No. 819,883. PATENTED MAY 8, 1906.

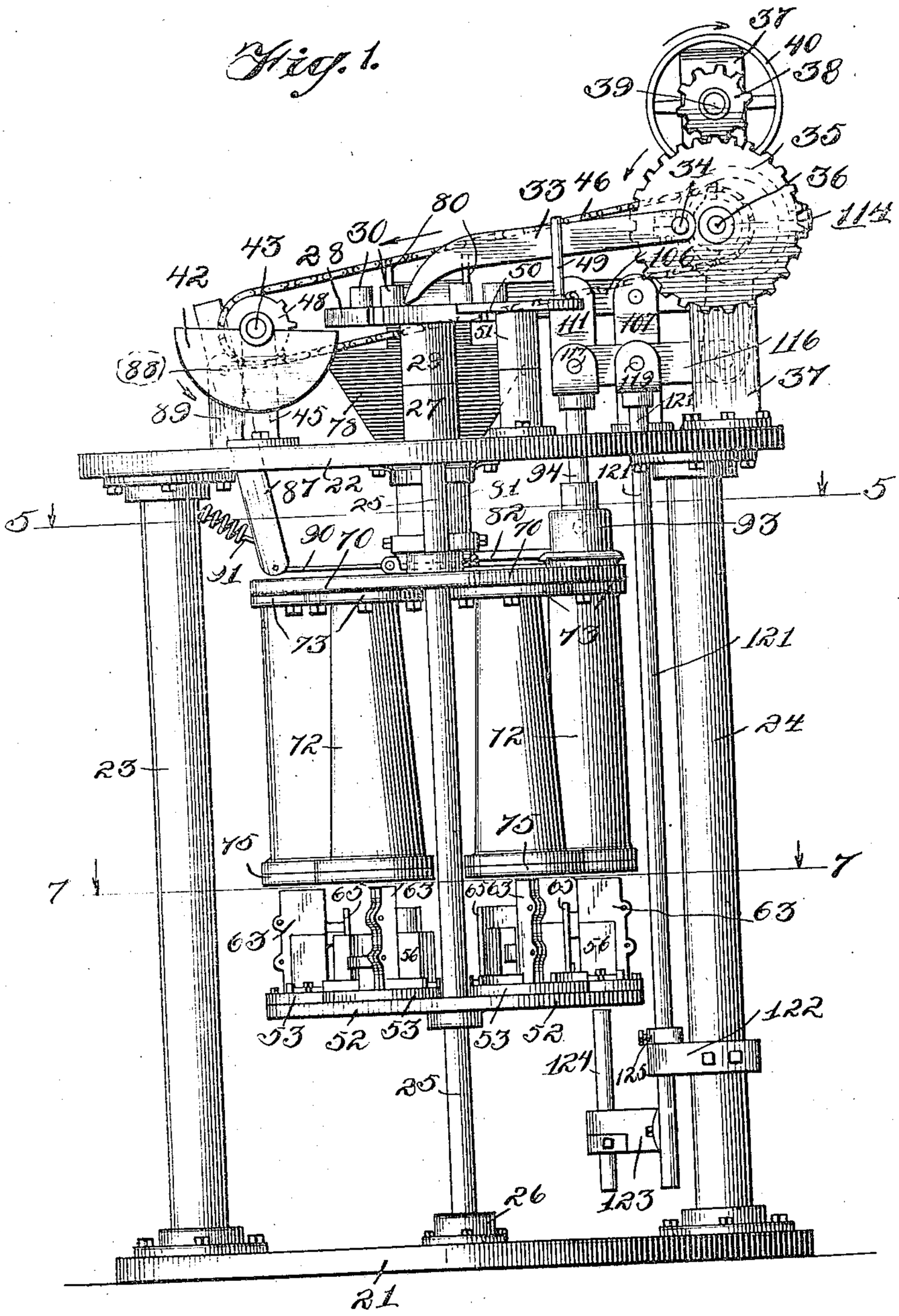
A. M. & M. J. HEWLETT.

MOLDING APPARATUS.

APPLICATION FILED OCT. 16, 1903.

8 SHEETS—SHEET 1.

Fig. 1.

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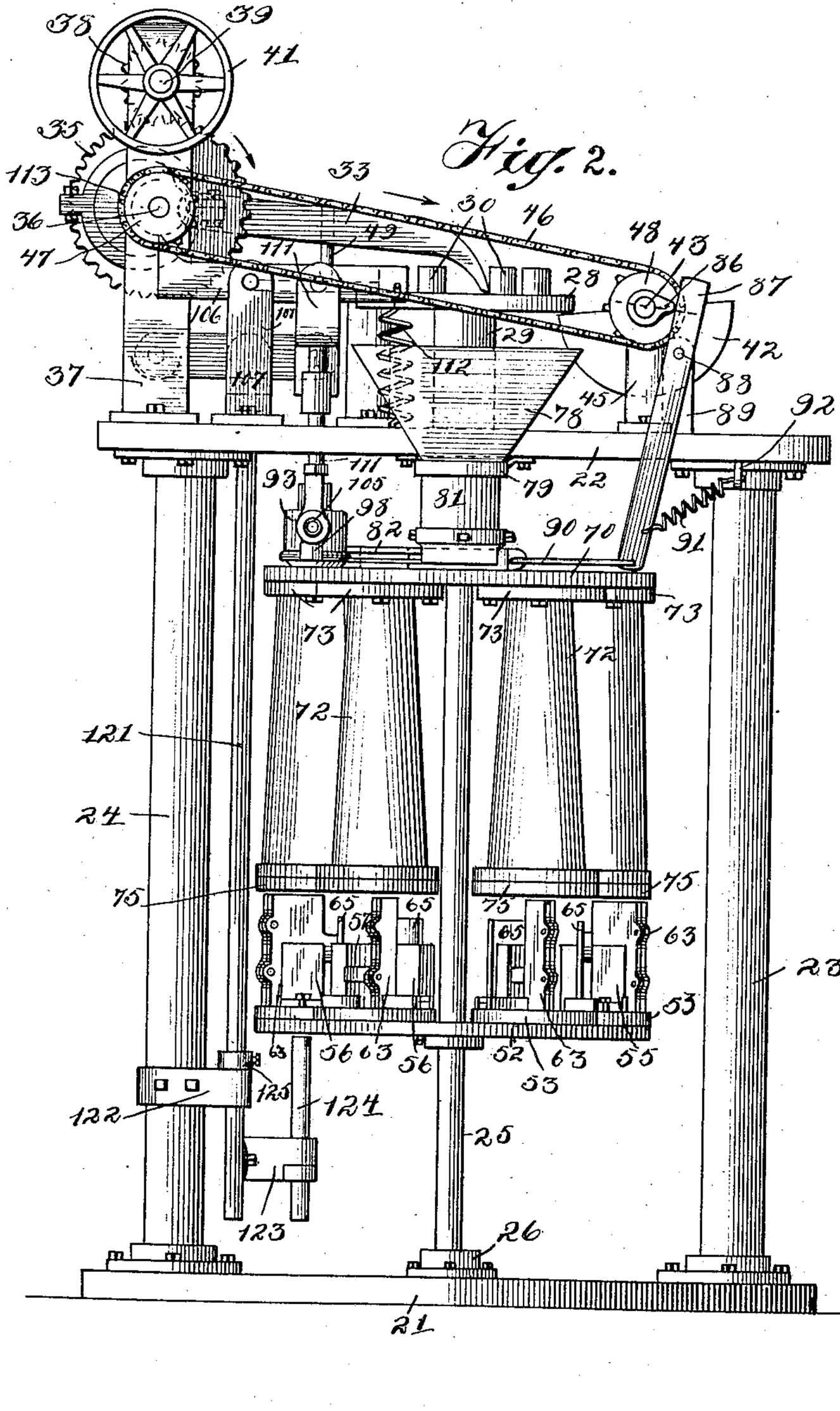
8 SHEETS—SHEET 2.

Fig. 2.

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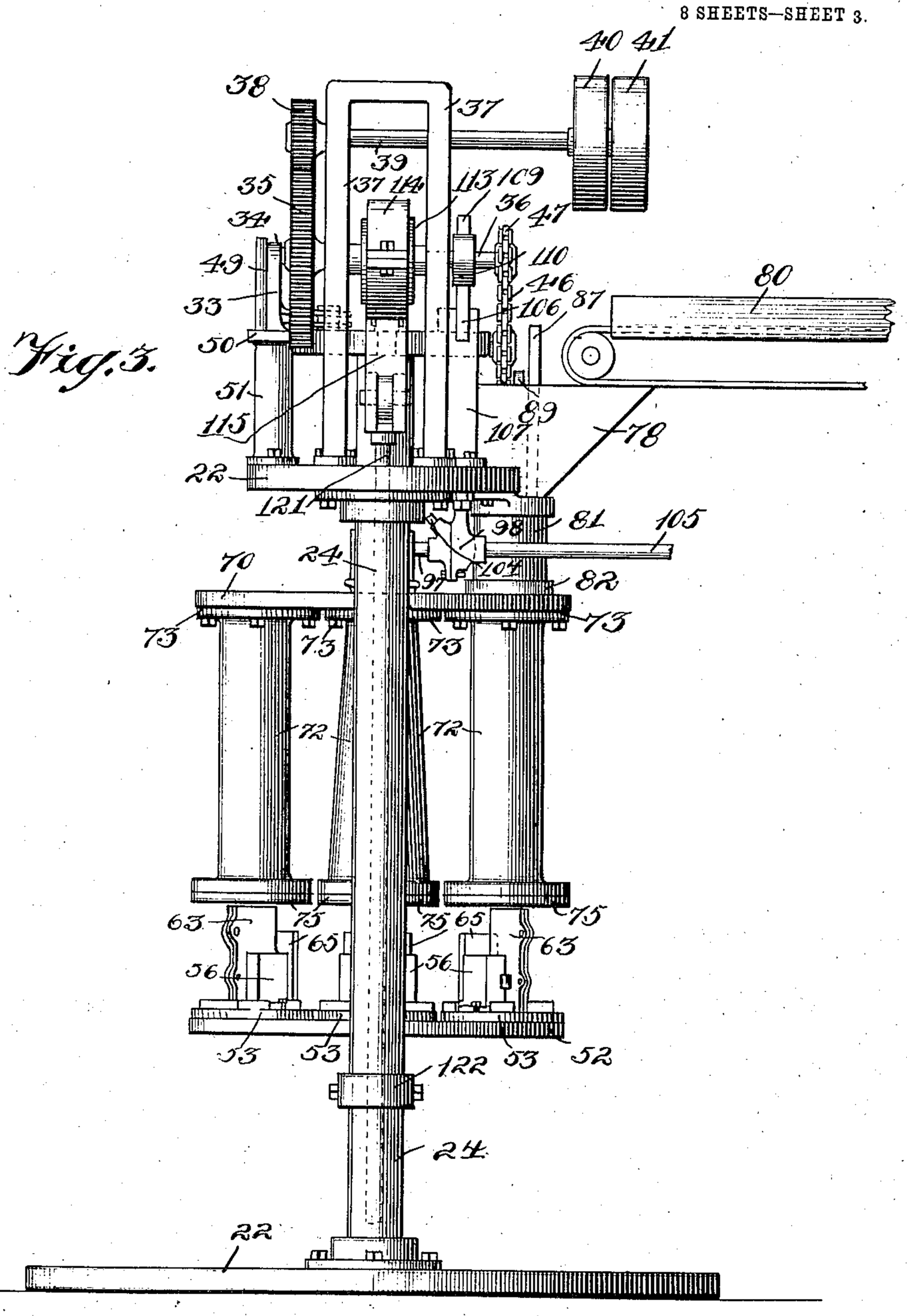
8 SHEETS—SHEET 3.

