D. BAKER.

FURNACE CHARGING MECHANISM.

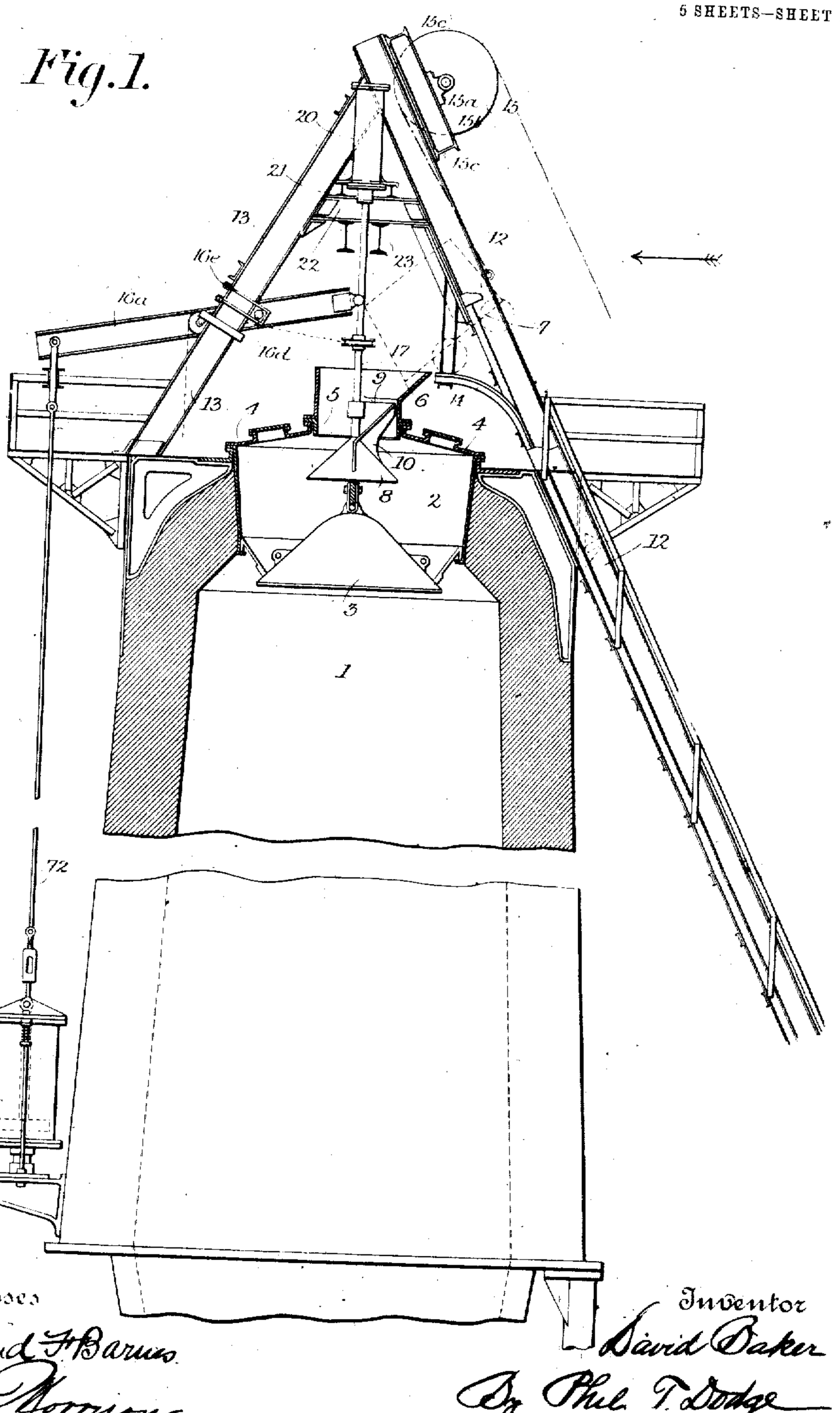
APPLICATION FILED MAY 13, 1907.

909,049.

Patented Jan. 5, 1909.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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5 SHEETS—SHEET 2.

Fig. 2.

