April 29, 1924. 1,492,352

D. J. CAMPBELL

PNEUMATIC SAND RAMMING MACHINE

Filed Nov. 10, 1919 6 Sheets-Sheet 1

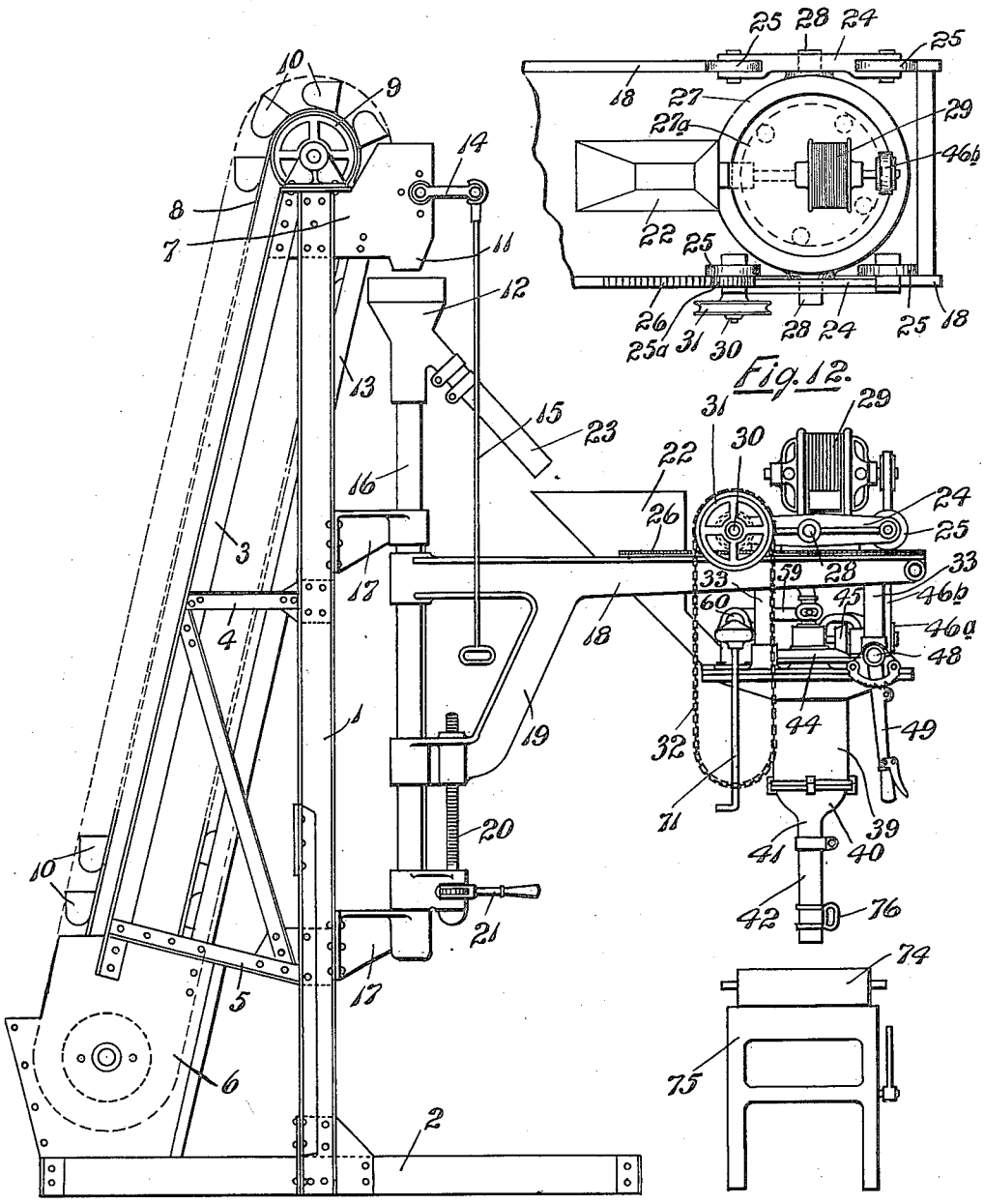


Fig. 1.

Fig. 12.

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Filed Nov. 10, 1919 6 Sheets-Sheet 2

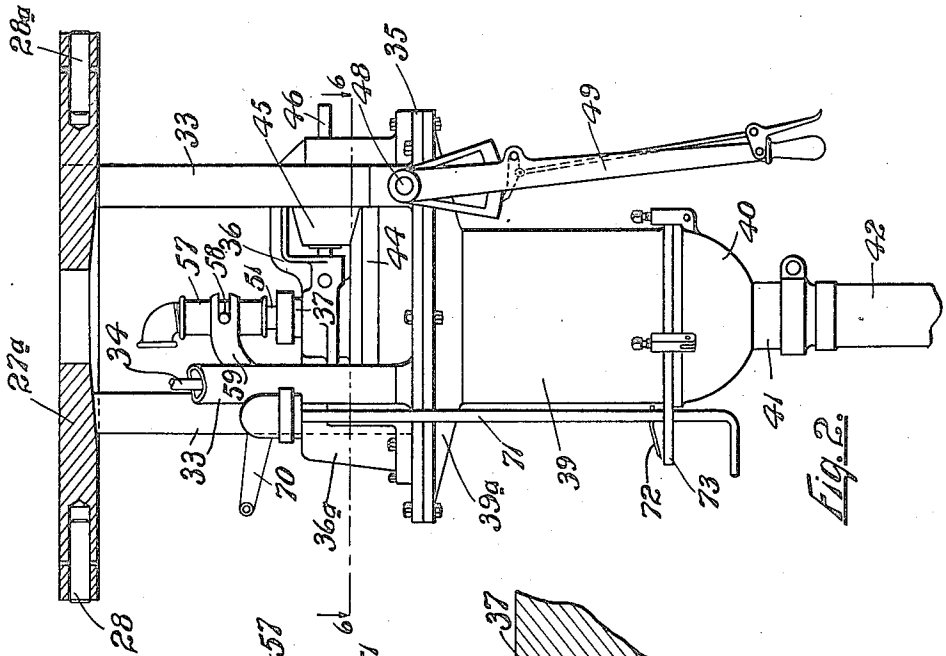


Fig. 2.