Fig. 3.

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8 SHEETS—SHEET 4.

Fig. 4.

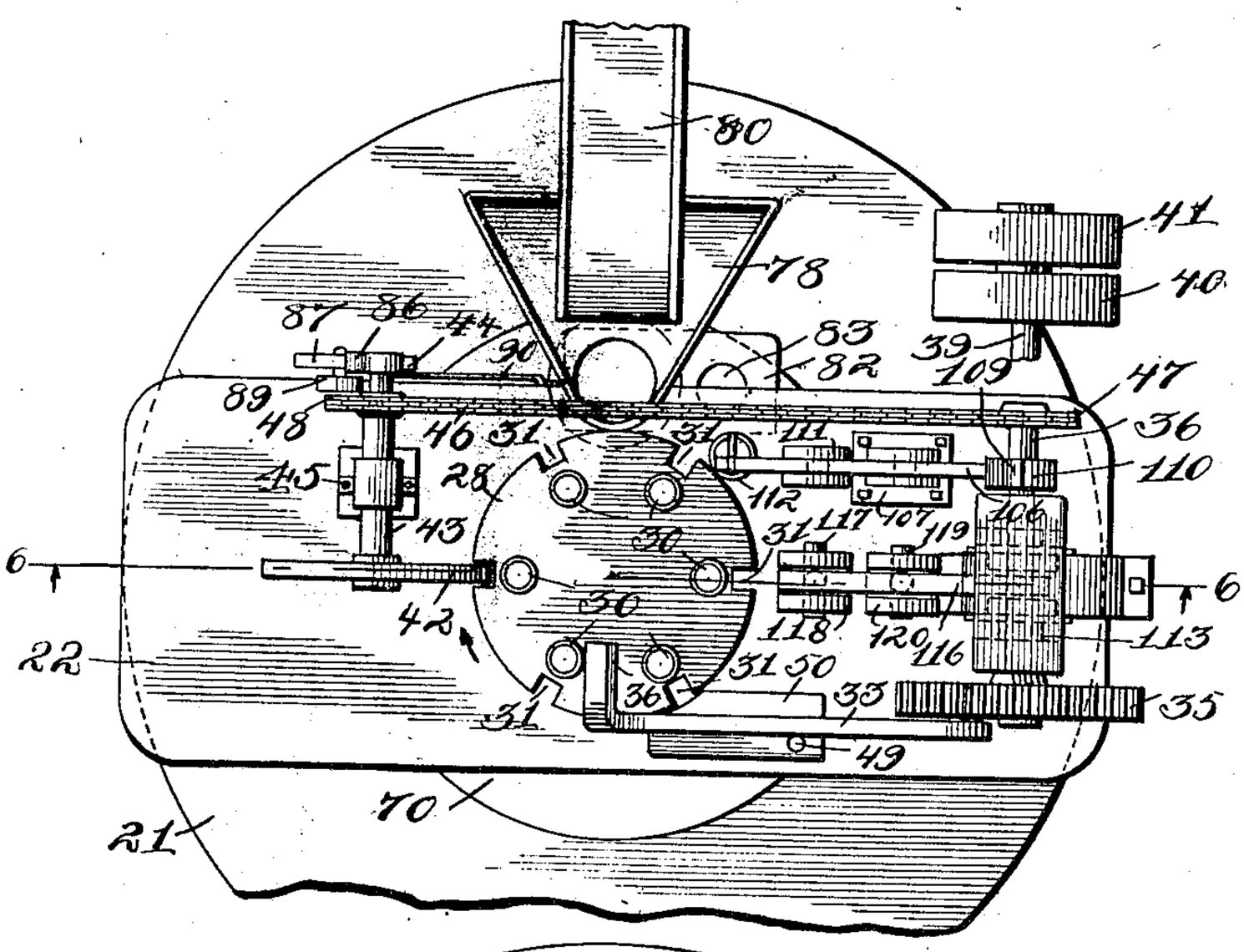
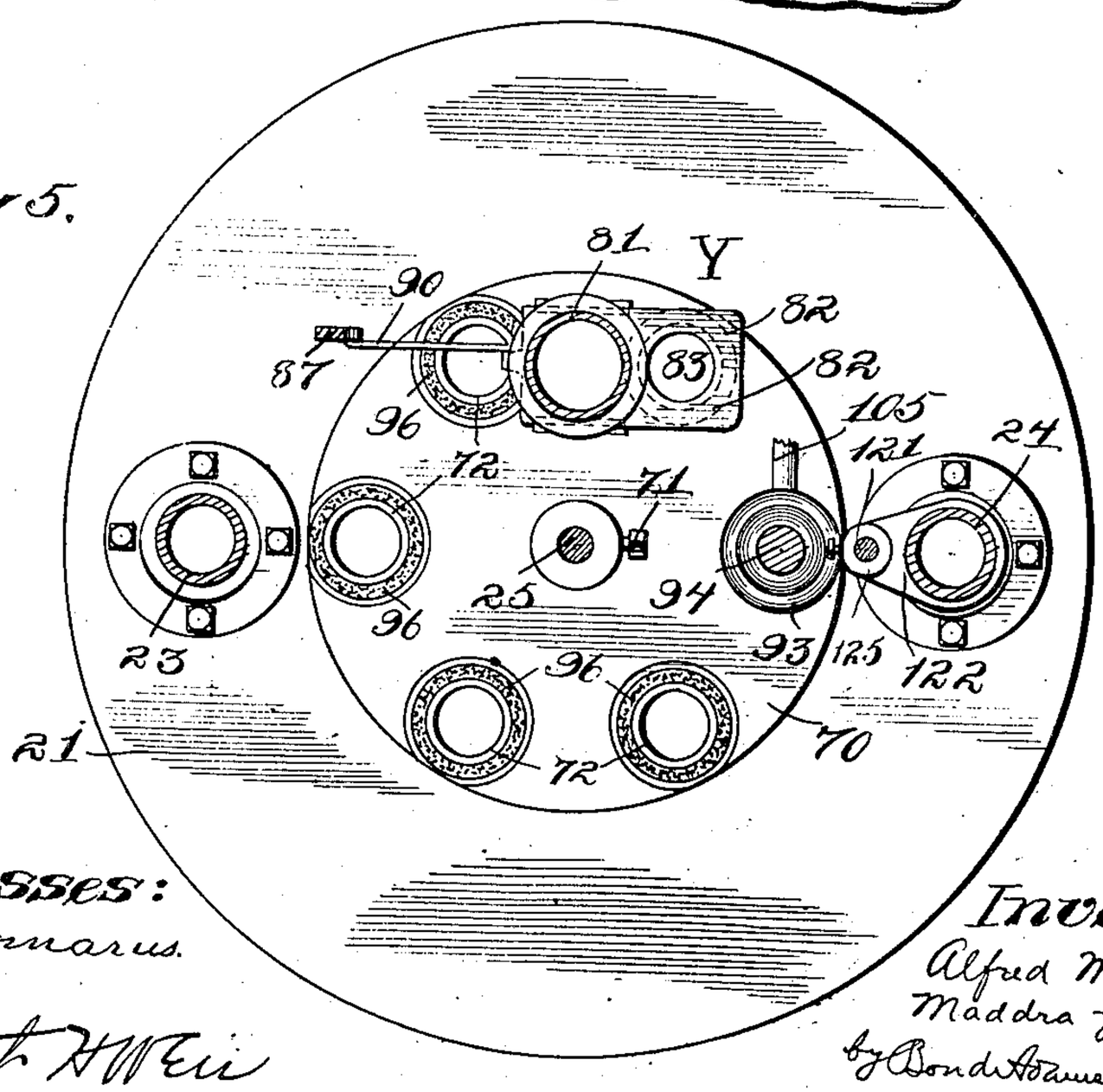



Fig. 5.

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No. 819,883. PATENTED MAY 8, 1906.

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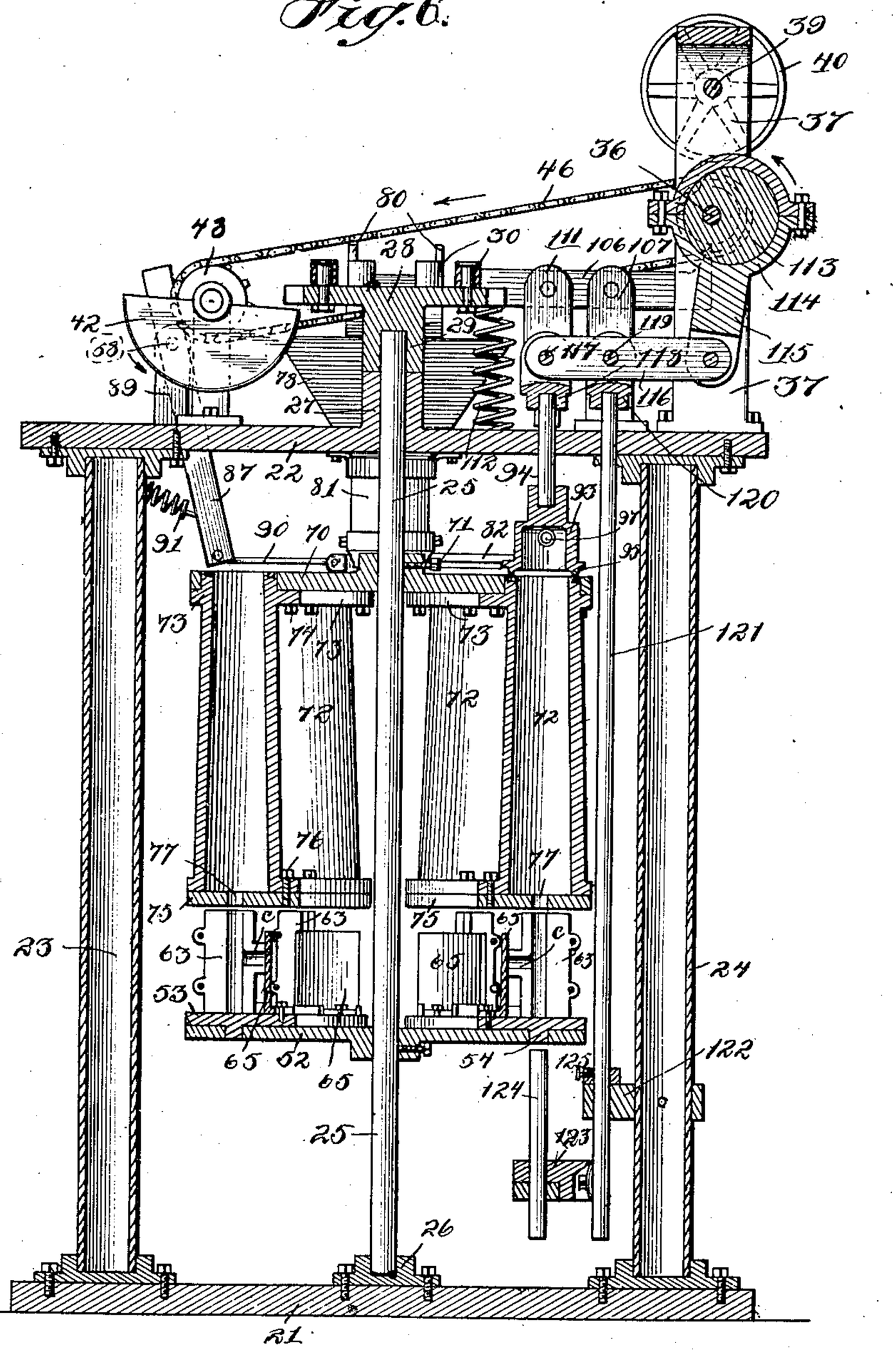
8 SHEETS—SHEET 5.

