March 18, 1969 H. E. FELLOWS 3,433,285

PNEUMATIC IMPACT-MOLDING MACHINE WITH SHUTTLE HOPPER

Filed July 30, 1965 Sheet 1 of 11

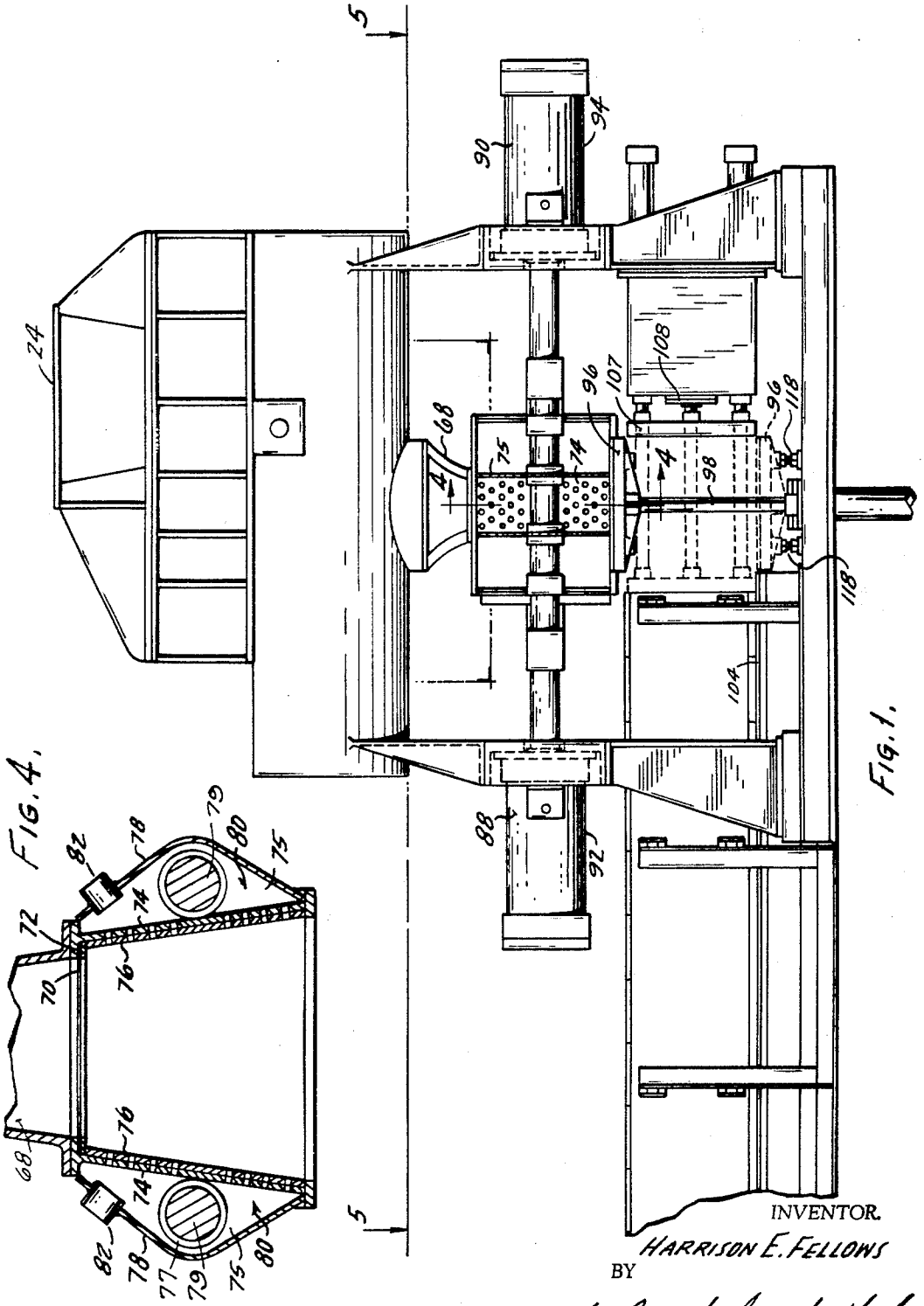


FIG. 1.




FIG. 4.

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PNEUMATIC IMPACT-MOLDING MACHINE WITH SHUTTLE HOPPER

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FIG. 2.

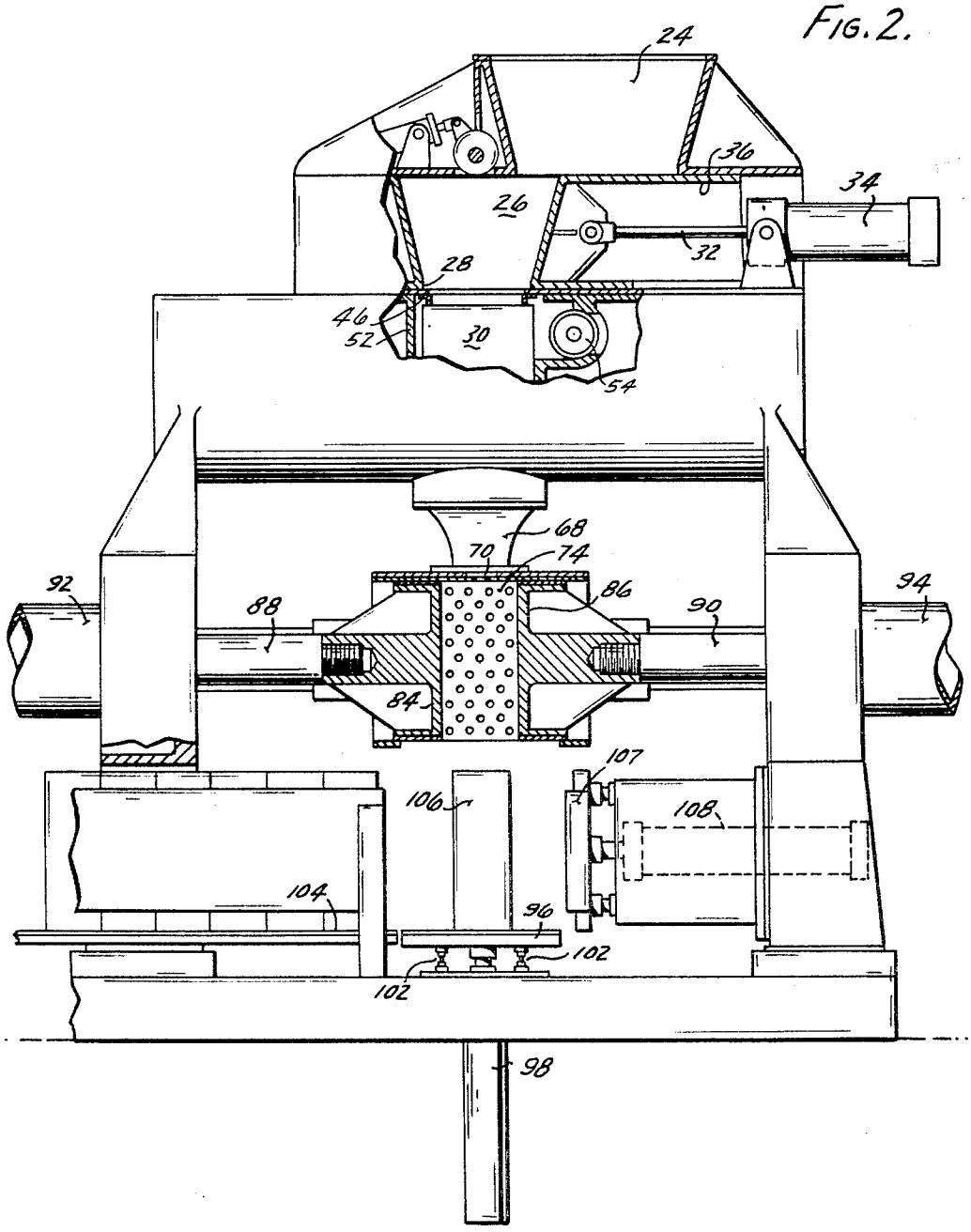


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FIG. 3.