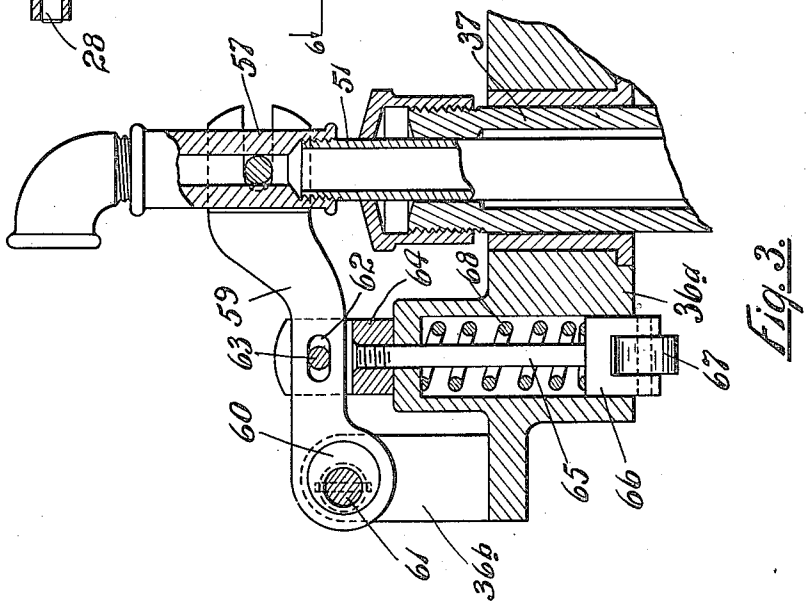


Fig. 3.

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PNEUMATIC SAND RAMMING MACHINE

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Fig. 5.

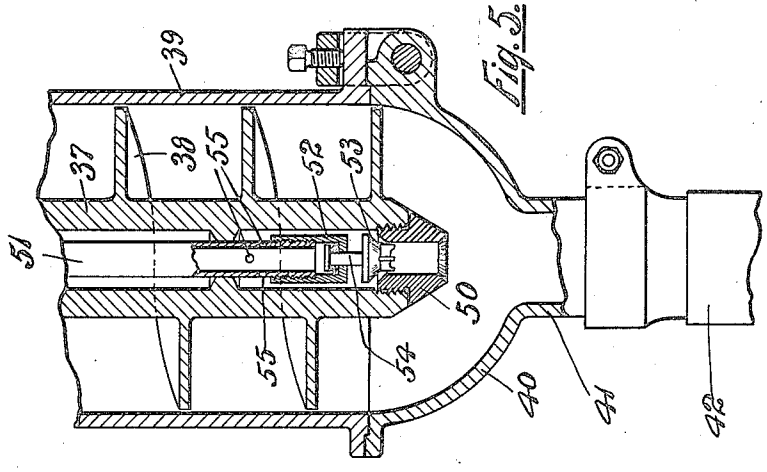
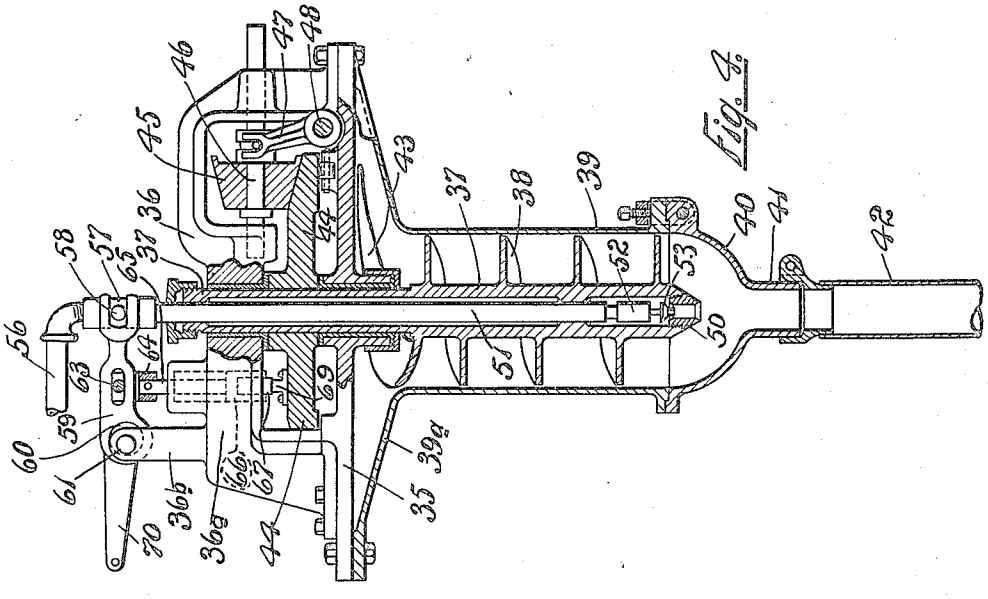


Fig. 4.



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PNEUMATIC SAND RAMMING MACHINE

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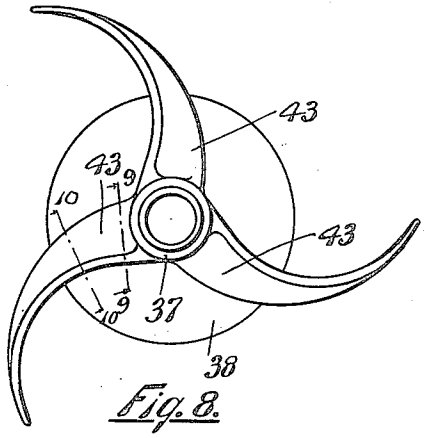


Fig. 8.

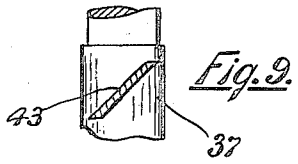


Fig. 9.

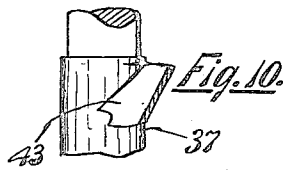


Fig. 10.