Fig. 6.

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No. 819,883. PATENTED MAY 8, 1906.

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MOLDING APPARATUS.

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8 SHEETS—SHEET 6.

Fig. 7.

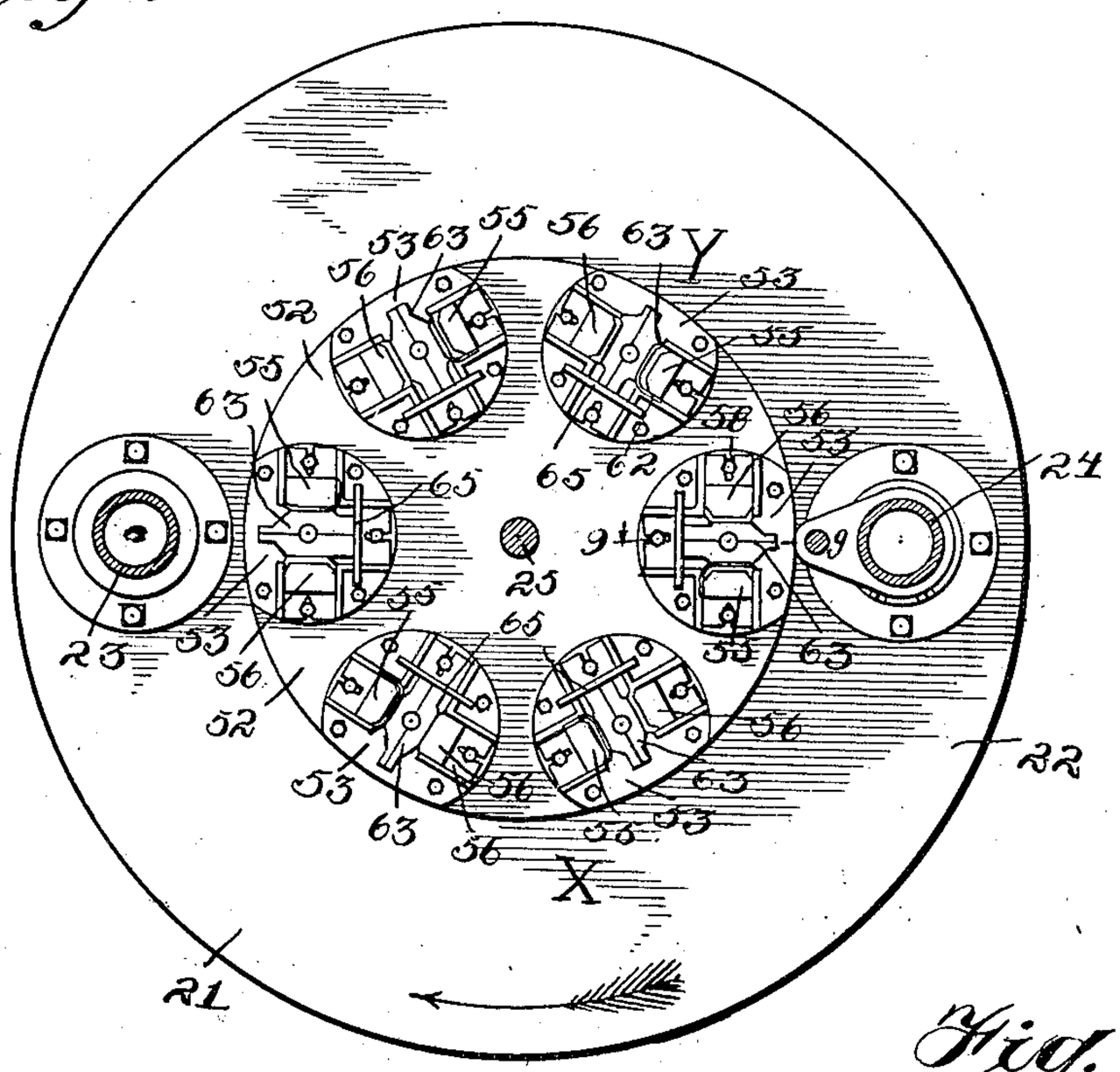



Fig. 8

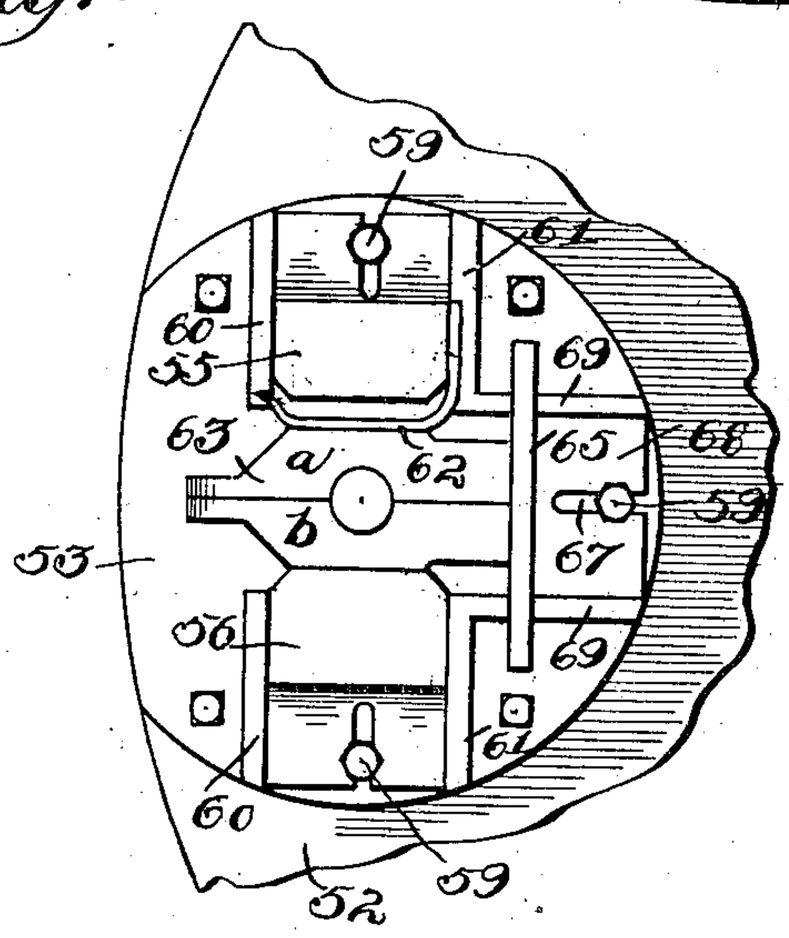
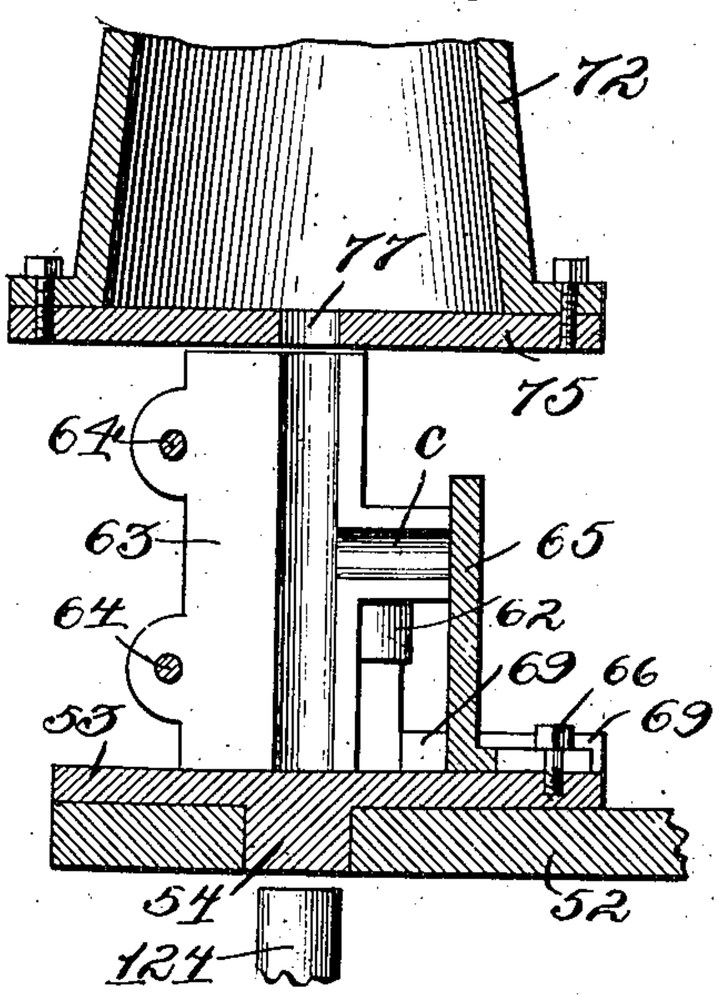



Fig. 9.

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MOLDING APPARATUS.

APPLICATION FILED OCT. 16, 1903.

8 SHEETS—SHEET 7.

Fig. 10.