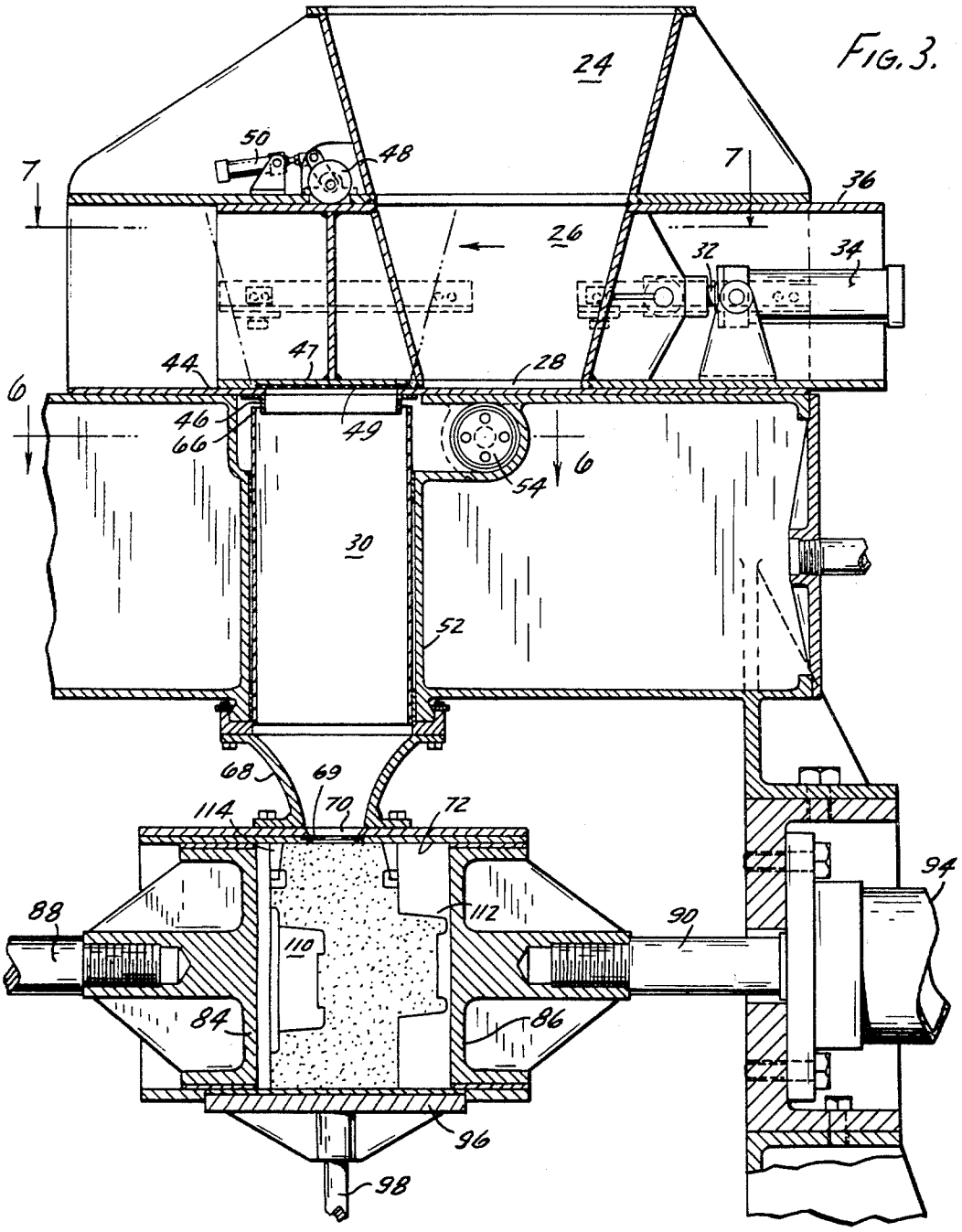


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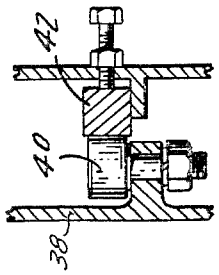
FIG. 8.



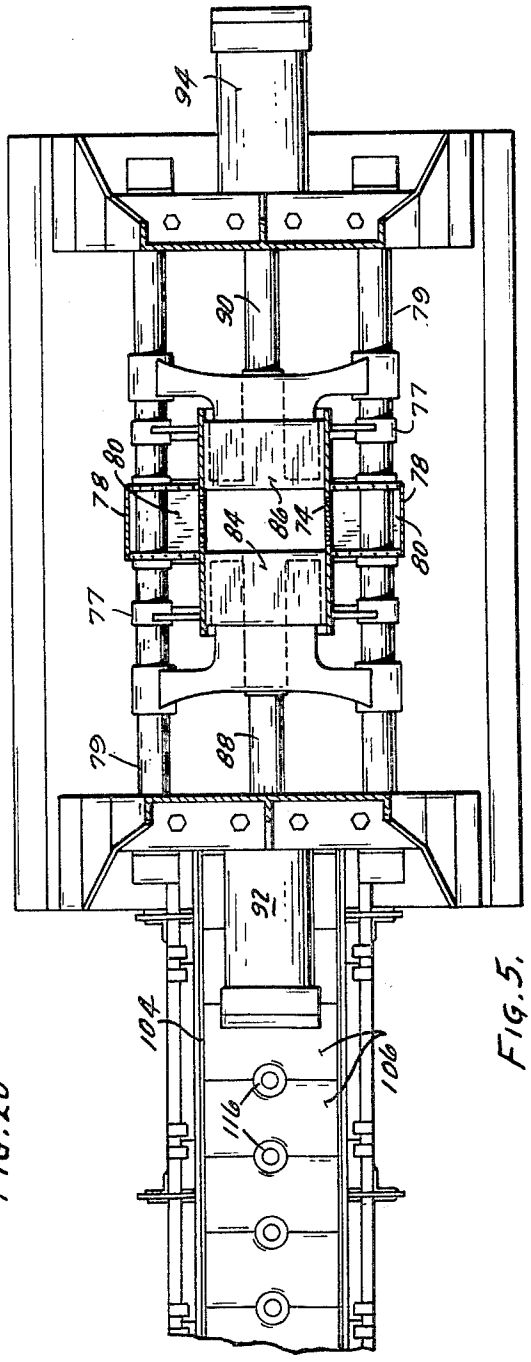




FIG. 5.