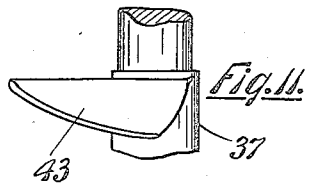


Fig. 11.

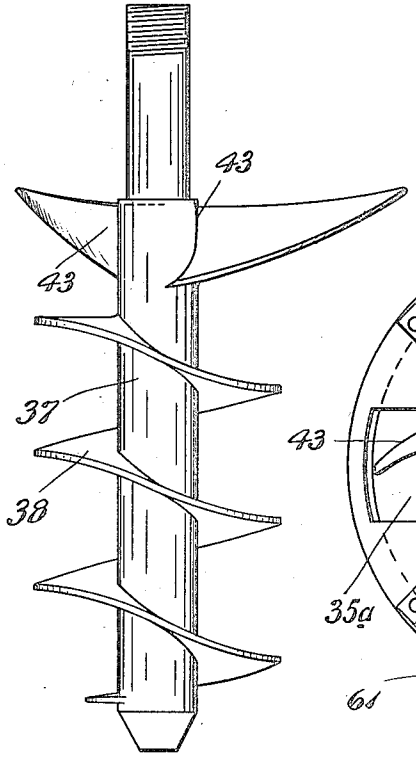


Fig. 7.

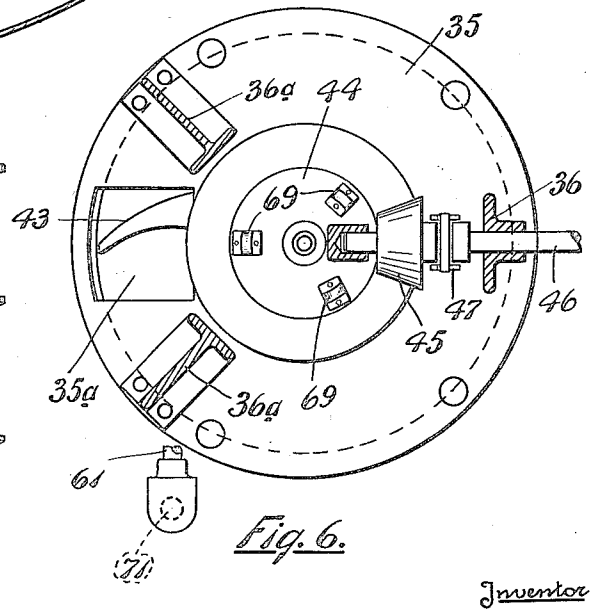


Fig. 6.

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PNEUMATIC SAND RAMMING MACHINE

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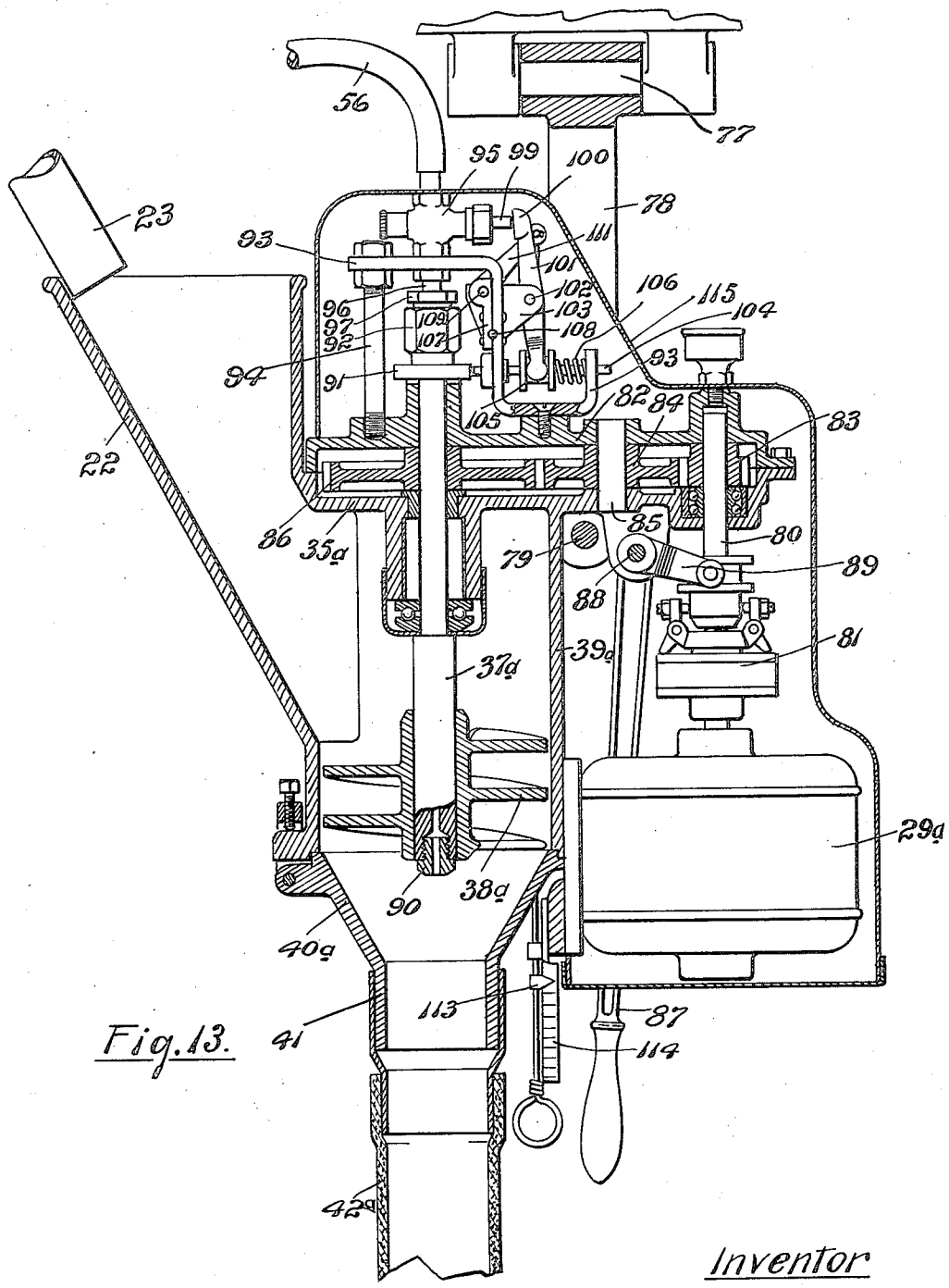


Fig. 13.

