means in said oven, means to move said oven from a first position of rest in retracted relation to said pattern to a second position of rest over said pattern, and from said second position to said first position, respectively, a door on said oven, means to hold said door open while said oven is moving, and means to close said door when said oven comes to rest in said first position and in said second position, respectively and cooperatively connected with said means to move said oven.

4. A shell molding machine comprising a frame, adjacent support means at a mold-ejecting position, a hopper on said frame and mounted rotatably thereon for movement from an upright to an inverted position, said hopper being adapted to carry an investment mixture, said hopper having means defining a mouth therefor at its upper end, bearing means carried by said hopper, a pattern carrying member normally resting on said support means and being hingedly connected to said hopper by said bearing means, a pattern fixedly secured to said pattern carrying member, said pattern carrying member carrying mold ejecting pins, said pattern carrying member being swingable from said normal position to lie over the mouth of said hopper, and being movable downwardly with said hopper to an inverted and pattern investment position of said hopper remote from said support means, and being movable with said hopper from its inverted position to an upright position of said hopper, and being then swingable away from the mouth of said hopper to carry a mold to the normal position of said plate carrying member, and operating means for said ejecting pins mounted at said mold ejecting position.

5. In the combination of claim 4, a support secured to said hopper and carrying said bearing means at a position near the mouth of said hopper.

6. In the combination of claim 4, fluid pressure means connected to said pattern carrying member to swing said member from its normal position to over the mouth of said hopper, and to hold said member over the mouth of said hopper when said hopper is in its inverted position.

7. A shell molding machine comprising a frame, a hopper mounted rotatably on said frame, said hopper being adapted to carry an investment mixture, said hopper having means defining a mouth therefor at its upper end, means adjacent said hopper defining initial support means for a pattern carrying member, a pattern carrying member initially resting on said support means, bearing means on said hopper, said pattern carrying member being swingable in said bearing means, means to swing said pattern carrying member from its initial position on said support means to a position over the mouth of said hopper, means to invert said hopper and the pattern carrying member thereon to an investment position, means to return said hopper to its upright position, means to then swing said pattern carrying member back to its initial position, and means to heat said pattern carrying member and thereby cure the investment mixture thereon while said pattern carrying member is at rest and returned to its initial position and in retained relation to said hopper.

8. In the combination of claim 7, said pattern carrying member carrying ejecting pins, and means to operate said ejecting pins to remove the investment mixture from said pattern carrying member while said pattern carrying member is at rest and returned to its initial position.

9. A mold forming machine comprising in combination a main frame, an open-top hopper for molding material rotatably mounted on said main frame, a pattern plate-holding frame swingably mounted on said hopper for movement between supported position upon said main frame and disposition upon said hopper to present a pattern plate carried thereby in confronting relation to said molding material, means for rotating said hopper and pattern plate-holding frame together into inverted position for coating the pattern plate with molding material, pattern plate heating means carried by the pattern plate-holding frame, mold curing means provided on said main frame for disposition above the coated pattern plate upon return of pattern plate-holding frame to supported position on said main frame, and mold ejection means mounted on said main frame for stripping of the cured mold from the pattern plate.

10. A mold forming machine comprising a frame, an open top hopper for molding material rotatably mounted on said frame, a pattern plate-holding frame swingably mounted on said hopper for movement between inoperative or outward position and operative disposition upon the open top of said hopper for presenting a pattern plate thereon in confronting relation to the molding mixture, means for swinging said plate-holding frame into operative position and then rotating the same and the hopper as a unit into inverted position wherein mold material may fall coveringly upon the pattern plate, and means to retain said plate-holding frame and said hopper together during movement into inverted position and during while said hopper is inverted.

11. A mold forming machine comprising a frame, an open top hopper for molding material rotatably mounted on said frame, a pattern plate-holding frame swingably mounted on said hopper for movement between inopera-

tive or outward position and operative disposition upon the open top of said hopper for presenting a pattern plate thereon in confronting relation to the molding mixture, means for swinging said plate-holding frame into operative position and then rotating the same and the hopper as a unit into inverted position wherein mold material may fall coveringly upon the pattern plate, heating means carried by the pattern plate-holding frame, mold curing means movable for disposition above the coated pattern plate upon return of said plate-holding frame to its outward position, and mold ejecting means for stripping of the cured mold from the pattern plate-holding frame while said plate-holding frame is in its outward position and in retained relation to said hopper.

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