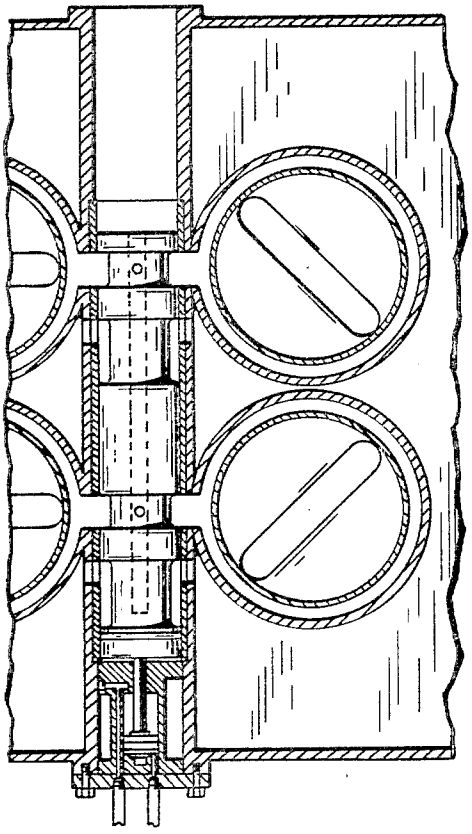


FIG. 20

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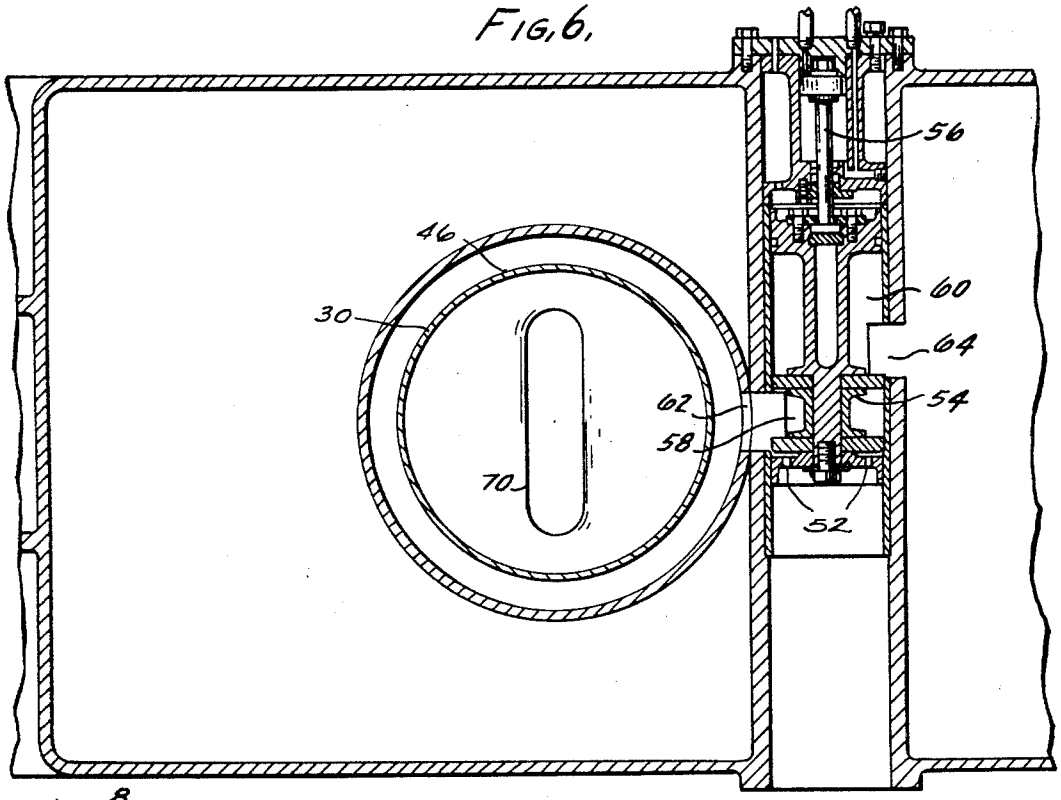
FIG. 6.



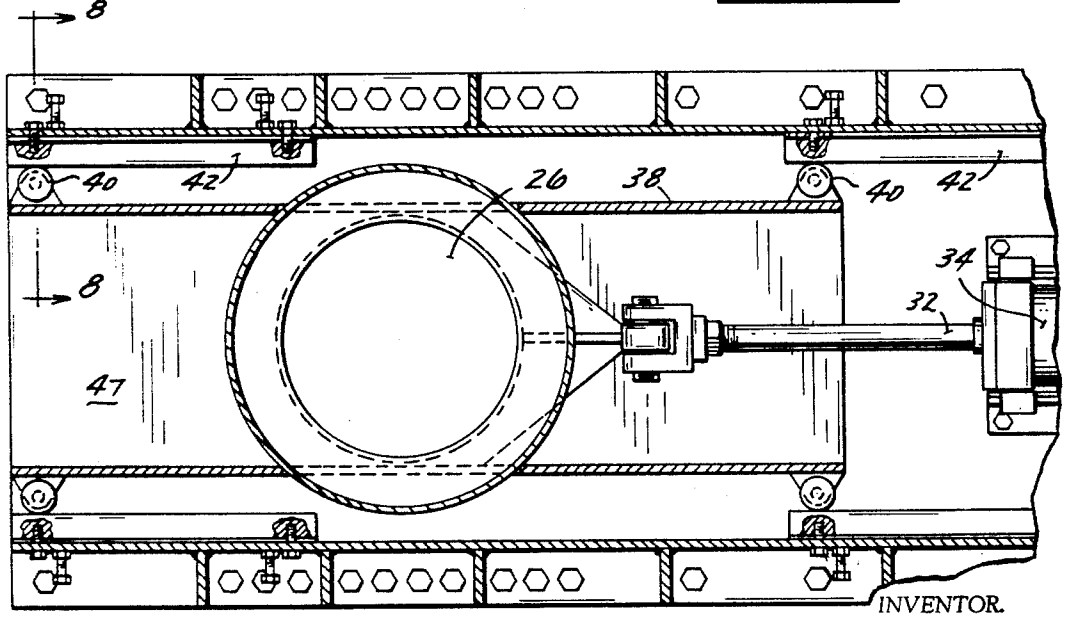




FIG. 7.

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PNEUMATIC IMPACT-MOLDING MACHINE WITH SHUTTLE HOPPER

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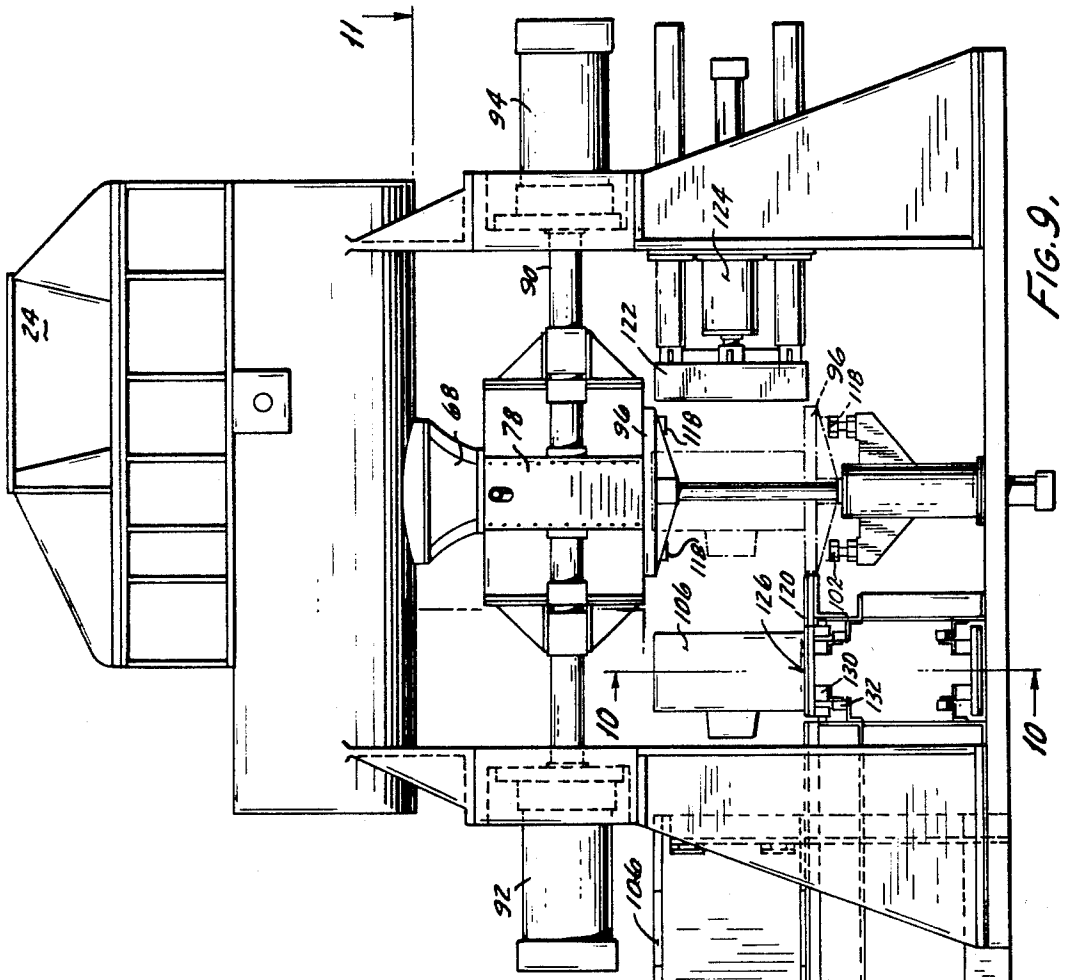


FIG. 9.