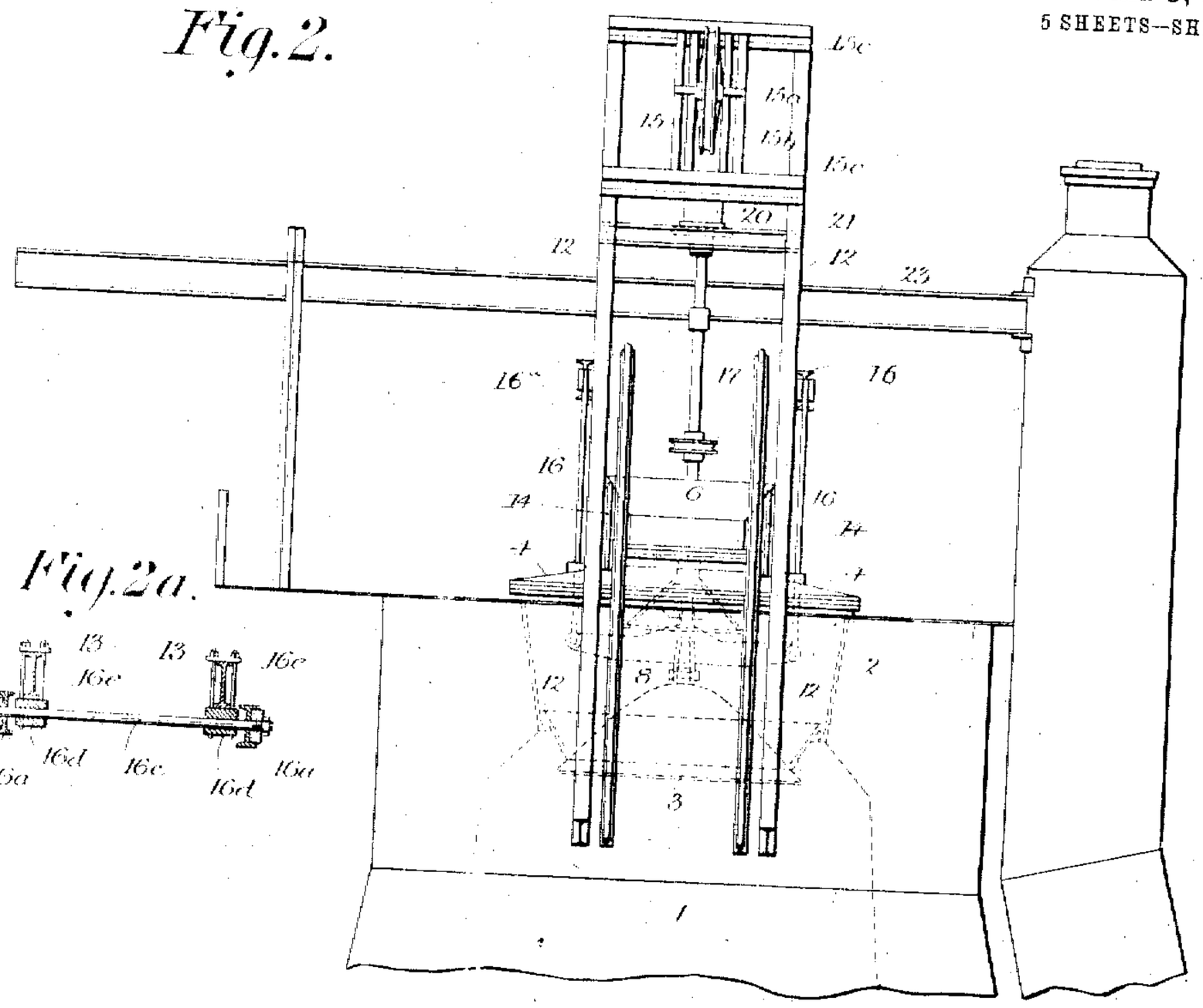