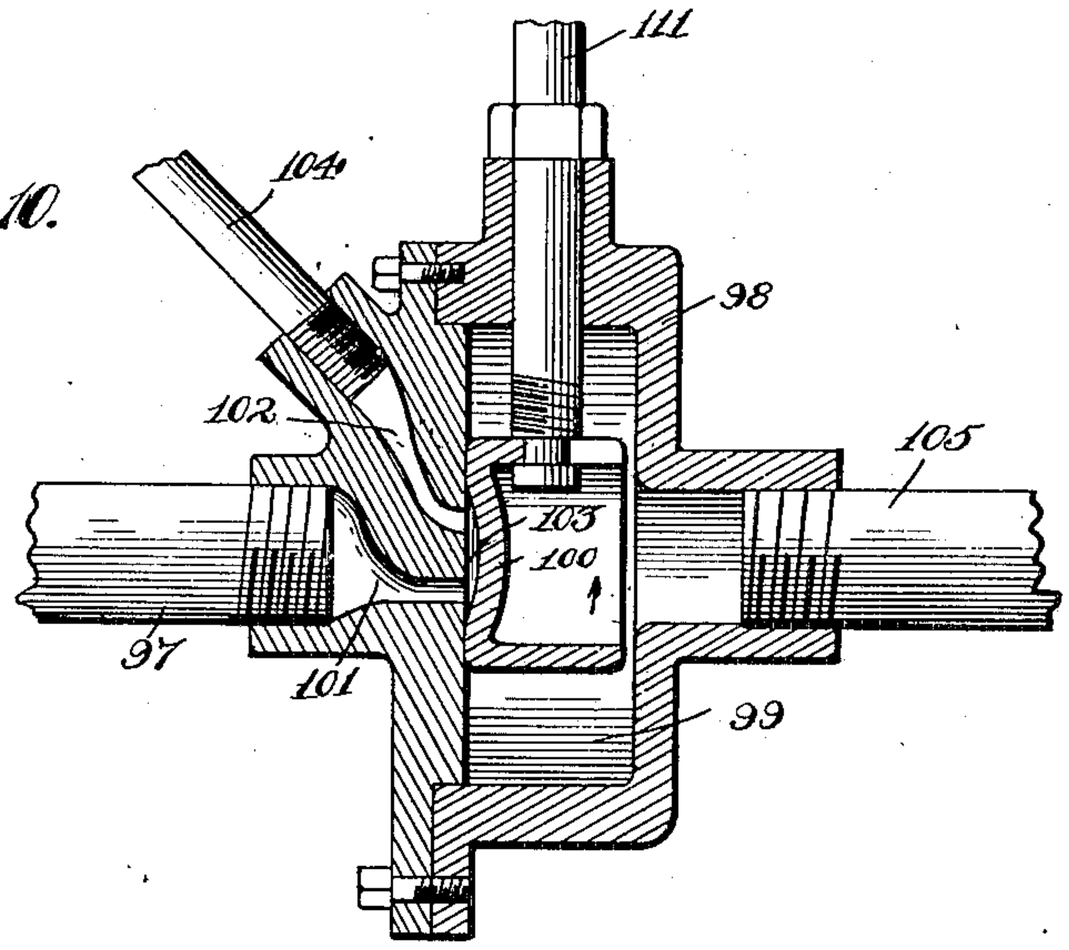



Fig. 11.

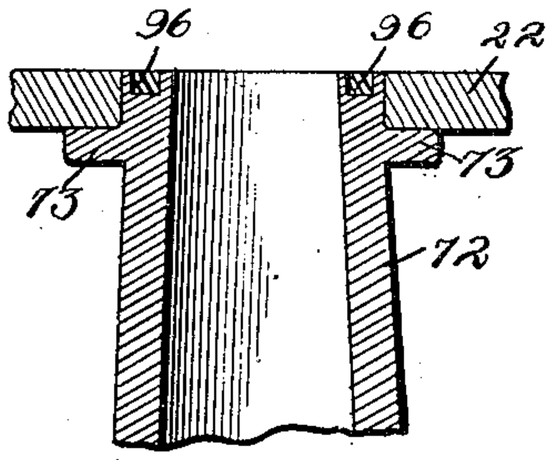



Fig. 12.

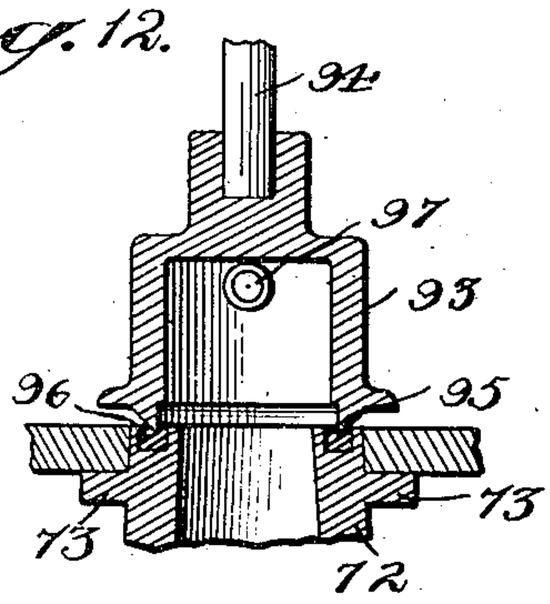



Fig. 13.

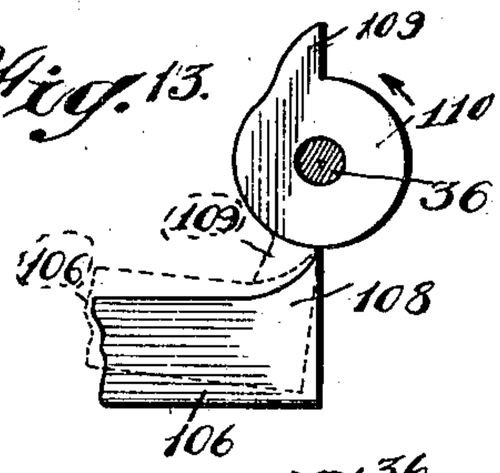
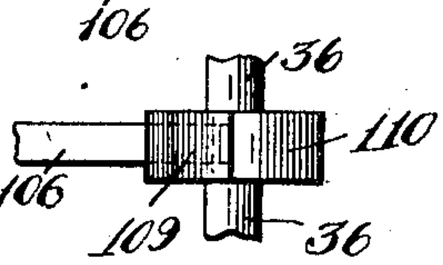



Fig. 14.

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No. 819,883. PATENTED MAY 8, 1906.

A. M. & M. J. HEWLETT.

MOLDING APPARATUS.

APPLICATION FILED OCT. 16, 1903.

8 SHEETS—SHEET 8.

Fig. 15.

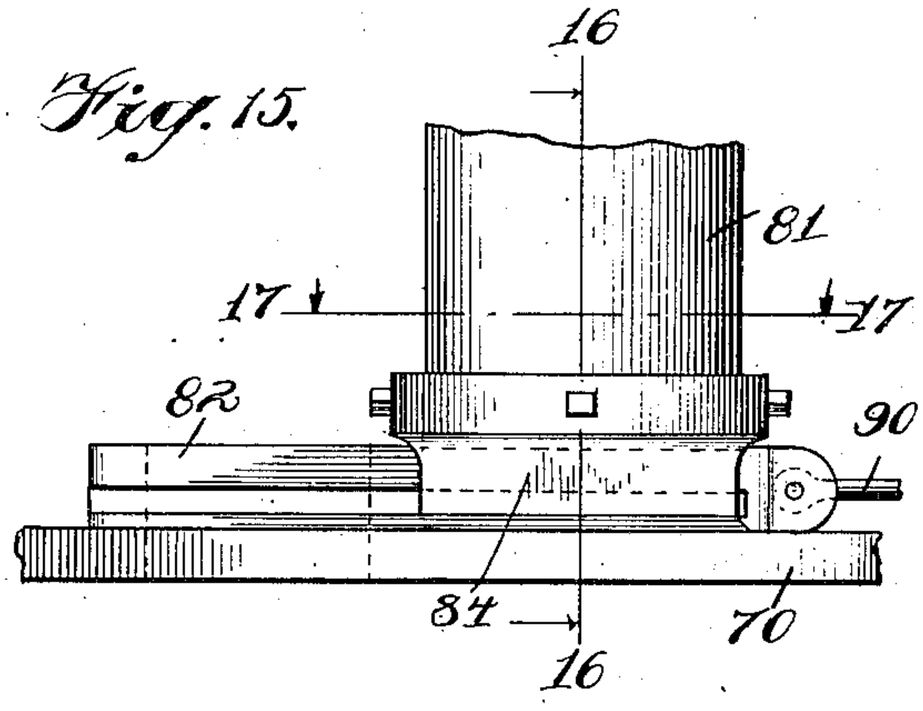
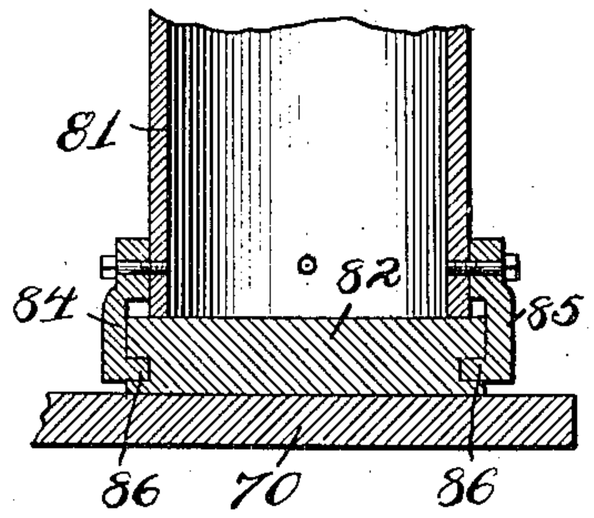



Fig. 16.