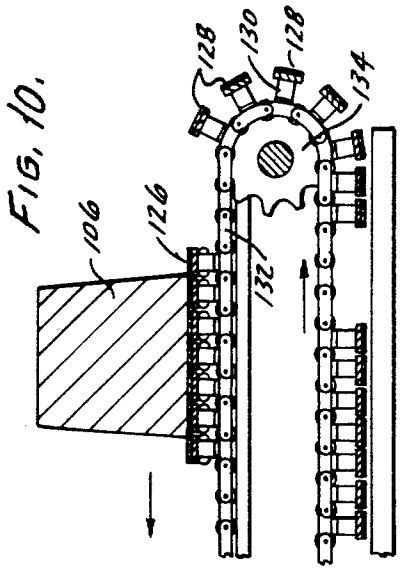


FIG. 10.

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PNEUMATIC IMPACT-MOLDING MACHINE WITH SHUTTLE HOPPER

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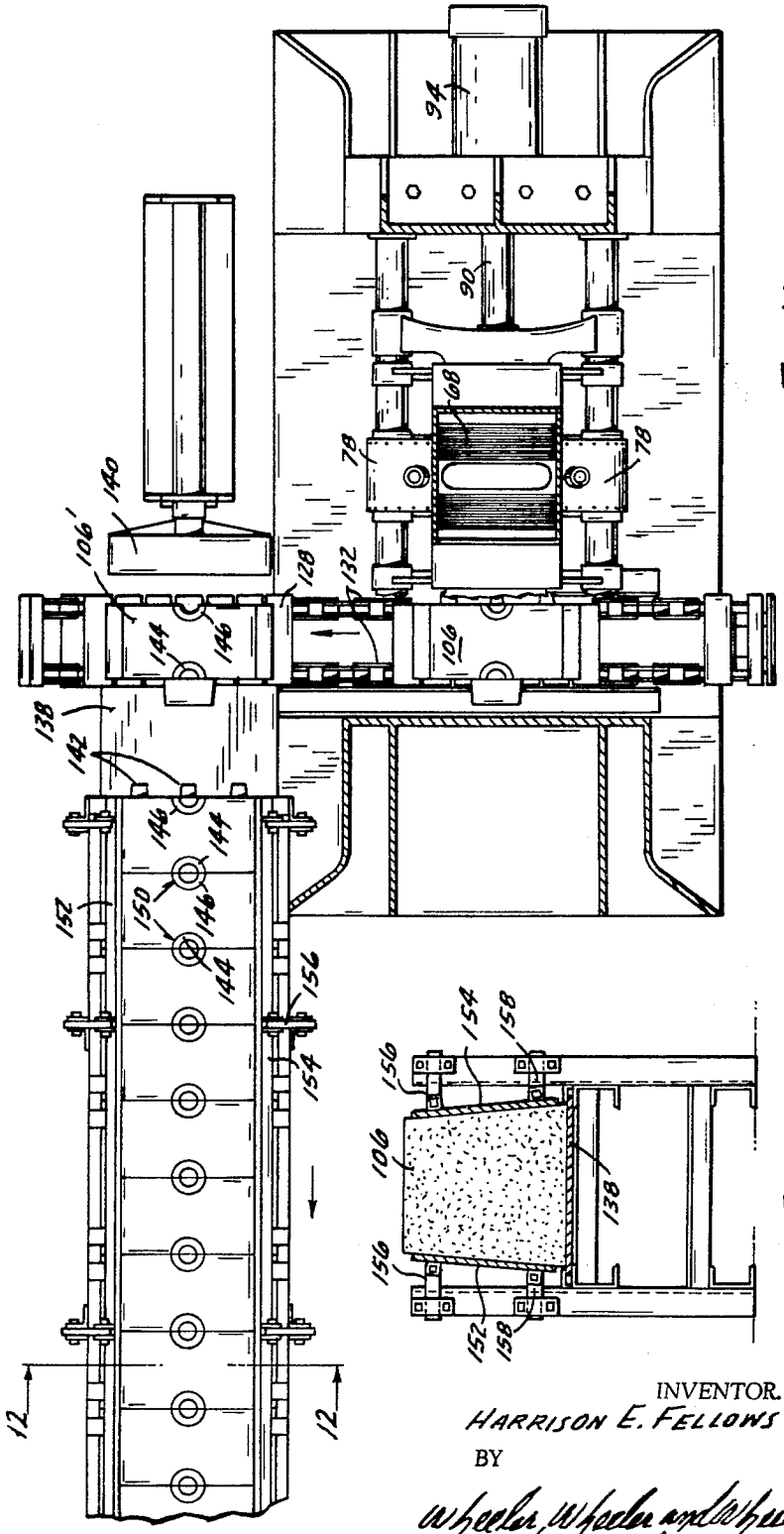


FIG. 11.




FIG. 12.

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PNEUMATIC IMPACT-MOLDING MACHINE WITH SHUTTLE HOPPER

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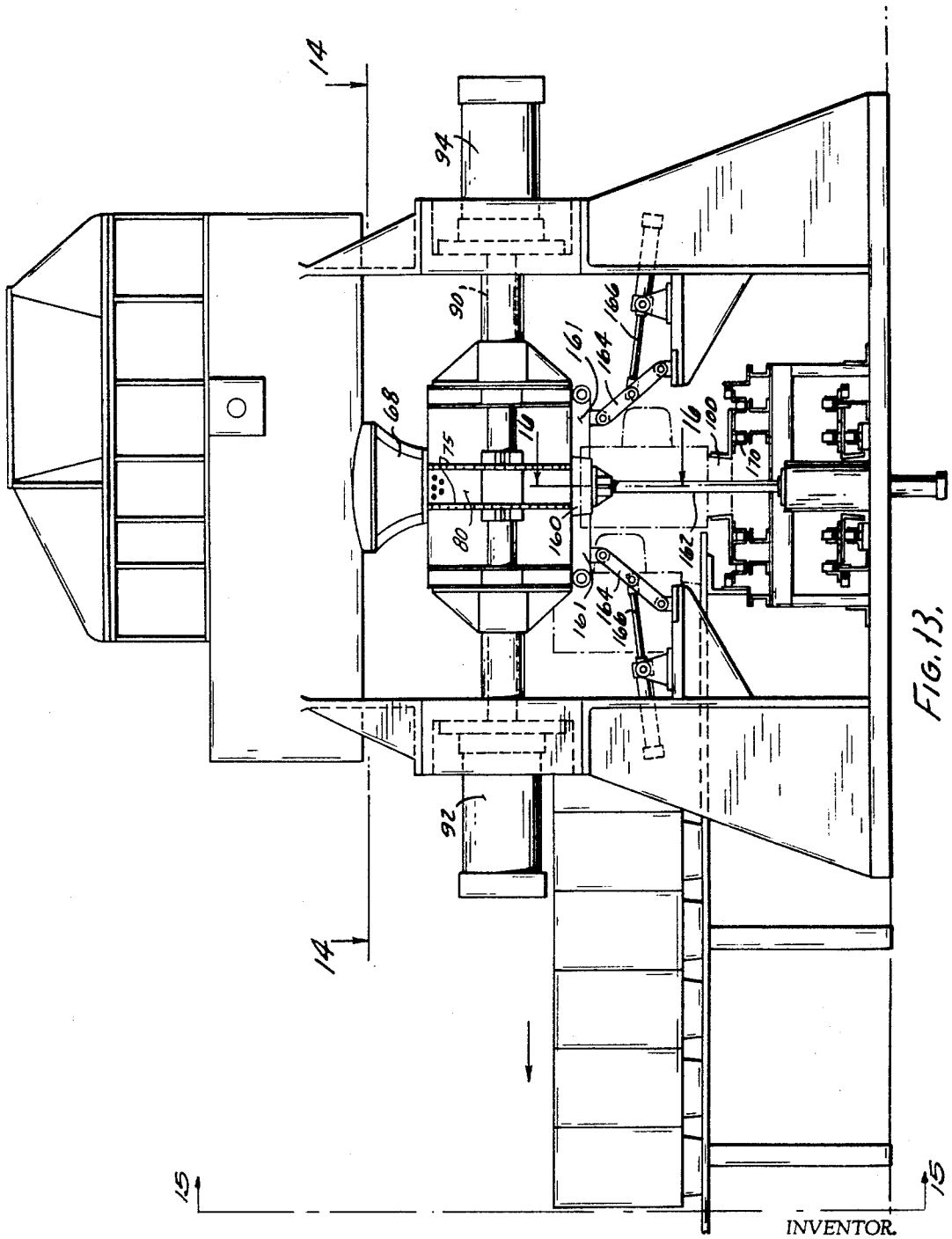


FIG. 13.