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PNEUMATIC SAND RAMMING MACHINE

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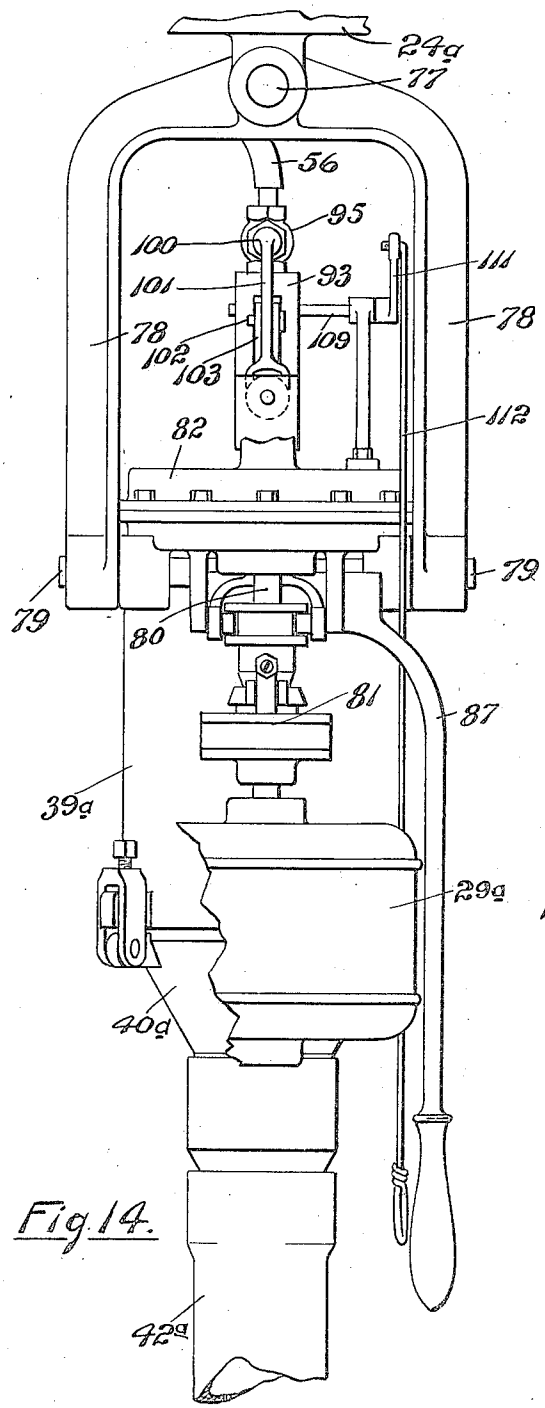


Fig. 14.

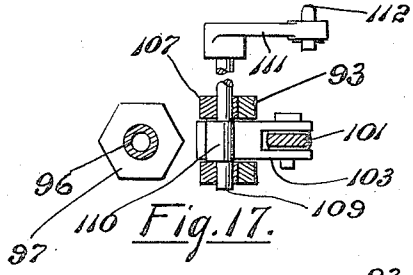


Fig. 17.

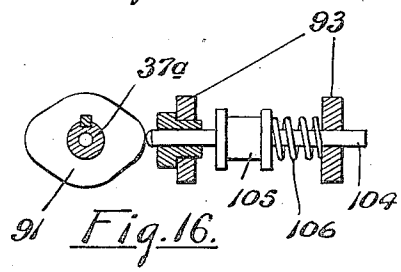


Fig. 16.

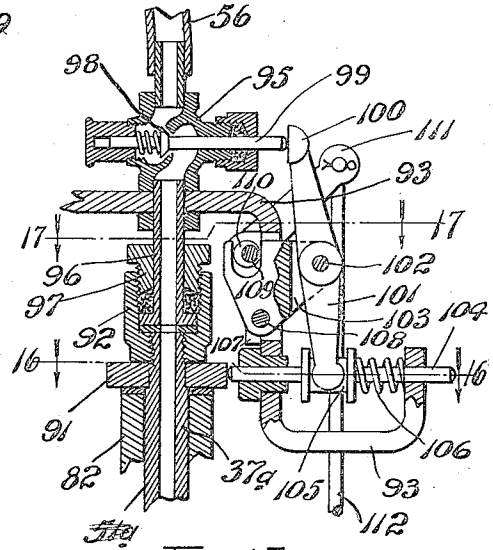


Fig. 15.

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UNITED STATES PATENT OFFICE.

DONALD J. CAMPBELL, OF MUSKEGON HEIGHTS, MICHIGAN.

PNEUMATIC SAND-RAMMING MACHINE.

Application filed November 10, 1919. Serial No. 336,832.

To all whom it may concern:

Be it known that I, DONALD J. CAMPBELL, a citizen of the United States of America, residing at Muskegon Heights, in the county of Muskegon and State of Michigan, have invented certain new and useful Improvements in Pneumatic Sand-Ramming Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to machines adapted to be operated so as to take small quantities of sand and pneumatically eject the same into a flask around a mould. Usually the ramming of sand in flasks in the operation of molding has been done manually. In my invention it is contemplated that the moulding sand shall be thrown into the flask with force sufficient to pack or ram the sand to the necessary degree and that the force of throwing the sand be supplied by compressed air which is applied periodically but at very close intervals so that successive small quantities of sand are rapidly thrown into the flask or practically forced thereinto by the force of compressed air. A further object of the invention is to provide a machine of this character which has a large range of movement whereby the same may be directed to different parts of the flask or may be used with flasks differently positioned or of different sizes. Various other objects and purposes of the invention consists in a novel construction and arrangement of parts for bringing the sand into proper position with respect to the compressed air nozzle so that the same shall be in position to receive the force of the air for purposes of ejecting the same; in means for controlling the passage of sand to the machine, and in many other novel features of construction and arrangement of parts for the practical and effective attainment of the ends for which the machine is designed, all of which will appear fully and in detail in the following description taken in connection with the accompanying drawings, in which;

Fig. 1 is a side elevation of the complete machine.