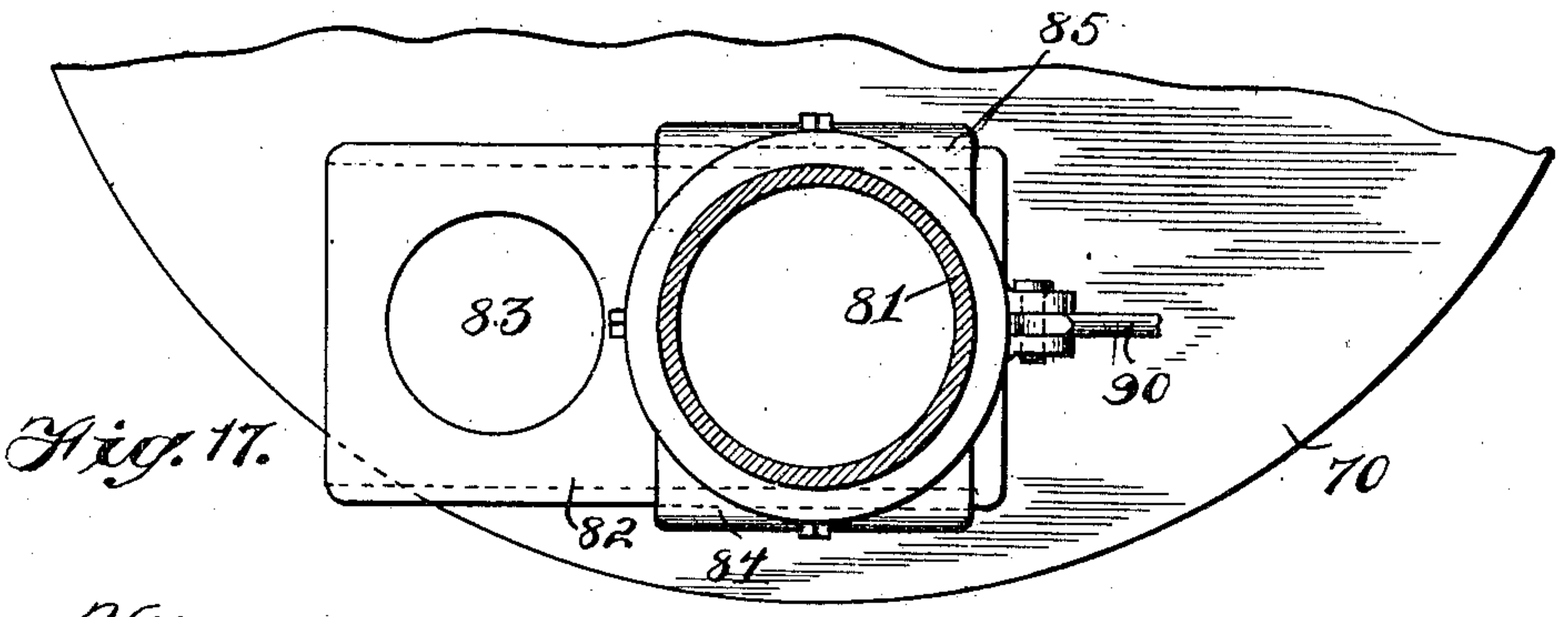




Fig. 17.

Fig. 18.

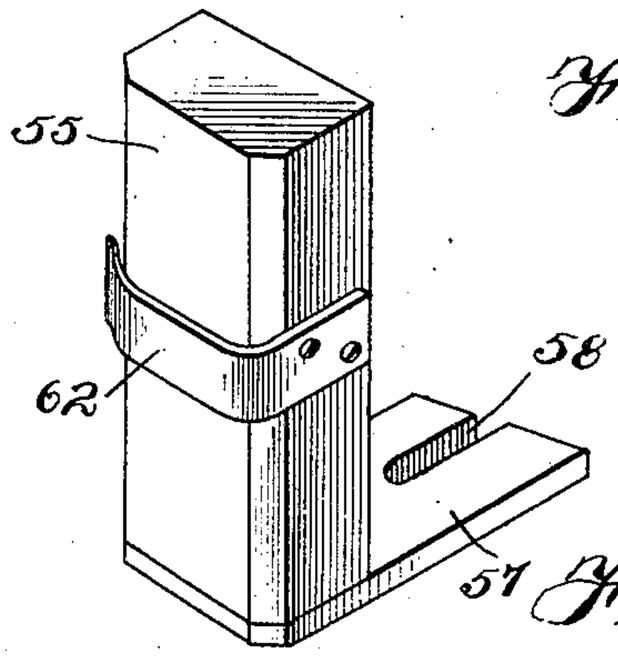
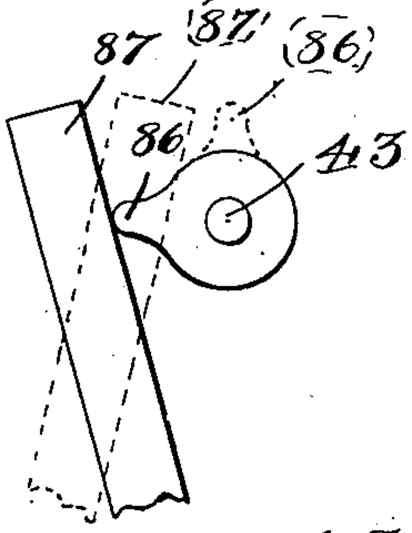



Fig. 19.



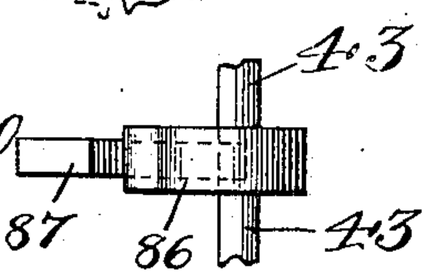




Fig. 20.

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# UNITED STATES PATENT OFFICE.

ALFRED M. HEWLETT AND MADDRA J. HEWLETT, OF KEWANEE, ILLINOIS; SAID MADDRA J. HEWLETT ASSIGNOR TO SAID ALFRED M. HEWLETT.

## MOLDING APPARATUS.

No. 819,883. Specification of Letters Patent. Patented May 8, 1906.

Application filed October 16, 1903. Serial No. 177,353.

*To all whom it may concern:*

Be it known that we, ALFRED M. HEWLETT and MADDRA J. HEWLETT, citizens of the United States, and residents of Kewanee, in the county of Henry and State of Illinois, have invented certain new and useful Improvements in Molding Apparatus, of which the following is a specification, reference being had to the accompanying drawings.

Our invention relates to the molding of sand or analogous material either for the formation of cores or in making molds, and our present application has to do particularly with apparatus for so molding sand or analogous material.

Heretofore various attempts have been made to form sand cores by the use of mechanical devices; but, so far as we are aware, such machines have been unsatisfactory and in many cases inoperative. In some of such machines it has been proposed to employ compressed air as a motive power to force the sand or equivalent material in mass into the mold, but without success, so that, so far as we know, compressed air has never before been successfully employed in connection with sand or equivalent material in a molding-machine. We have discovered, however, that the molding of sand may be very successfully accomplished by mechanical devices equipped with compressed-air mechanism for distributing and packing the sand in the flask or mold and that by the proper use of compressed air sand cores may be produced which are much superior to those produced by hand, since they may be made much firmer without employing the binding devices which are essential to the production of cores by hand.

The invention which forms the subject-matter of this application is generic in character and has to do particularly with the embodiment of our discovery in a machine arranged to utilize compressed air or equivalent power for molding sand or analogous material. The method involved is not herein claimed, as it forms the subject-matter of a separate application for patent. The machine illustrated is designed for the production of sand cores and operates automatically to carry the empty molds into position to receive the sand to fill the molds and afterward to carry them away from the filling or charging mechanism, so that they may be readily removed by the attendant. Our improved machine is further arranged so that the charges of sand are supplied automatically, and the compressed air by which the sand is distributed and the molds filled and packed is automatically controlled so as to operate at the proper times.

In general our improved apparatus in the form illustrated in the accompanying drawings consists in (*a*) a turn-table provided with means for receiving and supporting a plurality of molds; (*b*) a corresponding number of cylinders arranged over said mold-supporting devices, said cylinders, which may be termed "compression-cylinders," being adapted to carry the charges of sand and also to receive charges of compressed air, by which the sand is distributed through the molds; (*c*) mechanism for intermittently rotating said molds and compression-cylinders in unison; (*d*) mechanism for connecting the different compression-cylinders and molds at the proper times by substantially air-tight connections with means for supplying compressed air thereto; (*e*) automatic mechanism for exhausting the compressed air from the compression-cylinders after the charging operation, and (*f*) mechanism for releasing the molds after they have been charged.

In the accompanying drawings, Figure 1 is a side elevation of our improved molding-machine. Fig. 2 is also a side elevation showing the side opposite that shown in Fig. 1. Fig. 3 is an end elevation thereof. Fig. 4 is a plan view, part of the turn-table being broken away. Fig. 5 is a horizontal section on line 5 5 of Fig. 1. Fig. 6 is a vertical section on line 6 6 of Fig. 4. Fig. 7 is a horizontal section on line 7 7 of Fig. 1, illustrating the arrangement of the mold-holding devices. Fig. 8 is an enlarged detail of a part of the turn-table, illustrating the mold-holding devices. Fig. 9 is an enlarged detail, being a partial vertical section on line 9 9 of Fig. 7. Fig. 10 is an enlarged sectional detail illustrating the valve mechanism for controlling the compressed-air supply and exhaust. Fig. 11 is an enlarged sectional detail of the upper end of one of the compression-cylinders and the supporting devices therefor. Fig. 12 is a similar view showing also the connecting devices by which connection is made with the

air-supply. Fig. 13 is an enlarged detail illustrating the mechanism for operating the valve mechanism shown in Fig. 10. Fig. 14 is a plan view of the parts shown in Fig. 13. Fig. 15 is a partial side elevation illustrating the mechanism for supplying sand to the compression-cylinders. Fig. 16 is a vertical section on line 16 16 of Fig. 15. Fig. 17 is a horizontal section on line 17 17 of Fig. 15. Fig. 18 is a perspective view of one of the blocks which compose the mold-supporting devices. Fig. 19 is an enlarged detail illustrating a part of the mechanism for operating the sand-feeding devices, and Fig. 20 is a plan view of the parts shown in Fig. 19.

Referring to the drawings, 21 indicates the base-plate of the machine, and 22 the top plate thereof. The base-plate is preferably circular in form and the top plate elliptical; but they may be made of any suitable shape. Said plates are rigidly secured together by standards 23 24, which are preferably tubular, as shown in Fig. 5.

25 indicates a shaft centrally disposed, which is supported at its lower end in a bearing-block 26, secured to the base-plate 21, its upper end rising through the top plate 22 and extending a considerable distance above the said plate, as shown in Fig. 6. The top plate 22 is provided with a boss 27 around the shaft 25 to provide an extended bearing therefor, as shown in Fig. 6.

28 indicates a ratchet-disk which is horizontally disposed and is mounted upon the upper end of the shaft 25, as shown in Fig. 6, said disk having on its under side a boss 29, which fits on the upper end of said shaft and is fixedly secured thereto by a set-screw or other suitable means. The disk 28 has projecting above its upper surface a series of pins 30, which perform the function of ratchet-teeth, as will be hereinafter described. The disk 28 is provided at its periphery with a series of notches 31 to receive a locking device 32, which operates to prevent said disk from rotating except at the proper times, as will be hereinafter described.

The disk 28 and shaft 25 are rotated by means of a pawl 33, one end of which is pivoted on a wrist-pin 34, carried by a gear 35, as shown in Fig. 1. The other end of said pawl extends over the disk 28 and is adapted to engage the pins 30, carried thereby, and to that end is preferably bent laterally, as shown at 36 in Fig. 4. The gear 35 is mounted upon a shaft 36, horizontally arranged and supported in suitable bearings in a standard 37, carried on the top plate 22, as best shown in Fig. 3. The gear 35 meshes with a pinion 38, mounted on a shaft 39, also mounted in suitable bearings in the standard 37, as shown in Fig. 3. The shaft 39 carries fast and loose pulleys 40 41, respectively, so that it may be driven by a belt from any suitable source of power. By this construction by rotating the shaft 39 the gear 35 may be rotated, reciprocating the pawl 33. When the pawl 33 moves to the left, as shown in Fig. 1, it engages one of the pins 30, and consequently rotates the disk 28 and shaft 25 in the direction indicated by the arrow in Fig. 4. On the return movement of the pawl 33 it rides over the pins 30 without rotating the disk 28, said disk being at such time locked against rotation, as will be hereinafter described. The result is that the shaft 25 is given an intermittent rotation, moving a distance equal to the space between successive pins 30 for each rotation of the gear 35. This arrangement may of course be varied, if desired.