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PNEUMATIC IMPACT-MOLDING MACHINE WITH SHUTTLE HOPPER

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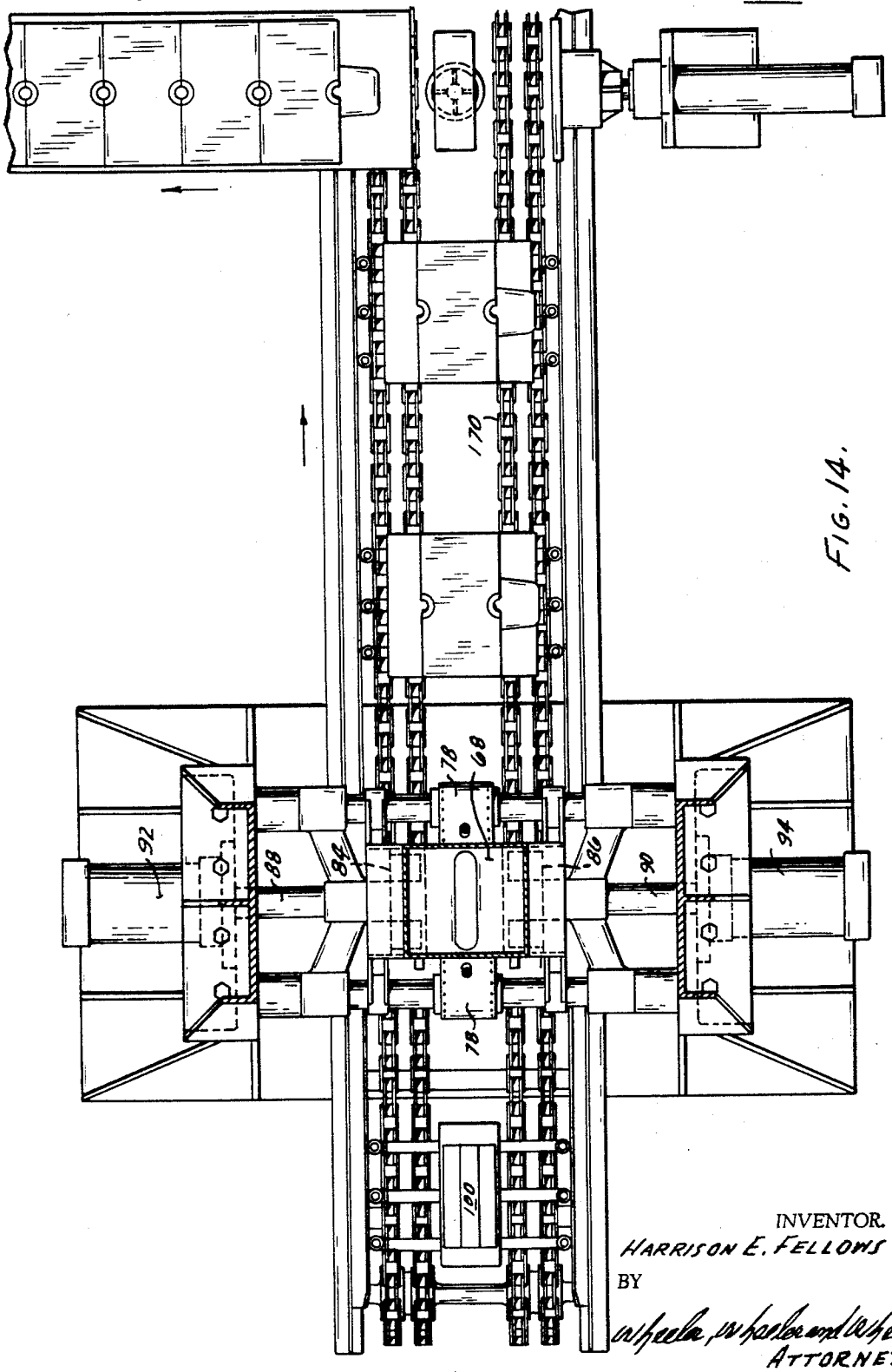


FIG. 14.

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FIG. 15.

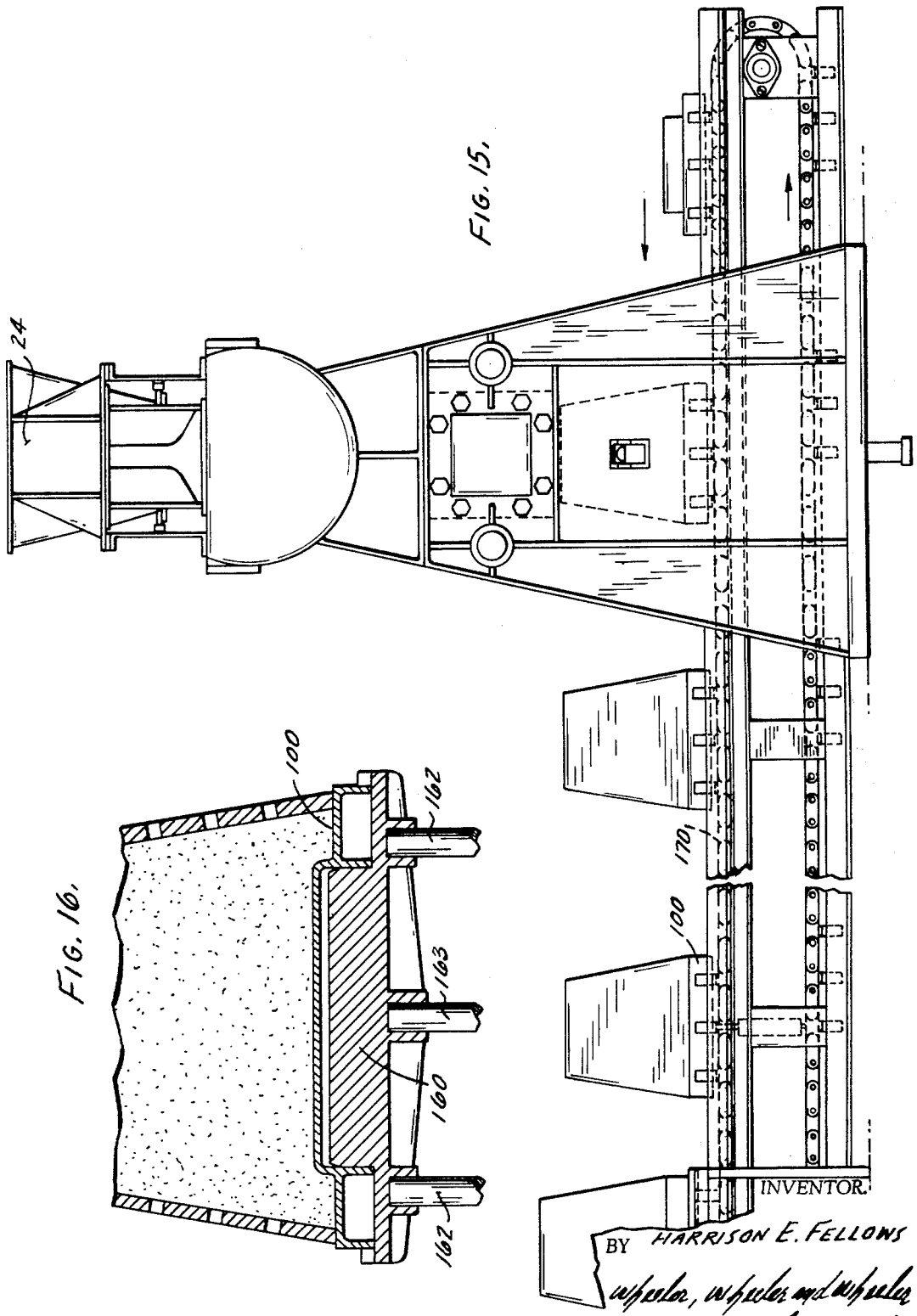


FIG. 16.