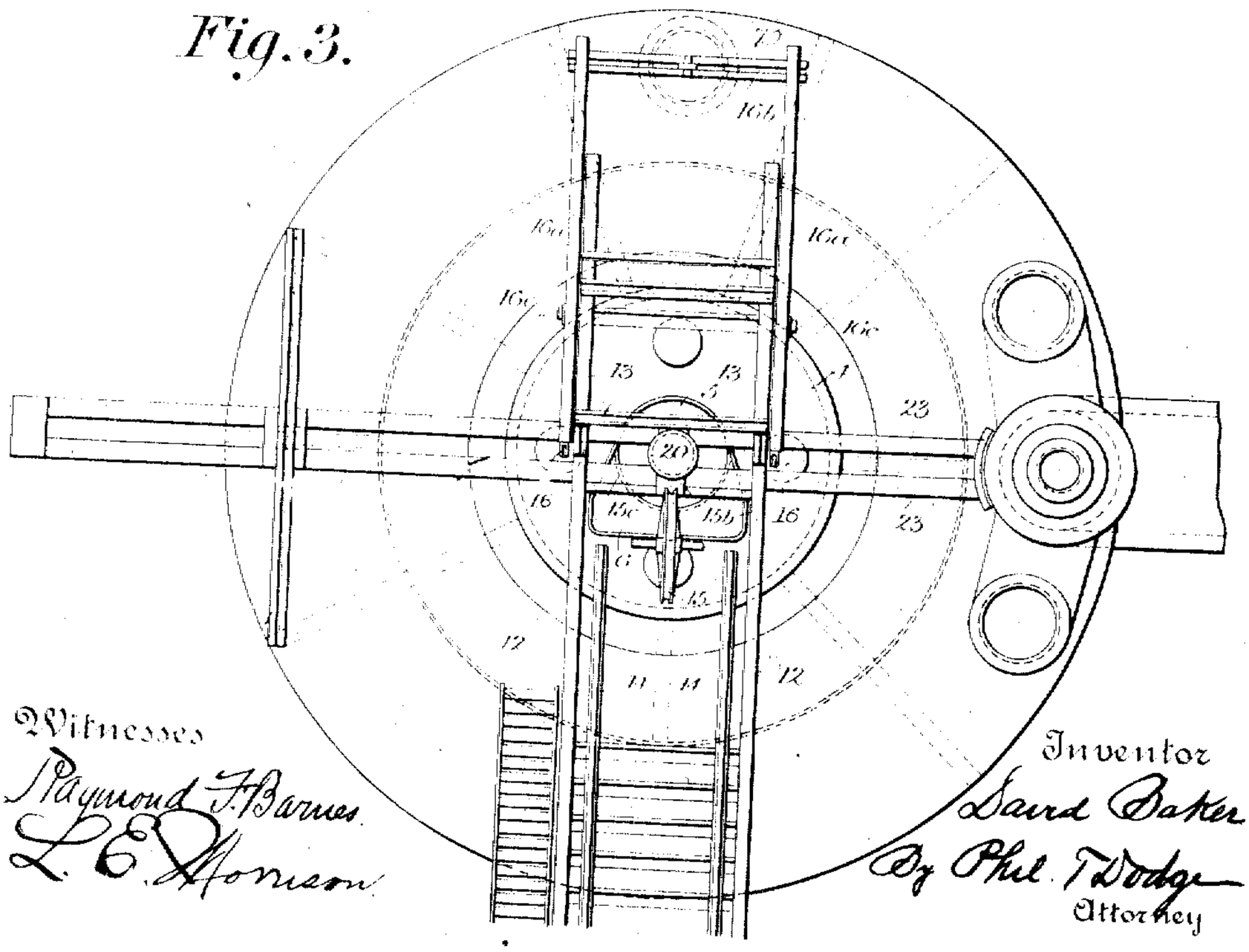