Fig. 2 is a side elevation enlarged, over that shown in Fig. 1 of the sand receiving and ejecting mechanism.

Fig. 3 is an enlarged fragmentary vertical section through a detail of mechanism having to do with the periodic operation of the air emmission.

Fig. 4 is a central vertical section taken through the construction shown in Fig. 2.

Fig. 5 is an enlarged section of the lower part of the sand receiving casing and the conveyor and the pneumatic air means located therein.

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

Fig. 7 is an elevation of the screw conveyor forming a part of the machine.

Fig. 8 is a plan view thereof.

Figs. 9 and 10 are fragmentary sections and elevation taken substantially on the lines 9—9 and 10—10 of Fig. 8.

Fig. 11 is a fragmentary side elevation of the upper part of the conveying screw illustrating one of the vanes used at the upper end of the screw for insuring that the sand is delivered to the screw;

Fig. 12 is a plan of the carriage and support therefor which carries the mechanism.

Fig. 13 is a view similar to Fig. 4 illustrating a modification in construction.

Fig. 14 is a side elevation thereof, the covering member being removed.

Fig. 15 is a fragmentary vertical section somewhat enlarged illustrating the mechanism used for operating the air valve; and

Figs. 16 and 17 are horizontal sections taken respectively on the lines 16—16 and 17—17 of Fig. 15.

Like reference characters refer to like parts in the different parts of the drawings.

In the construction a support, including vertical posts 1 attached at their lower ends to a suitable base 2 and with diagonal braces 3 connected to the posts 1 by suitable ties 4 and 5, is provided, the lower ends of the braces 3 being connected to a sand receiving receptacle 6 and at their upper ends to a hopper 7 to which the sand is delivered. An endless conveyor 8 is mounted to run around a wheel 9 mounted on a suitable horizontal shaft at the upper end of the support and a similar wheel within the sand receptacle 6, this conveyor being equipped with a plurality of sand cups 10 so that when the conveyor is operated the sand is carried from the receptacle 6 to the hopper 7. Said hopper 7 has an outlet at 11 for the sand to pass from the hopper to a second hopper 12.

A return conduit 13 is disposed between the hopper 7 and the sand receptacle 6. An arm 14 is mounted on the hopper 7 and is adapted to be moved by manual operation of a downwardly extending rod 15, it being designed that operation of this arm 14 is to control the delivery of the sand either to the second hopper 12 or to the return conduit 13. The specific means for effecting this control is not novel, forms no part of the invention, and is not specifically shown and described.

The second hopper 12 is secured at the upper end of a post 16 which is mounted in front of the posts 1 on upper and lower brackets 17, being mounted so as to turn about a vertical axis. A bracket comprising two upper horizontal arms 18 and diagonal downwardly extending braces 19 is mounted on the post 16 and may be raised or lowered by turning a screw 20 connected with the part 19 and operated by a handle 21 as shown in Fig. 1. The arms 18 of the bracket are supports for a carriage, hereafter described, on which the pneumatic sand ramming machine is mounted and to which sand is delivered from a receptacle 22 into which the sand passes from the second hopper 12 through an outlet pipe 23 as shown.

The carriage 24 is mounted on rollers 25 so as to move back and forth over the arms 18. A ring 27 is pivotally mounted on a horizontal axis between the arms 18 and a platform 27^a is pivotally mounted within the ring 27, the axes of the pivots 28 and 28^a of the ring and platform being at right angles to each other so that the platform and attached mechanism thereon have a universal movement with respect to the supporting arms 18. One of the carriage rollers is provided with a pinion 25^a which engages with a rack 26. The shaft 30 of the roller on which pinion 25^a is mounted is extended slightly and on it a wheel 31 is fixed, around which an endless chain 32 passes, the same extending downwardly so as to be within reach of the operator whereby by pulling on this chain the carriage may be moved to different positions with respect to the supporting arms 18. The platform 27^a carries a motor 29 on its upper side.

Sleeves 33 cover rods 34 which are attached at their upper ends to and depend from the platform, being connected at their lower ends to a cover plate 35 which forms a part of the sand receiving casing, having an opening 35^a in one side thereof, as shown in Fig. 6, for the passage of sand from the receptacle 22 through said cover. A bracket 36 having two branches 36^a is connected to and lies above the cover, being spaced at its intermediate portion a distance from the cover as shown. Suitable bearings one directly above the other are made in the bracket and in the cover plate 35 through which a hollow spindle 37 passes being provided at its lower end with conveying screw or helix 38. This lower portion of the spindle 37 with the attached conveyor screw 38 is housed within a housing 39 having an inner diameter but slightly larger than the diameter of the screw and having its upper end outwardly flared as shown in 39^a and attached permanently to the cover. The housing member 39 is of cylindrical form and has a closing cap 40 connected thereto at its lower end which is of substantially semi-spherical form and provided with an outlet neck 41 in its lower portion to which a flexible tube 42 is connected, to serve as an outlet member to the sand casing. At the upper end of the screw 38 the spindle 37 is equipped with a number of outwardly extending vanes 43 which are shaped to pass closely underneath the cover 35 and cut and scrape off sand which may be attempting to pass through the opening at 35^a but which, on account of the necessary dampness of moulding sand, does not always move freely and is liable to pack together and resist movement. These vanes 43 serve to carry the sand downwardly and inwardly to the casing 39 to below the screw and the lower end of the spindle 37.

To drive the spindle, a friction wheel 44 is attached thereto between the cover 35 and the bracket 36. Against this friction wheel a drive pulley 45, splined on a shaft 46, is adapted to bear and drive the same. The shaft 46 has a pulley 46^a at its outer end around which a belt 46^b driven by the motor 29, passes. The friction pulley 45 may be moved away from the friction wheel, a ram 47 being attached thereto at one end and at its opposite end connected to a shaft 48 from which a handle 49 depends, the same being movable so as to either hold the pulley 45 in frictional contact with the wheel 44 or to carry said pulley out of contact therewith.