In order to lock the disk 28 and shaft 25 against rotation during the return movement of the pawl 33, I provide a segmental locking-plate 42, which in the construction illustrated extends through an arc of approximately one hundred and eighty degrees. Said locking-plate is mounted upon a horizontal shaft 43, journaled in suitable standards 44 45, mounted on the top plate 22, as shown in Figs. 1 and 2, said shaft being adjacent to the periphery of the disk 28, so that as it rotates the plate 42 is adapted to enter that notch 31 in the disk 28 which registers therewith, as shown in Fig. 4. The parts are so adjusted that when the pawl 33 reaches the limit of its downward stroke and the disk 28 comes to rest one of the notches 31 will lie in the path of the locking-plate 42, which enters it as soon as the disk 28 comes to rest, the parts being timed to that end. Consequently the disk 28 is locked during half a revolution of the shaft 43, which corresponds with half a revolution of the shaft 36 and gear 35. In order to secure this operation, the shaft 43 is driven from the shaft 36 by a chain 46, which passes over sprocket-wheels 47 48, mounted on the shafts 36 43, respectively, as shown in Figs. 2 and 4. As the sprocket-wheels 47 48 are of the same size, the gear 35 and locking-plate 42 rotate in unison.

49 indicates a guide-pin mounted on a supporting-plate 50, carried on a standard 51, which is carried on the top plate 22, as shown in Figs. 1 and 4. The pin 49 serves to guide the pawl 33 and hold it properly to its work.

52 indicates a rotary support or turn-table in the form of a disk, which is mounted upon the shaft 25 and tightly secured thereto by a set-screw or other suitable means. The turn-table is designed to support the molds to be filled and to carry them successively into position to receive their charge of sand. In the construction shown the turn-table is provided with accommodation for six molds; but a greater or less number may be provided, as desired. The devices for receiving and retaining the molds in position are best shown in Figs. 7, 8, and 9, by reference to

which it will be seen that each mold-supporting device consists of a base-plate 53, which is circular in form and is provided on its under side with a boss 54, which fits in a suitable recess near the periphery of the turn-table, the lower surfaces of the bosses 54 normally being flush with the under surface of the turn-table, as shown in Fig. 9.

55 56 indicate side blocks, the construction of which is best shown in Fig. 18, said blocks being adjustably mounted opposite each other upon the plate 53, so that the space between them may be readily adjusted to accommodate molds of different widths. The side blocks 55 56 are preferably made adjustable by providing them with bottom plates 57, having slots 58 adapted to receive pins 59, screwed into the plate 53. The sides of the bottom plates 57 fit between guides 60 61, as shown in Fig. 8. One of the side blocks, as 55, is provided with a spring-plate 62, which extends over the outer face thereof, as shown in Figs. 8 and 18, so as to yieldingly engage one side of the mold and press it against the opposite block 56.

63 indicates the mold, which, in the form illustrated, is designed for the molding of T-shaped cores. Said mold is split longitudinally along a central line, one of the members, as *a*, being provided with dowel-pins 64, adapted to fit in holes in the other member, *b*, to bind the two members together.

As shown in Figs. 8 and 9, the mold is fitted between the side blocks 55 56, one end resting upon the base-plate 53 and that part of the mold which forms the stem of the T being at the back, as shown at *c* in Fig. 9. Said part of the mold abuts against an adjustable back plate 65, which is also secured upon the plate 53 and held in place by a set-screw 66, which lies in a slot 67 in the base 68 of the plate 65 and screws into the plate 53. Suitable guides 69 are provided for the base 68 of the back plate 65, as shown in Fig. 8. The back plate 65 serves not only as a stop to limit the extent to which the mold may be inserted between the blocks 55, but also closes that side of the mold tightly enough to limit the escape of sand, although the closure is not tight enough to prevent the escape of a limited amount of air.

From the foregoing description it will be seen that when a mold of the character described is placed on the turn-table it is closed at its lower end and at the side, its upper end only being open, and it is through the upper end that the air and sand are admitted, as will be hereinafter described. It will be understood, of course, that for molds of different shapes suitable guides and retaining devices are provided, so as to close the mold at all points except those through which the air and sand are to be introduced thereinto.

70 indicates a supporting-plate which is preferably circular in form, corresponding with the turn-table 52, said plate being secured upon the shaft 25, near the upper end thereof, as best shown in Figs. 1 and 6. The plate 70 is secured to said shaft by a set-screw 71 or other suitable means, so that it rotates in unison therewith. The plate 70 is provided with a series of openings corresponding in number with the plates 53, each of said openings registering with one of said plates.

72 indicates a series of cylinders the upper ends of which extend into the openings in the plate 70, as shown in Fig. 6. Each of said cylinders is provided with an annular flange 73, which fits closely upon the under surface of the plate 70 and is secured thereto by bolts 74 or other equivalent means, so that said cylinders are held tightly in place. The cylinders 72 are provided at their lower ends with heads 75, which fit closely thereupon and are tightly secured thereto by bolts 76 or other suitable means. The heads in the construction shown are each provided with a constricted passage or central perforation 77, which perforations register with the openings in the upper ends of the molds when said molds are in place. Normally the distance between the turn-table 52 and the lower surfaces of the heads 75 of the cylinders 72 is slightly greater than the length of the molds, so that when said molds are in place normally they are out of contact with the heads 75, but may be moved into contact therewith by slightly raising the plates 53 independently of the turn-table 52. The turn-table 52 may be adjusted vertically upon the shaft 25 by simply loosening the set-screw or other means by which it is secured to the shaft, so as to accommodate molds of different lengths.

The cylinders 72 are adapted to receive charges of sand or equivalent material and to supply it to the molds through the openings 77. They are also adapted to receive charges of compressed air, as will be hereinafter described. The cylinders regularly receive charges of sand through their open upper ends from a charging apparatus, which is best shown in Figs. 4, 5, 15, 16, and 17. Such charging apparatus consists of a funnel-shaped sand-bin 78, supported at one side of the top plate 22, preferably by a strap 79, secured to said top plate, as shown in Fig. 2. Said funnel 78 receives a constant supply of sand from an endless conveyer 80, driven from any suitable source of power. (Best shown in Fig. 4.) A spout 81 extends down from the funnel 78, terminating immediately over the path of the cylinders and adjacent to the upper surface of the plate 70, as shown in Fig. 2. Between the lower end of the spout 81 and the upper surface of the plate 70 is provided a reciprocating valve-plate 82, having an opening 83, adapted to overlie the open upper ends of the cylinders 72 when moved to its outermost position and to move into the spout 81 when the valve-plate 82 is

moved in the opposite direction. The spout 81 is provided with guides 84 85 at its opposite sides, adapted to fit in grooves in the sides of the valve-plate 82, as shown in Fig. 16. By this construction the valve-plate 82 may be reciprocated to move the opening 83 into the spout 81 to receive a charge of sand and to move it to its outermost position to supply such sand to the appropriate cylinder 72. It will be understood that the valve-plate 82 is of such thickness that the opening 83 accommodates the desired quantity of sand, so that each cylinder as it passes under the opening 82 in the valve-plate is supplied with a measured quantity of sand.

The valve-plate 82 is reciprocated from the shaft 43 by means of a cam 86, mounted on said shaft and adapted to engage the upper end of a lever 87, mounted on a pivot 88, carried by a suitable standard 89, mounted on the top plate 22. The lower end of said lever is connected by a link 90 with the valve-plate 82, so that when the upper end of said lever is moved to the right, as shown in Fig. 2, by the action of the cam 86 the lower end thereof is carried to the left, moving the valve-plate 82 to the left and carrying its opening 83 over one of the cylinders 72, as shown in Fig. 5. The lever 87 and valve-plate 82 are retracted by means of a spring 91, connected to the lower end of said lever and to a lug 92, carried by the top plate 22, as shown in Fig. 2. Thus the valve-plate 82 normally is in such position that the opening 83 lies under the spout 81.

The cam 86 is so placed upon the shaft 43 that it operates the lever 87 only while the cylinders are at rest. The sand thus supplied to the cylinders 72 does not escape through the openings 77 in the heads 75, for the reason that said openings are made small enough so that they do not contain a larger body of sand than is readily held in such openings by the natural packing of the sand therein. Where a large quantity of sand at a time must be supplied to the molds instead of a single opening 77 in each head, as shown in the drawings, a plurality of small openings would be provided.

After the cylinders 72 have been supplied with sand they are connected with means for supplying compressed air thereto for distributing the sand throughout the molds and packing it therein. The mechanism by which this is accomplished will now be described.

93 indicates an inverted air-cup which is carried at the lower end of a vertically-movable rod 94, fitted in a suitable bearing in the top plate 22. At its lower edge the cup 93 is provided with a comparatively sharp annular flange 95, which is adapted to register with the upper ends of the different cylinders 72 as said cylinders, respectively, come to rest below said cup. In order to form an air-tight connection between the air-cup 93 and the different cylinders 72, said cylinders are provided in their upper ends with an annular packing 96, of suitable flexible material, such as rubber, so that when the cup 93 is moved downward far enough its flange 95 will engage the packing 96, becoming embedded in it, and thereby forming a tight joint. The cup 93 is provided with an air-pipe 97, which communicates with a valve 98. (Best shown in Fig. 10.) Said valve consists of a valve-chamber 99, in which are a slide-valve 100 and passages 101 102. The passages 101 102 lie adjacent to each other and are normally cut off from the valve-chamber 99 and brought into communication with each other by the slide-valve 100, which, as shown in Fig. 10, overlies the inner ends of said passages and is provided with a concavity 103, which affords communication between said passages. By moving said slide-valve longitudinally in the direction indicated by the arrow in Fig. 10 it moves from over the passage 101, thereby opening the communication between said passage and the valve-chamber 99, the passage 102, however, being still cut off from said valve-chamber. The passage 102 communicates with an exhaust-pipe 104, while the valve-chamber 99 receives compressed air through a supply-pipe 105, which receives compressed air from any suitable source of power.

By the construction described when the slide-valve 100 is in the position shown in Fig. 10 the pipe 97 is connected with the exhaust-pipe 104 through passage 101, concavity 103, and passage 102. When, however, the slide-valve 100 is moved in the direction indicated by the arrow in Fig. 10, passage 101 is connected with valve-chamber 99 and compressed air is supplied to the pipe 97 and cup 93.