Fig. 2a.

Fig. 3.



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5 SHEETS—SHEET 3.

Fig. 4.

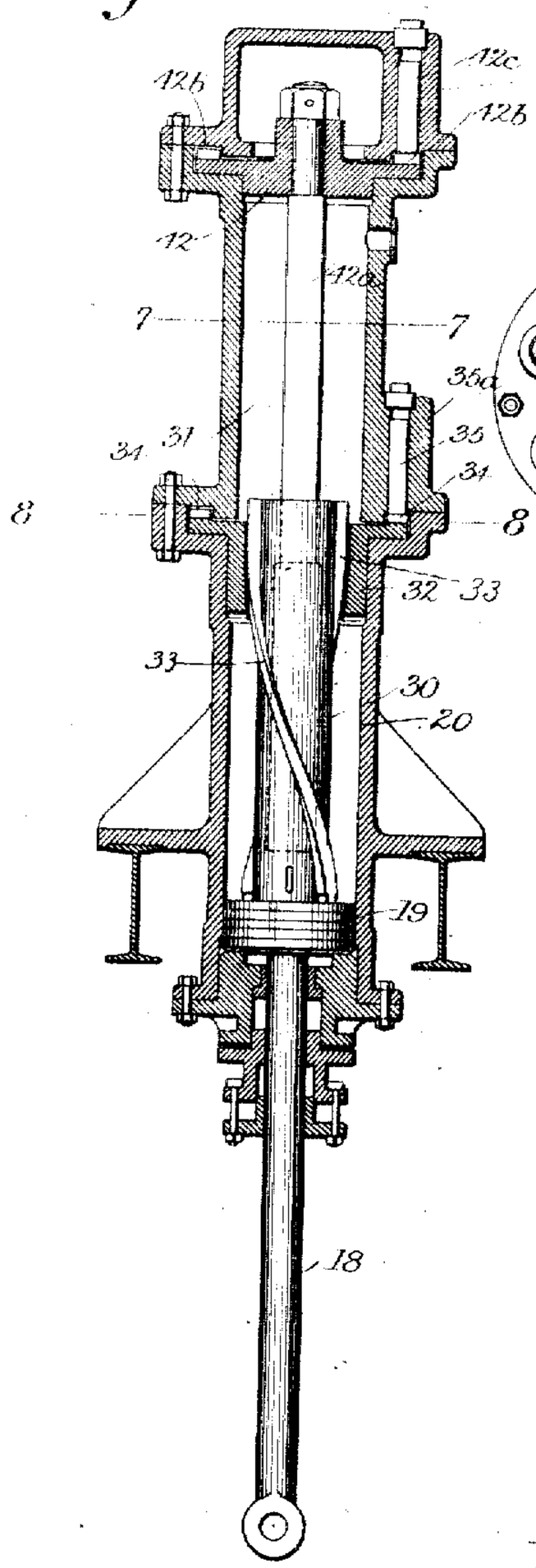


Fig. 6.

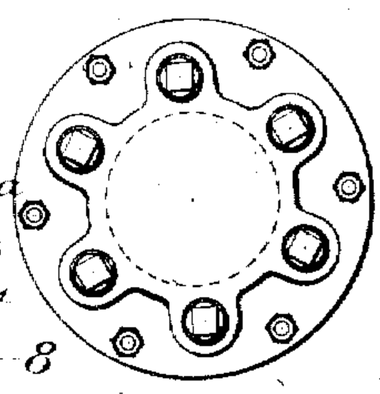


Fig. 5.

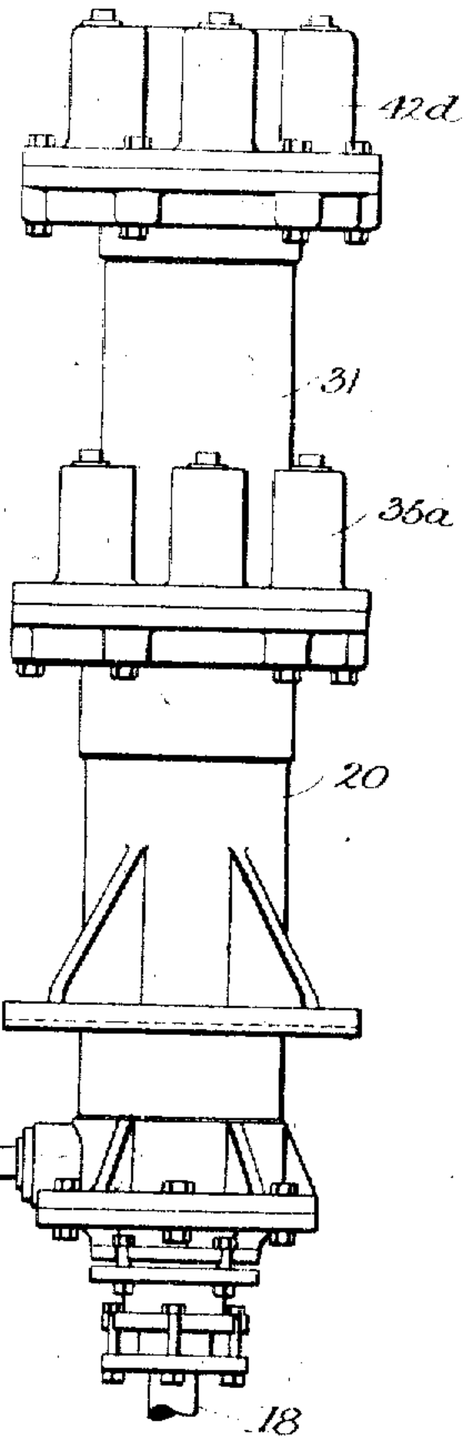


Fig. 7.