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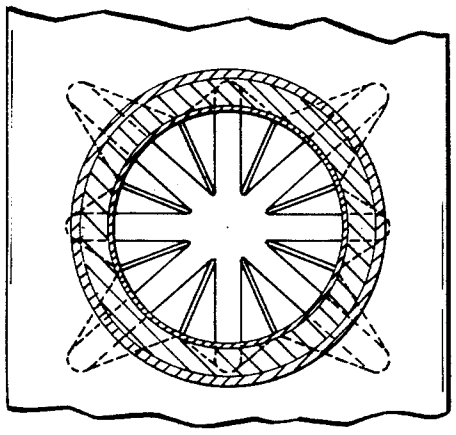

FIG. 19.

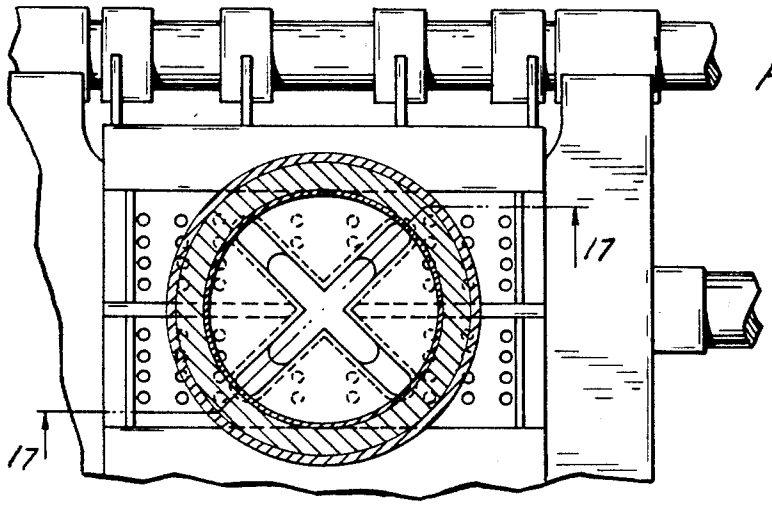


FIG. 18.

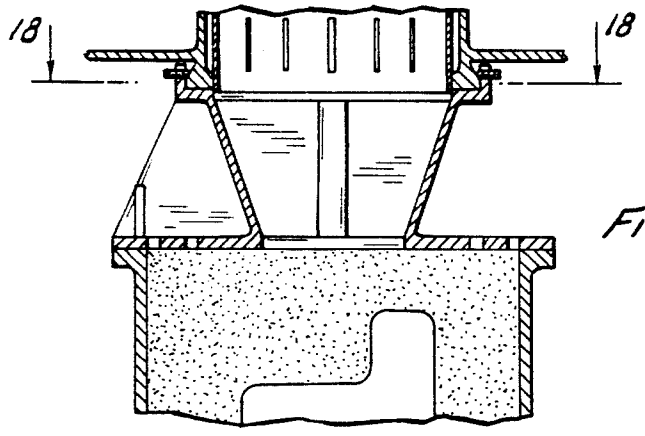


FIG. 17.

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United States Patent Office 3,433,285
Patented Mar. 18, 1969



3,433,285

# PNEUMATIC IMPACT-MOLDING MACHINE WITH SHUTTLE HOPPER

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Filed July 30, 1965, Ser. No. 476,090
U.S. Cl. 164—193 8 Claims
Int. Cl. B22c 5/12, 15/22

## ABSTRACT OF THE DISCLOSURE

A pneumatic impact-molding machine including a magazine for delivering sand into the molding chamber, a source of sand offset from the magazine, a shuttle hopper mounted for movement transversely of the magazine between a position of registry with the source and a position of registry with the magazine, means for sealing the shuttle hopper to the magazine, and means for admitting a pneumatic fluid under pressure to the magazine for the impact filling of the molding chamber with sand delivered from the magazine.

This invention relates to a pneumatic impact-molding machine.

Sand from a suitable source is transferred by a reciprocable shuttle hopper to a magazine to which the hopper can be sealed under pressure during the refilling of the hopper. This prevents leakage when the sand in the magazine is subjected to the amount of air pressure required for pneumatic impact transfer from the magazine into the mold or core box cavity. In the preferred embodiment, the pressure which seals the shuttle hopper carriage to the magazine is applied only when the hopper registers with the magazine and is relieved preliminary to the movement of the hopper toward the source.

With the magazine full of sand received from the shuttle hopper and closed by the hopper, the magazine is subjected to air pressure. A spool valve controlling the air supply to the magazine permits a single valve to function in its respective advanced and retracted positions to control both inlet and exhaust and to obtain rapid action with a relatively small-bore operating piston. For covering a large mold area, a number of such magazines can be used, all actuated from the same spool valve.

While the magazine will deliver and pack sand into a conventional mold, in the preferred embodiment the sand is packed into a molding chamber in a flaskless molding unit which has downwardly tapered fixed sides and movable ends comprising compression rams which are operable between said sides to further compact the sand. The downward taper of the sides of the molding chamber permits the finished mold to be withdrawn downwardly from between the compression rams after the latter have been retracted. As each successive mold section is withdrawn, it is advanced in contact with the preceding section, all being maintained at precisely the same level and guided between lateral confining plates to a pouring position where the friction of such plates on the sections maintains a seal between the mold sections (with a minimum of sections on both sides of the pouring station) so that they will resist hydrostatic pressure of molten metal poured into the successive molds at the pouring station.

In order to permit cores to be set without interfering with the functioning of the machine, it is preferred that each successive mold section be transferred to a core setting station from which it is then advanced on the pouring line. Since the core setting station is offset from the line upon which the sections are advanced after being lowered from the molding chamber, the setting of cores does not interfere with advance of the next section.



In the drawings:

FIG. 1 is a fragmentary view in side elevation of one embodiment of my invention.

FIG. 2 is a detail view partially in side elevation and partially in longitudinal section through the apparatus shown in FIG. 1.

FIG. 3 is a view similar to FIG. 2 showing the parts in different position.

FIG. 4 is an enlarged fragmentary detail view in transverse section through the molding chamber.

FIG. 5 is a view taken in section on the line **5—5** of FIG. 1.

FIG. 6 is a view taken in section on the line **6—6** of FIG. 3.

FIG. 7 is a view taken in section on the line **7—7** of FIG. 3.

FIG. 8 is a detail view taken in section on the line **8—8** of FIG. 7.

FIG. 9 is a view similar to FIG. 1 showing a modified embodiment of the invention.

FIG. 10 is a fragmentary detail view taken in cross section on the line **10—10** of FIG. 9.

FIG. 11 is a view partially in plan and partially in horizontal section on the line **11—11** of FIG. 9.

FIG. 12 is a detail view in cross section on the line **12—12** of FIG. 11.

FIG. 13 is a view similar to FIG. 1 showing another modified embodiment of the invention.

FIG. 14 is a view taken partially in plan and partially in section on the line **14—14** of FIG. 13.

FIG. 15 is an end elevation on the line **15—15** of FIG. 13.

FIG. 16 is a view taken in section on the line **16—16** of FIG. 13.

FIG. 17 is a view taken in section on the line **17—17** of FIG. 18.

FIG. 18 is a view taken in section on the line **18—18** of FIG. 17.

FIG. 19 is a view showing a modified pattern of slots in a sand guide, the viewpoint being similar to that of FIG. 18.

FIG. 20 is a fragentary view taken in horizontal section through the spool valve and a series of pressure magazines to and from which the spool valve controls air pressure admission and exhaust.