In the lower end of the spindle 37 a nozzle member 50 is secured having a passage therethrough and formed at its upper end with a valve seat. A tube 51 extends lengthwise of the spindle 37 being closed at its lower end by a cap 52. A conical valve 53 depends from a stem 54 which passes through the lower side of the cap 52 being provided with a head, as shown in Fig. 5, to prevent disengagement. A number of openings 55 are made in the tube 51 immediately above the cap 52. Compressed air is supplied to the tube 51 through a pipe 56 which, through a suitable union 57, joins with the upper end of the tube 51 above the spindle 37. In the position of the air tube and of the valve shown in Figs. 4 and 5 compressed air escapes through the openings 55 and thence past the valve 53 through

the nozzle 50, and any sand which may be below this nozzle is forced through the neck 41 and the flexible conduit 42.

The union 57 has oppositely projecting pins 58 with which the forked end of a lever 59 engages, said lever being mounted on an eccentric 60 at its opposite end. The eccentric has a shaft 61 passing therethrough, off center, as shown in Fig. 3, and mounted in suitable vertical parts 36^b on the divided ends 36^a of the bracket 36. The lever 59 is slotted between its ends as shown at 62. Through this slot a pin 63 carried by a block 64, passes, the block being attached at the upper end of a rod 65 which extends downwardly through a suitable housing made in the bracket part 36^a, and has a forked member 66 at its lower end on which a roller 67 is mounted. A heavy coiled spring 68 under compression, is located in the housing between the upper side thereof and the fork 66, the tendency of which is to move the tube 51 in a downward direction and bring the valve 53 into engagement with the seat made in the upper end of the nozzle 50 and thus shut off the passage of air through the nozzle member. The roller 67 bears against the upper side of the friction wheel 44. A plurality of cams 69 are attached to the upper side of the friction wheel 44 so as to come under the roller, elevating the same and attached parts. I have shown three of these cams in Fig. 6 though the number may be varied as desired. Whenever a cam runs under the roller the air tube 51 and attached valve 53 are elevated and the compressed air is permitted to escape through the nozzle 50. It is evident that in the operation of the machine there is a periodic change of position of the air tube 51 and that the air passes through the nozzle 50 in successive jets which follow each other closely.

It will be noted that the valve 53 is not lifted off from the valve seat until the head of the stem 54 is directly engaged by the cap 52 to lift it. Normally the tendency is for the valve to seat firmly against its valve seat due to the pressure of air against the upper side of the valve. The air cannot pass through the nozzle 50 until the valve is lifted from the seat and the time of passage of the air is governed by the distance that the valve is lifted. Accordingly, I have provided a means to control this by changing the position of the eccentric 60. Shaft 61 extends beyond the cover 35 and may be operated in any suitable manner by turning a vertically positioned rod or shaft 71 so as to turn the eccentric 60 to different positions and thereby give a greater or less range of movement to the end of the lever 59, which is connected to the air tube 51. An indicating pointer 72 may be connected to the shaft 71 passing over an indicating plate 73 to inform the operator as to the amount of change he may make.

When the machine is in operation the sand is carried to the lower part of the casing being directed by the curved form of the end member 40 of the casing to immediately below the nozzle member. The pitch of the screw 38 is such that the sand will not pack but is carried downwardly and delivered in loose form to directly below the nozzle. The sand thus delivered is acted upon by the jets of compressed air which pass from the nozzle directly against it, impelling the same through the neck 41 and the flexible conduit 42. There can be no large accumulation of sand below the nozzle as the jets of air come with great frequency and which may be controlled by the number of cams 69 which pass under the roller 67. The sand as it passes from the nozzle member 42 may be directed to any portion of a flask 74 located on a suitable support 75 under the lower end of the conduit 42. On this conduit a handle 76 is placed, preferably, so that the same may be bent to different positions to direct the sand to any portion of the flask.

In Figs. 13 to 17 inclusive a construction is shown accomplishing the same ends but with a simplified mechanism and for that reason preferred. The carriage which traverses the arms 18 may be modified so as to support a horizontal rod 77 lying parallel to the length of the arms and on which a yoke having depending spaced apart sides 78 is pivotally mounted. The pneumatic sand ramming mechanism is mounted between and at the lower ends of the arms 78, a rod 79 passing through just underneath the upper side 35^a of the casing 39^a of the machine, the mechanism being practically balanced on this rod. It is apparent that the universal movement of the mechanism is attained by this construction as well as by that previously described and in a simpler manner.

The casing 39^a is shorter than casing 39 and has an inlet at its upper end and to one side for the passage of sand thereinto from the hopper 22. The screw 38^a is shorter and is connected to a spindle 37^a which has an opening through its entire length and which passes upwardly through the upper side 35^a to the casing. The lower part of the casing 40^a is modified slightly in that it is of frusto-conical shape instead of semi-spherical as in the first construction but it likewise has a reduced neck 41 to which a flexible conduit 42^a is connected.

The motor 29^a for running the device is located at one side of the casing 39^a and is connected with a vertical shaft 80 by a clutch 81. The shaft passes upwardly through an extension to the cover 35^a and also through a plate 82 which covers the

upper side 35ª of the casing being spaced therefrom for the reception of a train of gearing. One of these is a pinion 83 fastened on the shaft 80 to mesh with an idler 84 on a shaft 85, the idler in turn engaging with a gear 86 keyed to the spindle 37ª. The clutch is operated by a handle 87 pivotally mounted at 88 below the extension to the upper side 35ª of the casing, and from the shaft 88 a yoke 89 extends to engage with a suitable collar on the clutch whereby by operating the handle 87 the clutch may be disengaged when desired.