The slide-valve 100 is automatically operated to control the compressed-air supply and the exhaustion thereof from the cup 93 and cylinders 72 by means of a lever 106, pivoted upon a standard 107, supported on the top plate 22, as shown in Fig. 2. At its outer end the lever 106 is provided with a finger 108, which is adapted to be engaged by the projecting portion 109 of a cam 110, mounted on the shaft 36, as best shown in Figs. 2 and 13, so that as said cam rotates in the direction indicated by the arrow in Fig. 13 it depresses the outer end of the lever 106, thereby throwing the inner end of said lever upward. The inner end of said lever is connected by a connecting-rod 111 with the slide-valve 100, as shown in Figs. 2 and 10. It follows that when the cam 110 acts upon the lever 106 the slide-valve 100 is moved into position to supply air to the cup 93 and the cylinder 72, with which it is in engagement. The lever 106 is restored to its normal position, which is that shown in Fig. 10, by a spring 112, connected to its inner end and to the top plate 22, as shown in Fig. 2.

The cup 93 is operated to connect the cylinders 72 in turn with the compressed-air supply by means of an eccentric 113, mounted on the shaft 36, as shown in Fig. 6. Said eccentric is connected by an eccentric-strap 114 and arm 115 with a lever 116, the middle portion of which is connected by a pivot 119 with a head 120 at the upper end of a rod 121, which extends down at one side of the cylinders 72 and turn-table 52, having a suitable bearing in the top plate 22 and in a bracket 122, supported by the standard 24, as shown in Fig. 6. At its lower end the rod 121 carries a bracket 123, in which is secured a pin 124. The pin 124 is vertically disposed in such position as to register with the boss 54 of the different mold-supports when they are in charging position.

125 indicates a collar on the rod 121 above the bracket 122 to limit the downward movement of said rod.

Each of the pivots 117 and 119 alternately serve as a fulcrum for the lever 116, the operation being as follows: When the outer or right-hand end of the lever 116 is raised by the operation of the eccentric, as the pivot 117 and the parts connected therewith offer less resistance to movement than the pivot 119 and the parts suspended therefrom, the pivot 119 acts as a fulcrum for the lever, and the first effect produced is the depression of the inner end of the lever 116 and the downward movement of the rod 94 and cup 93, the cup moving into engagement with the cylinder 72 lying immediately below it. As soon as the cup engages said cylinder further downward movement of the inner end of the lever 116 is prevented. The pivot 117 then becomes the fulcrum of the lever, which is converted from a lever of the first-class to one of the second class. Further upward movement of the outer end of the lever therefore raises the pivot 119, and with it the rod 121 and pin 124, the latter moving into engagement with the boss 54 and raising said boss, and with it the mold-support 53 and the mold carried by it. The mold is thereby moved into close contact with the lower surface of the head 75 of the cylinder, which is in charging position. This continues until the outer end of the lever 116 again moves downward, when the operations above described are reversed.

The compressed-air-supplying mechanism is so timed with reference to the action of the lever 116 that the slide-valve 100 moves away from over the passage 101, and thereby admits air to the cup 93 as soon as the outer end of the lever 116 reaches its highest point, and the cup 93 and the mold are held tightly in contact with the upper and lower ends, respectively, of the cylinder 72. As air is admitted only momentarily by the action of the projecting finger 109 of the cam 110 on the lever 106 immediately after the air is admitted to the cylinder 72 the pipe 97 is connected with the exhaust 104, so that the pressure in the cylinder 72 is relieved before the mold and the cup 93 are moved away therefrom.

The general operation of the machine is as follows: The turn-table being given an intermittent rotation in the direction indicated by the arrow in Fig. 7, an attendant standing at about the point *x* on Fig. 7 takes the filled molds from the mold-holders and supplies empty molds thereto, the empty molds being slid between the blocks 55 56, so that the part *c* thereof fits closely against the back plate 65, as shown in Fig. 9. The empty mold thus placed in position is carried around until it reaches the position *y* on Figs. 5 and 7, where the cylinder 72 over it receives a charge of sand from the valve-plate 82. The mold then moves under the cup 93, which moves down into engagement with the cylinder immediately over it, and the mold itself is moved up into engagement with the head 75 of such cylinder in the manner already described, thus making comparatively tight connections at both ends of the cylinder. By the action of the cam 110 compressed air is then admitted to the cylinder, forcing the sand therein into and through the mold, packing it uniformly therein.

It should be understood that by the use of our apparatus the air is not employed as a motive power to move a body of sand as a mass into a mold. On the contrary, the air permeates the mass of sand and is distributed therein, so that when it leaves the constricted or relatively small opening or openings of the compression-chamber and enters the vacant space of the mold the air by its expansive force carries the sand with it in individual particles or very minute masses into and throughout the different portions of the mold, leaving the sand packed uniformly, while the air escapes through the partings and connections of the mold, which are tight enough to retain the sand but not the air. The result is that a certain amount of pressure is applied directly to each particle of sand to pack it in position. The result is very different from what could be secured by applying pressure to the upper surface of an extensive body of sand, as in the latter case the sand at the bottom of the mass would be comparatively unaffected by the air-pressure. By the use of our improved apparatus, however, the sand is packed in a homogeneous mass, the packing being just as solid at the bottom thereof as at the top. The result is that the core produced is firm and strong throughout, making the use of binding devices unnecessary, even for cores of shapes that heretofore invariably have required the use of binding devices to hold them together.

The mold is filled with packed sand instantly upon the admission of the compressed

air, so that it is unnecessary to maintain pressure in the cylinder 72, and in order to avoid blowing out any surplus sand in the cylinder the cylinder is connected with the exhaust, as already described, before the cup and mold are separated therefrom.

For molding sand over patterns and flasks the operation would be substantially the same as that above described, the only difference being in the arrangement of the devices for supporting the flasks and for connecting them with the sand carrying and supplying mechanism. For machines designed to operate on very large molds or on flasks it may be desirable to employ other forms of devices for carrying the molds into and out of position to be charged. For example, a reciprocating carrier or conveyer may be employed in lieu of the rotary carrier or turn-table herein shown and described; but while our present application includes generically any suitable carrier, whether rotary, reciprocating, or of other construction, and the broad claims are to be so construed we have not shown such other forms herein, as they form the subject-matter of separate applications for patent. Furthermore, we wish it to be understood that in other respects, except in so far as the specific features of the construction described are particularly claimed, we do not limit ourselves to such specific features of construction, but claim generically the subject-matter of the broader claims.

We believe ourselves to be pioneers in the art of molding sand by the use of the expansive force of compressed air or equivalent gas to distribute and pack the sand in the mold, and our claims are to be construed accordingly.

That which we claim as our invention, and desire to secure by Letters Patent, is—

1. A sand-molding apparatus, comprising means for supporting the mold, and means for introducing compressed air and sand together into the mold and permitting the air to expand in the mold and distribute the sand therein by its expansive force.

2. A sand-molding apparatus, comprising a mold-support, and means for introducing compressed air charged with sand into the mold, said means having a contracted discharge-passage.

3. A sand-molding apparatus, comprising means for supporting the mold, and contracted means communicating with the mold for introducing compressed air and sand together thereinto, so that the expansive force of the compressed air acts to distribute and pack the sand in the mold, substantially as described.

4. A sand-molding apparatus, comprising means for supporting the mold, a chamber adapted to contain sand, and means for introducing compressed air and sand from said chamber together into the mold and permitting the air to expand in the mold and distribute the sand therein by its expansive force.

5. In a sand-molding apparatus a sand-chamber, having a fixed partly-open bottom, whereby a mass of sand may be supported in said chamber and portions thereof intermittently discharged by compressed air supplied to said chamber and means for supplying compressed air to said chamber.

6. A sand-molding apparatus, comprising means for supporting the mold, a cylinder adapted to contain sand and having a constricted opening for the passage of sand therefrom to the mold, and means for introducing compressed air and sand from said cylinder together into the mold.

7. A sand-molding apparatus, comprising means for supporting the mold, a cylinder above said mold-supporting means and having a constricted opening for the passage of sand therefrom to the mold, and means for supplying compressed air to said cylinder, substantially as described.

8. A sand-molding apparatus, comprising a cylinder adapted to contain sand in mass, means for supporting the mold in communication with said cylinder, and means for supplying compressed air to the mass of sand in said cylinder, substantially as described.

9. A sand-molding apparatus, comprising a cylinder adapted to contain sand in mass, means for supporting the mold in communication with said cylinder, means for supplying compressed air to the mass of sand in said cylinder, and means for exhausting the compressed air from said cylinder, substantially as described.

10. A sand-molding apparatus, comprising a sand-holding receptacle having one or more constricted openings in the lower portion thereof, and means for introducing compressed air and sand from said sand-holding receptacle together into the mold.

11. A sand-molding apparatus comprising a mold-support, means arranged to support a mass of sand and having a contracted passage at the bottom for introducing sand from above into the mold, and means for introducing compressed air and sand from said mass together into the mold.

12. A sand-molding apparatus, comprising a sand-holding receptacle having one or more constricted openings at its lower end for the discharge of sand therefrom, means for supporting the mold in communication with said openings, means for supplying sand to said receptacle, and means for supplying compressed air to the sand in said receptacle, substantially as described.

13. A sand-molding apparatus, comprising a sand-holding receptacle open at its upper end and having one or more constricted openings at its lower end, means for supporting the mold in communication with said lower

openings, means for closing the upper end of said receptacle, and means for supplying compressed air to the sand therein, substantially as described.

14. A sand-molding apparatus, comprising a sand-holding receptacle open at its upper end and having one or more constricted openings at its lower end, means for supporting the mold in communication with said lower openings, means for closing the upper end of said receptacle, means for supplying compressed air to the sand therein, and means for supplying sand to said receptacle, substantially as described.

15. A sand-molding apparatus, comprising a sand-holding receptacle open at its upper end and having one or more constricted openings at its lower end, means for supporting the mold in communication with said lower openings, means for closing the upper end of said receptacle, means for supplying compressed air to the sand therein, and means for exhausting said receptacle, substantially as described.

16. A sand-molding apparatus, comprising a sand-holding receptacle open at its upper end and having one or more constricted openings at its lower end, means for supporting the mold in communication with said lower openings, means for automatically closing the upper end of said receptacle, and means for thereafter supplying compressed air to the sand therein, substantially as described.

17. A sand-molding apparatus, comprising a sand-holding receptacle open at its upper end and having one or more constricted openings at its lower end, means for supporting the mold in communication with said lower openings, means for automatically closing the upper end of said receptacle, and means for automatically supplying compressed air to the sand in said receptacle when the upper end thereof is closed, substantially as described.

18. A sand-molding apparatus, comprising a sand-holding receptacle open at its upper end and having one or more constricted openings at its lower end, means for supporting the mold in communication with said lower openings, means for automatically opening and closing the upper end of said receptacle, and means for alternately supplying compressed air to the sand in said receptacle and exhausting it therefrom while the upper end thereof is closed, substantially as described.

19. A sand-molding apparatus, comprising a sand-holding receptacle open at its upper end and having one or more constricted openings at its lower end, means for supporting the mold in communication with said lower openings, means for automatically opening and closing the upper end of said receptacle, means for alternately supplying compressed air to the sand in said receptacle and exhausting it therefrom while the upper end thereof is closed, and means for supplying sand to said receptacle, substantially as described.