Referring, first, to the embodiment shown in FIGS. 1 to 4, the funnel shaped member **24** constitutes for the purposes hereof a source of molding sand. The shuttle hopper **26** reciprocates from a first position of full registry with the source **24** as shown in FIG. 3 to a laterally offset position as shown in FIG. 2 in which the shuttle hopper discharge port **28** registers with the pressure magazine **30**. Movement of the shuttle hopper is effected by means of the ram piston **32** having a cylinder **34**. A skirt **36** on the shuttle hopper closes the source when the shuttle hopper moves from the FIG. 3 position to the FIG. 2 position. Details of the shuttle hopper **26** will be seen in FIG. 7, it being noted that the hopper is mounted on or is part of a carriage **38** having rollers **40** guided upon rails **42**, the latter being adjustable as best shown in FIGS. 7 and 8.

Shuttle hopper carriage **38** is supported by a plate **44** which is apertured over the magazine **30**, the aperture registering with collar **46** which depends into the magazine **30** and is spaced both radially and axially from the upper end of the magazine **30** as clearly appears in FIG. 3. When the transfer hopper registers with the magazine, the sand falls from the transfer hopper into the magazine. In this position the top opening of hopper **26** is still partially open to the source **24** as shown in FIG. 2, to permit flow of sand from the main source should there not be enough sand in hopper **26** to fill the magazine **30**. On the

return stroke back to the position of FIG. 3, the top of the magazine is completely closed by the bottom wall **47** of the carriage **38**. This wall preferably has inlaid into it a packing or sealing means such as an O-ring **49**. When this packing registers with the magazine, the cam **48** is actuated by the ram **50** to press the wall to plate **44**, whereby to completely seal the magazine over the sand therein.

Surrounding the magazine is a pressure housing **52** into and from which air is admitted and exhausted subject to the control of a spool valve **54** actuated by ram piston **56**. In the position of the parts shown in FIG. 6, section **58** of the valve **54** is in registry with the port **62** of the magazine. Valve section **58** communicates with exhaust holes **52** opening the magazine to the atmosphere. When the ram piston **56** moves the valve section **60** into registry with port **64** of the pressure source, it also registers with port **62** of the magazine to admit pressure to the magazine.

When spool valve section **60** registers with port **64** of the air reservoir and port **62** of the magazine, air will be admitted into the magazine **30** to flow between the upper end of the magazine **30** and the depending collar **46**, whereby the pressure is imposed on the top of the sand in the magazine to expel the sand vigorously through the tapered discharge throat **68** of the magazine into a mold, or into the mold chamber presently to be described. It is very desirable that this have inwardly curved sides as shown. The sand flows better than as if the walls were straight.

Also, it is preferred to have a thin plate **69** with a small opening to break up the sand as it enters the mold chamber. This is supported by a bottom wall plate **72**. The plates **69** and **70** may both be interchangeable so that the pattern of openings formed therein can be used to control the flow and distribution of the sand in the mold or mold chamber.

A preferred mold chamber is shown in longitudinal section in FIG. 3 and in transverse section in FIG. 4. Its sides comprise a pair of foraminous plates **74** which are downwardly divergent as best shown in FIG. 4. These desirably are provided with interchangeable liners at **76**. The side walls **74** are preferably reinforced by ribs **75**, which carry bearing bosses **77** engagaging guide rods **79** for centering the mold chamber. To the center ribs are connected outwardly convex plates **78** to define the air exhaust manifolds **80** shown in FIG. 4. From these manifolds, the air discharge pipes **82** lead to any appropriate point of discharge.

The ends of the molding chamber are provided by the ram pressure heads **84** and **86** which are respectively operated by the ram pistons **88** and **90** having cylinders **92** and **94**. The pressure heads **84** and **86**, each of which carries a half of the pattern, fit snugly between the side walls **74** and the liners **76**, if any, and will serve to compress between the side walls **74** the sand fill already compressed in the mold chamber by the impact with which it has been driven into such chamber by the air pressure in the magazine **30**. Parenthetically, it may be remarked that, as already indicated, the magazine **30** may be used, if desired, to fill conventional molds rather than merely to fill a mold chamber such as that herein described.

Assuming that the device includes a mold chamber rather than a mold, the bottom of such chamber may be made either by the elevator ram table **96** on the elevator ram **98**, as in FIG. 2, or I may use at the bottom of the mold chamber a slide plate such as that shown at **100** in FIGS. 15 and 16. Particularly when there is no such plate and the sand surface of the resulting mold is to slide across a table of any sort, precise registry of the elevator table **96** with the receiving table is desired and, accordingly stops are provided at **102** which can be so adjusted that the elevator table **96** will register exactly with the fixed receiving table surfaces **104** onto which the finished mold shown in FIG. 2 at **106** is to be delivered.

Upon compression of the sand in the mold chamber, the pressure heads **84**, **86** are retracted. This motion draws the pattern halves **110**, **112**, **114** from the mold. Thereupon the elevator ram **98** lowers the finished mold to a level such that it clears the molding chamber and ram assembly. To assist in freeing the finished mold from the sides of the mold chamber, a regulated back pressure of air is applied to the vents as the finished mold is lowered. A pusher **107**, operated by ram **108**, then slides the finished mold section from the elevator table **96** to the receiving table **104**.

As best shown in FIG. 3, any desired patterns such as the male pattern **110** and the complementary female pattern **112** may be attached to the pressure heads **84**, **86**, along with the smaller patterns **114** used to form the pouring cups. As the finished sand molds **106** are moved by pusher **107** away from the molding area on the receiving table **104**, they are in tight face contact, each successive section advancing under the pressure of the discharge ram head **107** being pressed against and serving to advance the mold section preceding it. The pouring cup notches formed by molds **114** will now register to provide cooperatively the pouring openings seen at **116** in FIG. 5.

The arrangement thus far described makes no provision for inserting cores. If cores are to be inserted, it is necessary in the device thus far described to stop the moulding press for this purpose. In order to give ample time for inserting cores without interfering with the operation of the press, it is preferred that each finished mold section be moved laterally from the path on which it is delivered from the molding chamber, thus making room for immediate delivery of another mold section from the chamber. Meantime, the laterally delivered section has a brief period of dwell in a location wherein cores can be inserted and it is then propelled from that location in a direction which is parallel to the original path of delivery from the molding chamber. In its movement along said last mentioned path, it propels previously completed and cored mold sections under pressure (attributable to frictional resistance), the resultant pressure holding the several sections tightly engaged to receive molten metal.

The invention contemplates that the finished mold sections may be supported for the above described transverse motion upon a sectional table conveyor or, alternatively, they may be provided in the molding chamber with supporting trays upon which they will be lowered from the molding chamber onto the cross conveyor, delivered by the cross conveyor to the coring station; and thence propelled upon the discharge path in which the pouring occurs.

Assuming that the trays are not to be used, the mold section will be lowered from the mold chamber on the ram table **96** when the ram plunger **98** is retracted to the position shown in dotted lines in FIGS. 1 and 9. Desirably, stops will be used as indicated diagrammatically at **118** in FIG. 9 so that the lowered table **96** will stop in precise registry with the transfer flange **120** across which the mold will be pushed by head **122** of ram **124** (FIGS. 1 and 9) onto the sectional conveyor table **126**.

As best shown in FIG. 10, the various sections **128** which comprise this table are mounted on arms **130** that project from the links of chains **132** operating over appropriate sprockets, one of which is shown at **134** in FIG. 10. Together the several sections **128** provide a smooth and substantially continuous surface on the horizontal run of the conveyor so that the finished mold sections **106** as received thereon are propelled laterally with respect to the path of delivery from the mold. It will be understood that the conveyor operates only intermittently following receipt of a mold section. It delivers successive sections **106** into registry with the discharge table **138**. During the ensuing dwell, while a new section is being received from the molding chamber onto the conveyor **126**, the previously delivered section shown at

106' in FIG. 11 will be discharged from the conveyor 126 by the ram head 140 onto the table 138. Here, any desired cores 142 can be placed in positions where they will be received into the openings provided in the complementary face of the next arriving section.