In the lower end of the spindle 37ª a nozzle 90 is mounted. Above the plate 82 a cam 91 is keyed to the spindle 37ª. This spindle at its upper end is threaded above the cam and on its threaded upper end a nut 92 is secured. A bracket 93 bent into the form shown in Figs. 13 and 15 is secured at one point to the plate 82 and is connected at its upper end by a rod 94 to the plate. Directly above the uppermost part of this bracket a valve casing 95 is positioned into which the compressed air conduit 56 leads. A short pipe 96 connects with the valve casing 95, passing through the bracket 93, and extends into the upper part of the nut 92 which is interiorly bored and threaded for its reception. The lower end of the pipe 96 is enlarged to make a head and suitable packing is pressed above said head and secured in place by a nut 97 threaded into the nut 92 as shown in Fig. 15. This permits the free rotation of the spindle 37ª while the pipe 96 remains stationary and without any loss of air at the connection.

A spring actuated valve 98 mounted on a rod 99 is located within the valve casing 95, the valve normally occupying a closed position to prevent the passage of air through the valve casing and through the spindle 37ª. Rod 99 projects beyond the valve casing and at its end is engaged by a head 100 at the upper end of a lever 101 which is pivotally mounted at 102 on a supporting bracket 103. This supporting bracket 103 is adjustably mounted on the bracket 93 by means of a construction which will later be described. A horizontal rod 104 is mounted for longitudinal movements in the lower part of the bracket 93 and at one end is designed to bear against the cam 91. The lower end of the lever 101 is formed into a yoke to engage with a collar 105 fixed on rod 104 and the rod is normally pressed against the cam by a coiled spring 106 disposed between the collar and an upstanding portion of the bracket 93. It is evident when the spindle 37ª is driven, that rod 104 is twice reciprocated with the construction of cam shown at 91 in Fig. 16. The movement or reciprocation of the rod, however, may be readily controlled with different designs of cams having a greater or less number of projections for operating the rod. With every reciprocation of the rod lever 101 is oscillated about its pivot 102 and the valve 98 first opened and then allowed to close, this permitting periodical passage of compressed air downwardly through the spindle and out of the nozzle at 90, as is obvious.

The bracket 103 passes through a slot in bracket 93 back and at each side of which members 107 are secured. A shaft 108 passes through the bracket 103 and between the members 107 and the bracket 93 whereby bracket 103 is pivotally mounted on the shaft 108. A shaft 109 is located above shaft 108 and mounted at its ends in the members 107. The bracket 103 is slotted for the passage of this shaft and for the reception of an eccentric 110 mounted on or formed integral with the shaft 109. At one end the shaft 109 extends beyond the adjacent member 107 for a distance and has an arm 111 secured thereto from which an operating rod 112 depends. By grasping this rod and moving it up or down the bracket 103 may be moved toward or away from bracket 93 and the position of the pivot for the lever 101 changed relative to the bracket 93, this changing the relation of the lever 101 to the valve rod 99. It is evident that by changing this position the amount that valve 98 is opened is varied and the passage of the compressed air in this way controlled. Adjacent the lower end of rod 112 a pointer 113 is fixed, the same being adapted to pass over an indicating scale 114, serving to guide the operator in adjusting the air. The motor clutch, plate 82 and the mechanism located above the same are all covered preferably, by a sheet metal cover 115 so as to preclude the entrance of sand, dust or the like which would be injurious to the mechanism.

This construction of mechanism is simpler than that previously described and with it the same results are attained. The compressed air acts periodically, passing from the lower end of the spindle 37ª in jets which come frequently, this periodically forcing small quantities of sand out of the lower part of the casing and through the flexible conduit 42 to the flask. It is apparent that with either construction there is a wide range of movement. The mechanism as a whole may be mounted for movement on the supporting arms 18; the sand casing and attached parts may be swung on horizontal axes located at right angles to each other whereby a practically universal movement may be attained; and in addition the flexible outlet tube or conduit 42 may be turned to different positions so that the sand may be directed wherever desired. In both constructions the sand is carried in loose

form to below the screw and is more or less packed between the lower turn of the screw and the end 40 or 40ª of the casing, making a seal which prevents the blowing of sand in an upward direction in the casing and escape of air in that direction, the sand being forced out through the reduced portion 41 at the lower end of the casing. Various changes in minor detail of construction may be resorted to without departing from the invention and I, accordingly, consider myself entitled to all modifications of structure which fall within the scope of the appended claims defining the invention.

I claim:

1. In combination, a hollow cylindrical casing having a cover at its upper end provided with an opening therein, a sand receiving hopper adapted to deliver sand to the casing through said opening, said casing having an outlet neck of reduced size at its lower end, a vertical spindle extending downward into the casing and mounted for rotation on the cover, means to drive the spindle, a conveying screw on the spindle, said screw carrying the sand in losse form to the lower end of the casing and below the lower end of the spindle, and means to automatically deliver compressed air at periodic intervals from the lower end of the spindle against the sand below said spindle to project the sand out of the casing through the outlet, substantially as described.

2. In combination, a support including a horizontal supporting member, a carriage mounted to move back and forth thereon, a casing suspended from the carriage and mounted thereon to have pivotal movement about two horizontal axes located at right angles to each other, means rotatably mounted within the casing for carrying sand entered into the casing at its upper end to the lower end of the casing, and means for periodically ejecting said sand from the casing at the lower end thereof, substantially as described.

3. In combination, pneumatic means for projecting sand in small quantities and in quick succession into a moulding flask, and means for delivering sand to said pneumatic means, substantially as described.

4. In combination, a sand receiving casing having a cover for the upper end thereof, said cover having an inlet opening therethrough, a spindle mounted to turn on a vertical axis and extending through the cover into the casing, a conveying screw on the spindle for carrying sand to the lower part of the casing, means on the spindle above the screw and below the cover for carrying sand entered into the casing through said inlet opening to the screw, means to rotate the spindle, and means to periodically deliver compressed air from the lower end of the spindle against sand which has been carried to the lower portion of the casing, said lower portion of the casing being provided with an outlet through which the sand may be ejected by the air, substantially as described.

5. In combination, a sand receiving and ejecting mechanism, and supporting means therefor, including means for moving the mechanism back and forth in a horizontal plane, means for turning the mechanism about either of two horizontal axes located at right angles to each other, and means to raise and lower the mechanism, substantially as and for the purposes described.