20. A sand-molding apparatus, comprising a mold, a compression-cylinder adapted to supply sand to said mold, fluid-pressure mechanism for packing the sand in said mold, and means for automatically actuating said mechanism.

21. A sand-molding apparatus comprising a sand-receptacle, fluid-pressure-supplying mechanism adapted to communicate therewith, for charging the mold with sand from said receptacle and means supporting said sand-receptacle so that it may be moved into and out of operative relation to said fluid-pressure-supplying mechanism.

22. A sand-molding apparatus comprising a sand-receptacle, fluid-pressure-supplying mechanism adapted to communicate therewith for charging the mold with sand from said receptacle, a mold-support, and means supporting said sand-receptacle so that it may be moved into and out of operative relation to said fluid-pressure-supplying mechanism.

23. A sand-molding apparatus, comprising fluid-pressure-supplying mechanism, a sand-receptacle movable into and out of operative relation to said fluid-pressure-supplying mechanism, and means for automatically supplying sand to said receptacle, substantially as described.

24. A sand-molding apparatus comprising a sand-receptacle, fluid-pressure-supplying mechanism adapted to communicate therewith for charging the mold with sand from said receptacle, means supporting said sand-receptacle so that it may be moved into and out of operative relation to said fluid-pressure-supplying mechanism, and means for automatically suppyling sand to said receptacle when it is out of operative relation to said fluid-pressure-supplying mechanism.

25. A sand-molding apparatus comprising a sand-receptacle having one or more openings at its lower end, fluid-pressure-supplying mechanism adapted to communicate with said receptacle for charging the mold with sand therefrom, means supporting said sand-receptacle so that it may be moved into and out of operative relation to said fluid-pressure-supplying mechanism, a mold-support, and means for moving said sand-receptacle and mold-support into and out of operative relation to said fluid-pressure-supplying mechanism.

26. A sand-molding apparatus comprising a sand-receptacle having one or more openings at its lower end, fluid-pressure-supplying mechanism adapted to communicate with said receptacle for charging the mold with sand therefrom, means supporting said sand-receptacle so that it may be moved into and out of operative relation to said fluid-pres-

sure-supplying mechanism, a mold-support, means for moving said sand-receptacle and mold-support into and out of operative relation to said fluid-pressure-supplying mechanism, and means for supplying sand to said receptacle.

27. A sand-molding apparatus, comprising fluid-pressure-supplying mechanism, a sand-holding cylinder movable into and out of operative relation to said fluid-pressure-supplying mechanism and having one or more openings at its lower end, a vertically-movable mold-support below said cylinder, and means for raising said mold-support to press the mold carried thereby closely in contact with the lower end of said cylinder over said openings, substantially as described

28. A sand-molding apparatus, comprising fluid-pressure-supplying mechanism, a sand-holding cylinder open at its upper end and having one or more openings at its lower end, a vertically-movable cover for said upper opening, said cover being connected with said fluid-pressure-supplying mechanism, means for supporting the mold in communication with said lower openings, and means for moving said cover into and out of engagement with said cylinder, substantially as described.

29. A sand-molding apparatus, comprising fluid-pressure-supplying mechanism, a sand-holding cylinder open at its upper end and having one or more openings at its lower end, a vertically-movable cover for said upper opening, means for supporting the mold in communication with said lower openings, means for moving said cover into and out of engagement with said cylinder, and means for automatically supplying compressed air to said cylinder when said cover is in operative position, substantially as described.

30. A sand-molding apparatus, comprising fluid-pressure-supplying mechanism, a sand-holding cylinder open at its upper end and having one or more openings at its lower end, a vertically-movable cover for said upper opening, a vertically-movable mold-support below said cylinder, means for moving said mold-support to move the mold closely into contact with the lower end of said cylinder over said openings, and means for supplying compressed air to said cylinder while the ends thereof are closed, substantially as described.

31. A sand-molding apparatus comprising means for supporting a plurality of molds, means for directing sand into said molds, fluid-pressure-supplying mechanism for carrying the sand into the molds and means for bringing the molds severally into operative relation to said fluid-pressure-supplying mechanism.

32. A sand-molding apparatus, comprising a plurality of mold-supporting devices, a corresponding number of sand-receptacles for supplying sand to the molds carried by the mold-supporting devices, fluid-pressure-supplying mechanism, and means for moving said mold-supporting devices and sand-receptacles severally into and out of operative relation to said fluid-pressure-supplying mechanism, substantially as described.

33. A sand-molding apparatus, comprising a plurality of mold-supporting devices, a corresponding number of sand-receptacles for supplying sand to the molds carried by the mold-supporting devices, fluid-pressure-supplying mechanism, means for moving said mold-supporting devices and sand-receptacles severally into and out of operative relation to said fluid-pressure-supplying mechanism, and means for supplying sand to said sand-receptacles, substantially as described.

34. A sand-molding apparatus, comprising a plurality of mold-supporting devices, a corresponding number of sand-receptacles arranged respectively over the mold-supporting devices and having one or more openings at their lower ends for supplying sand to the molds carried by the mold-supporting devices, fluid-pressure-supplying mechanism, and means for moving said mold-supporting devices and sand-receptacles severally into and out of operative relation to said fluid-pressure-supplying mechanism, substantially as described.

35. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-receptacles rotatably supported above said mold-supports and rotating in unison therewith, fluid-pressure-supplying mechanism for supplying sand from said sand-receptacles severally to the molds, and means for connecting said fluid-pressure-supplying mechanism with the different sand-receptacles, substantially as described.

36. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-receptacles rotatably supported above said mold-supports and rotating in unison therewith, and stationary fluid-pressure-supplying mechanism for supplying sand to the molds from said sand-receptacles, substantially as described.

37. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-receptacles rotatably supported above said mold-supports and rotating in unison therewith, stationary fluid-pressure-supplying mechanism for supplying sand to the molds from said sand-receptacles, and means for supplying sand to said receptacles, substantially as described.

38. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-holding receptacles, having one

or more constricted openings at their lower ends, rotatably supported above said mold-holding devices and rotating in unison therewith, means for intermittently rotating said turn-table and sand-holding receptacles, fluid-pressure-supplying mechanism for supplying the molds with sand from said sand-receptacles, and means for connecting said fluid-pressure-supplying mechanism with the different sand-receptacles, substantially as described.

39. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-holding receptacles having one or more constricted openings at their lower ends, rotatably supported above said mold-holding devices and rotating in unison therewith, means for intermittently rotating said turn-table and sand-holding receptacles, means for holding the molds while in charging position in engagement with the lower ends of said sand-holding receptacles, and means for supplying compressed air to said receptacles, substantially as described.

40. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-holding receptacles having one or more constricted openings at their lower ends, rotatably supported above said mold-holding devices and rotating in unison therewith, means for intermittently rotating said turn-table and sand-holding receptacles, means for holding the molds while in charging position in engagement with the lower ends of said sand-holding receptacles, and means for supplying compressed air to said receptacles and for exhausting it therefrom while the molds are in engagement with said receptacles, substantially as described.

41. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-receptacles rotatably supported above said mold-holding devices and rotating in unison therewith, each of said sand-receptacles consisting of a cylinder open at its upper end and having one or more constricted openings at its lower end, means for intermittently rotating said mold-holding devices and sand-receptacles, means for closing the upper ends of said receptacles when in charging position, means for moving the mold-supports to carry the molds into engagement with the lower ends of said receptacles when in charging position, and means for supplying compressed air to said receptacles for charging the molds, substantially as described.

42. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-receptacles rotatably supported above said mold-holding devices and rotating in unison therewith, each of said sand-receptacles consisting of a cylinder open at its upper end and having one or more constricted openings at its lower end, means for intermittently rotating said mold-holding devices and sand-receptacles, means for closing the upper ends of said receptacles when in charging position, means for moving the mold-supports to carry the molds into engagement with the lower ends of said receptacles when in charging position, means for supplying compressed air to said receptacles for charging the molds and for exhausting the air therefrom while the upper end thereof is closed, substantially as described.

43. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-receptacles rotatably supported above said mold-holding devices and rotating in unison therewith, each of said sand-receptacles consisting of a cylinder open at its upper end and having one or more constricted openings at its lower end, means for intermittently rotating said mold-holding devices and sand-receptacles, means for closing the upper ends of said receptacles when in charging position, means for moving the mold-supports to carry the molds into engagement with the lower ends of said receptacles when in charging position, means for supplying compressed air to said receptacles for charging the molds, and means for supplying sand to said receptacles before they reach the charging position, substantially as described.

44. A sand-molding apparatus, comprising a turn-table, a plurality of mold-holding devices carried thereby, a corresponding number of sand-holding receptacles for supplying sand to the molds carried by the turn-table, stationary fluid-pressure-supplying mechanism for charging the molds with sand from said receptacles, means for intermittently rotating said turn-table, and means for locking said turn-table against rotation while the molds are being charged, substantially as described.

45. A sand-molding apparatus, comprising means for supporting the mold, a sand-receptacle having a constricted opening communicating with the mold, and means for admitting compressed air directly to the sand in said receptacle, substantially as described.

46. A sand-molding apparatus, comprising means for supporting the mold, mechanism for introducing compressed air and sand together into the mold, and means for automatically operating said mechanism.

47. A sand-molding apparatus, comprising movable means for supporting a plurality of molds, sand-holding means for supplying sand thereto, fluid-pressure mechanism for charging the molds, and means for automatically operating said parts, substantially as described.

48. A sand-molding apparatus, comprising

means for holding sand, means for moving a plurality of molds into and out of position to be charged with sand, fluid-pressure mechanism for charging the molds, and means for automatically operating said moving and charging mechanisms.

49. A continuously-operating molding apparatus, comprising means for supporting a plurality of molds, fluid-pressure mechanism for successively charging the molds with sand, and means for automatically operating said charging means to charge the molds successively.

50. A sand-molding apparatus, comprising means for supporting the mold, a sand-chamber having a partly-open bottom to support the sand, and means for supplying compressed air to said sand-chamber to carry sand from said sand-chamber and pack the same in the mold.

51. A sand-molding apparatus comprising means for supporting a mold and means for conducting compressed air charged with sand to and causing it to expand in the mold.

52. A sand-molding apparatus comprising a sand-holding receptacle adapted to hold a mass of sand, said receptacle having one or more contracted outlet-passages, means for supporting a mold in communication with said receptacle, and means for causing compressed air to permeate the mass of sand in said receptacle and carry particles of sand into the mold.

53. A sand-molding apparatus comprising means for supporting the mold, a receptacle adapted to hold sand in mass, and means for conducting compressed air charged with sand from said receptacle into the mold.

54. A sand-molding apparatus comprising means for supporting the mold, a compression-chamber adapted to contain sand in mass, and to be placed in communication with the mold, and means for directing compressed air through the mass of sand in said chamber into the mold, to fill the mold with sand from the mass.

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