The respective sections have complementary channels 144 and 146 which, as the several sections are assembled on table 138, are made to register with each other to form the pouring openings 150 (FIG. 11).

The assembled sections have step-by-step movement along table 138 toward a pouring station, all of the sections being advanced on such table each time the ram 140 is operated. The friction of the foremost sections offers sufficient resistance to the stepped advance under pressure of ensuing sections so as to assure the tight engagement of the complementary faces of the sections about the cores and cavities. If desired, the friction between the sections and the table 138 may be augmented, and the several sections guided, by means of lateral confining plates 152 and 154 which are guided by arms 156 and 158 as shown in FIG. 12. Spring bias (springs not shown) may be provided if desired.

As already indicated, the invention contemplates the optional use of trays 100 which serve as bottoms for the mold and support the molds or mold sections successively formed therein. FIGS. 13 and 16 show an arrangement in which the tray 100 partially closes the bottom of the mold chamber and is supported on a conformed carrier 160. The carrier 160 has vertically reciprocable guides at 162. It is operated by ram 163 between its elevated full line position and its lowered dotted line position.

The rest of the mold chamber bottom is closed by hinged plates 161 actuated by toggle links 164 operated by rams 166. These plates lock carrier 160 in place against the pressure forcing the sand into the mold chamber. The plates 161 are retracted when the carrier 160 supporting the tray 100 is lowered through the cross conveyor 170.

A tray 100 which is mounted on the carrier, and supports a mold section, is deposited on the conveyor when the carrier passes downwardly through the conveyor. The conveyor thereupon advances one step to bring an empty tray into registry with the carrier to be picked up by the next upward movement of the ram 163 to reclose the bottom of the molding chamber together with plates on toggle links 164 and to receive another mold section (FIGS. 14 and 15). Thus, the up and down movement of the carrier 160 alternates with the step by step movement of the conveyor 170, each vertical reciprocation of the carrier in a downward direction transferring a finished mold section to the conveyor; each movement of the conveyor removing the finished mold section and advancing an empty tray into registry with the carrier; and each upward movement of the carrier moving the empty tray into position to close the bottom of the molding chamber.

It will be understood that the device herein disclosed will be equipped with pressure switches, limit switches and the like, which do not require illustration here since it is well within the skill of the art to provide these in the light of the following description of the operating sequence.

*Operating sequence*

When the machine is idle, the shuttle hopper will be open, the magazine vent valve will be open, the ram pistons 88 and 90 at the ends of the molding chamber will be advanced to close the molding chamber for filling. All other rams will be retracted and all solenoids de-energized.

The operator will initiate operation, preferably automatic, by energizing the solenoid of a spring-centered valve to raise the elevator ram table for closing the mold chamber bottom. This operation will also energize the solenoid of a 4-way valve to advance the shuttle hopper into registry with the magazine where it will contact the limit switch to energize the solenoid of a 4-way valve which actuates the clamp for pressing the shuttle hopper to the magazine.

A pressure switch responsive to pressure in the elevator ram 98 (and having interlocked limit switches closed only when the mold forming ram heads 84 and 86 are in molding position and the hopper is closed) will energize a circuit controlled by a timer. By means of this circuit, the solenoid of a 4-way valve will be energized to open the spool valve 54 to apply pneumatic pressure abruptly to the column of sand in the magazine for delivering the sand under high impact pressure into the mold chamber. At the conclusion of the period fixed by the timer, this solenoid will be de-energized to close the valve and the mold-forming rams 88 and 90 will be advanced from their initial positions to compress the charge of sand impacted in the mold chamber. The ram heads 84 and 86 are already in position to close the chamber as determined by limit switches adjustable so that they can be set by the operator as required for each pattern. The amount of pressure in the cylinders 92 and 94 will determine the hardness to which the mold section will be compressed in the chamber.

The circuit energizing the solenoid of the spool valve will also energize the solenoid of another timer which will determine the period for which compression of the mold by the heads 88 and 90 will be maintained.

When final pressure has been reached in the ram cylinders 92 and 94, pressure switches which are in series and respectively connected to be operated by the pressure of these cylinders will energize a pair of 2-way valves to transfer hydraulic pressure through a restricted bypass to the ram cylinders 92 and 94 to exert this pressure in a retracting direction upon the pistons 88 and 90 in a withdrawal direction to effect a slow draw. After initial slow movement has freed the pressure heads from the work, a timer will de-energize these solenoids and divert the hydraulic pressure to effect rapid withdrawal of the heads for the remainder of their retraction strokes. At the ends of the retraction strokes, limit switches will be used to de-energize the controlling solenoids of the respective valves so that the retractive movement of the ram pressure heads will terminate.

One of these switches may also be used to de-energize the solenoid of the valve which caused the hopper to move into registry with the magazine. The other such switch will energize through a timer, the solenoid of a valve which applies air pressure to the several vents. These two switches in series will energize the valve which controls the elevator ram to initiate the lowering of the completed mold section.

At this point the elevator ram is automatically energized to lower the elevator and thereby to withdraw the mold from the molding chamber. The stop above described will determine the extent of such movement and at or about the point at which the elevator engages the stops, a limit switch will be contacted to return the ram pressure heads 84 and 86 to their original intermediate positions from which they will advance only after a further batch of compacted sand has been delivered into the molding chamber thus closed by them. Limit switches will stop the rams when the pressure heads reach these intermediate positions.

The limit switch energized by the elevator in its fully retracted position will also energize the solenoid of a 4-way valve which effects operation of ram 108 to transfer the finished mold to the pouring line. Concurrently, it will de-energize the solenoid of the spring-centered valve controlling the elevator. When the shuttle hopper reaches registry with its source and receives sand therefrom, a limit switch engaged by the shuttle hopper will return it into registry with the magazine, where it will dwell pending initiation of a new cycle. If the device is set for automatic operation, and the general control switch is closed, the new cycle will commence automati-

cally when the ram controlling the shuttle hopper contacts a limit switch engaged when the shuttle hopper registers with the magazine.

I claim:

1. In a pneumatic impact-molding machine, the combination with a molding chamber, and a magazine for delivering sand into the molding chamber, and a source of sand offset from the magazine; of a shuttle hopper mounted for movement transversely of the magazine between a position of registry with the source and a position of registry with the magazine, means for sealing the magazine while the shuttle hopper is in registry with the source, and means operative while the shuttle hopper registers with the source for admitting a pneumatic fluid under pressure to the sealed magazine for the impact filling of the molding chamber with sand previously delivered to the magazine from the shuttle hopper.

2. A pneumatic impact-molding machine according to claim 1 in which the molding chamber comprises sides, ram heads fitted between said sides and guided for movement between retracted and advanced positions through intermediate positions wherein the heads constitute end walls for said chamber, rams connected with said heads for advancing and retracting the heads, and retractable means for closing the bottom of the molding chamber between the side walls and said ram heads.

3. A pneumatic impact-molding machine according to claim 2 in which said sides of the molding chamber are downwardly divergent.

4. A pneumaic impact-molding machine according to claim 1 in which the means for closing the bottom of the chamber comprises an elevator having means for raising and lowering said bottom closing means between a first position in which the molding chamber is closed and a second position in which a mold formed in said chamber is wholly removed to a level below the level of the chamber.

5. A pneumatic impact-molding machine according to claim 4 in which the closing means comprises a tray for the support of a molded article and which is removably connected with said elevator means.

6. A pneumatic impact-molding machine according to claim 5 in further combination with means for propelling laterally from said elevator means successive articles lowered by said elevator means from said chamber.

7. A pneumatic impact-molding machine according to claim 6 in further combination with a conveyor having openings through which said elevator means is advanced upwardly and retracted downwardly, the mold supporting tray being engageable with said conveyor to be supported thereon when the elevator means is retracted through the conveyor, said conveyor constituting the means for laterally propelling the mold.

8. A pneumatic impact-molding machine according to claim 1 in which a throat provides communication between the magazine and the molding chamber, said throat having side walls inwardly convex toward each other for guiding the flow into the molding chamber.

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