6. In combination, a sand receiving and ejecting mechanism and supporting means therefor, including means for raising and lowering the mechanism, means for moving the mechanism back and forth in a horizontal plane, means for swinging the mechanism back and forth about either of two horizontal axes located a distance above the mechanism, said mechanism having an outlet thereto and a nozzle attached to the outlet adapted to swing to any desired angle with respect to the outlet, substantially as described

7. In combination, a support, a sand receiving and ejecting mechanism suspended from and movable back and forth on the support, means for delivering sand to the mechanism, means included in the mechanism for continuously carrying the sand delivered thereto to a lower position in the mechanism, and pneumatic means for acting on the sand at close intervals to eject the sand in small quantities into a moulding flask, substantially as and for the purposes described.

8. In combination, a support, a casing movably mounted on the support and depending below the same, said casing having an entrance opening in the upper part for the entrance of sand into the casing and an outlet at its lower end, a spindle extending downwardly through the top of the casing, a screw mounted thereon for carrying sand entered into the casing to a point below the screw, a motor, gearing connections for driving the spindle from the motor, said spindle having an opening throughout its entire length, and means for passing compressed air at short intervals through the spindle to the lower end thereof, substantially as and for the purposes described.

9. In combination, a casing having an upper inlet opening and a lower outlet, a spindle passing through the casing at the upper end thereof, said spindle having an opening extending its entire length, a conveying screw at the lower end of the spindle, means for driving the spindle, a conduit, a valve located therein above the upper end of the spindle, means for connecting said conduit and spindle, means for carry-

ing air under pressure to the valve, and means for opening the valve at intervals with the rotation of the spindle to permit the passage of air through the valve and through the spindle to the lower end thereof, substantially as described.

10. In combination, a hollow casing having an upper inlet opening and a lower outlet, a spindle passing through the upper side of the casing and extending downwardly into the casing, said spindle having an opening throughout its length, a conveying screw on the lower part of the spindle, a motor, gearing mounted on the upper side of the casing driven by the motor for thereby turning the spindle, a plate covering the gearing, means to conduct compressed air to the upper end of the spindle, a normally closed valve interposed in the length of said means for stopping the passage of air, and means operated by the rotation of the spindle for opening the valve at intervals to permit the passage of air therethrough and through the spindle to a point below the lower end thereof, substantially as described.

11. In combination, a hollow casing having an upper inlet opening and a lower outlet thereto, a spindle mounted in the casing and extending above the same, a conveying screw on the spindle, said spindle having an opening throughout its entire length, a cam on the spindle, a conduit for carrying compressed air to the upper end of the spindle, a normally closed valve located in the length of the conduit, and means operated by movement of the cam as the spindle turns for opening the valve to permit the passage of air through the spindle and out at the lower end thereof, substantially as described.

12. In combination, a casing having an upper inlet opening and a lower outlet thereto, a spindle mounted vertically in the casing, a conveying screw on the spindle between said inlet opening and outlet, said spindle having a longitudinal opening therethrough, a conduit for carrying compressed air to the upper end of the spindle, a normally closed valve located in the length of the conduit, a cam on the spindle, means to drive the spindle, means operated by the cam for opening the valve at intervals, and means to adjust said cam operating means to different positions to govern the extent that the valve is opened, substantially as and for the purposes described.

13. In combination, a casing provided with an upper inlet opening and with an outlet thereto, a spindle passing through the upper side of and extending a distance into the casing, a conveying screw on the spindle between the inlet and outlet to the casing, a gearing on the spindle above the upper side of the casing, a motor located alongside of the casing, gearing connections between the motor and the gear on the spindle for continuously driving the spindle, a plate covering the gears, a cam mounted on the spindle above the plate, a conduit for carrying compressed air to the upper end of the spindle, said spindle having an opening through its entire length, a normally closed valve mounted in the conduit, a bracket mounted on the plate, a lever pivotally mounted between its ends on the bracket, a rod attached to the valve and projecting outwardly into engagement with the lever, and means operated by the cam for turning the lever about its pivot to thereby open the valve to permit the passage of air through the spindle, substantially as described.

14. In combination, a casing having an upper inlet and lower outlet thereto, a spindle mounted vertically in the casing and extending above the same, a conveying screw on the lower part of the spindle, a conduit for carrying air under compression to the upper end of the spindle, said spindle having a longitudinal opening through its entire length, a normally closed valve in said conduit, means for continuously driving the spindle in one direction, means operated by the spindle for opening the valve at intervals, and means for controlling the extent that the valve shall open, substantially as and for the purposes described.

15. In combination, a casing having an upper inlet opening and a lower outlet thereto, a mechanism mounted on the casing for periodically projecting sand in small quantities from the casing through the lower outlet thereto, a yoke on which said casing is mounted to turn about a horizontal axis, and means for mounting the yoke to turn about a horizontal axis located at right angles to the axis on which the casing is mounted, substantially as described.

16. In combination, a casing having an upper inlet and a lower outlet thereto, a spindle having an opening throughout its entire length mounted vertically in the casing and extending above the same, means for turning the spindle, a conveying screw secured to the lower part of the spindle, a conduit for carrying compressed air to the upper end of the spindle, a valve casing forming a part of the conduit, a spring actuated valve in the valve casing normally closing against the passage of air, a rod attached to the valve and extending beyond the valve casing, a plate mounted above the casing, a bracket on the plate, a cam on the spindle, a second rod mounted on the bracket, spring means acting to force said second rod against the cam, a second bracket mounted on the first bracket, means to adjust the second bracket to different positions, and a lever pivotally mounted between its ends on the second bracket and

bearing at its upper end against the valve rod and connected at its lower end to the second mentioned rod, substantially as and for the purposes described.

17. The process of supplying sand to a flask in molding, which comprises impacting it in said flask and about the pattern by application of compressed air with explosive effect.

18. An apparatus for supplying sand to molding flasks, comprising means for containing a charge of sand, and fluid pressure means for suddenly applying fluid pressure behind said charge and ejecting it bodily into said flask with impacting force.

In testimony whereof I affix my signature.

DONALD J. CAMPBELL.