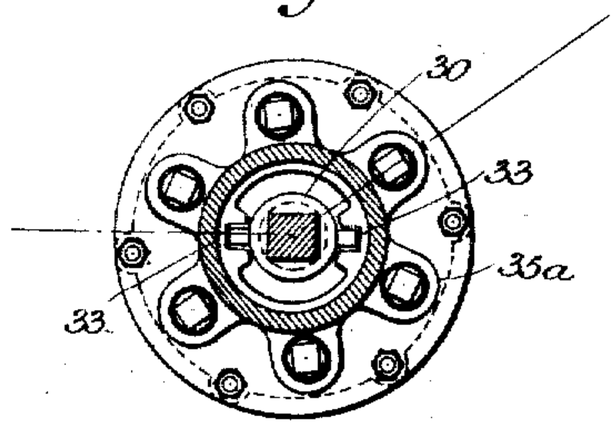
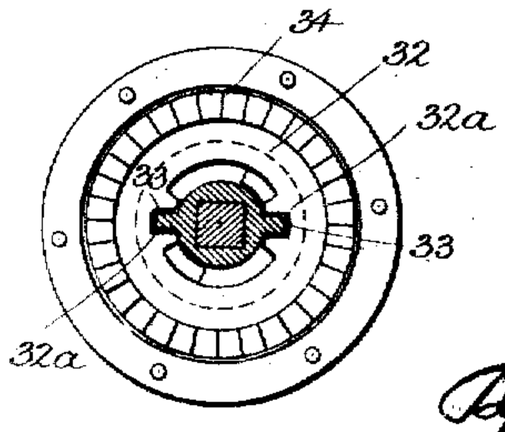


Fig. 8.



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5 SHEETS—SHEET 4.

Fig. 9.

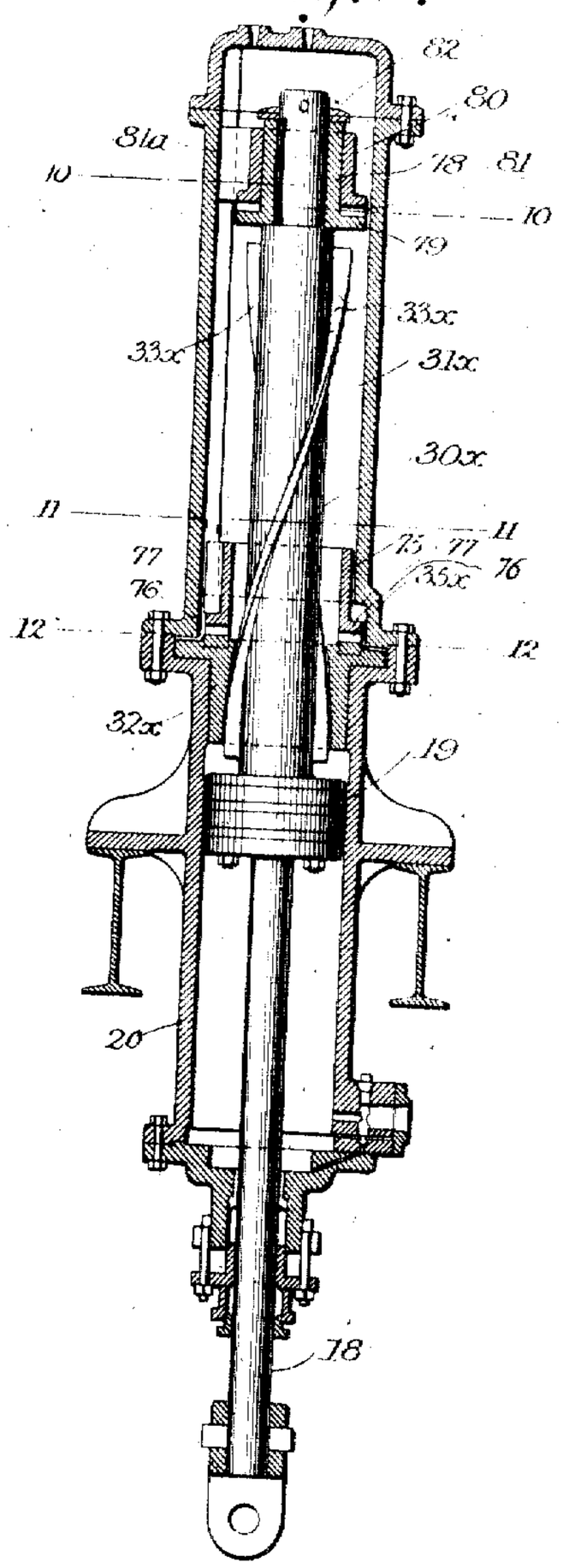


Fig. 10.

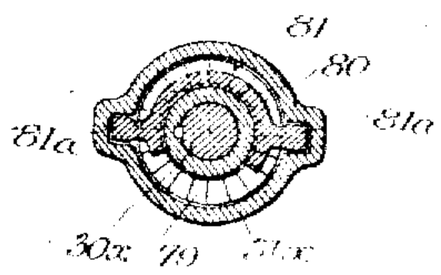


Fig. 11.

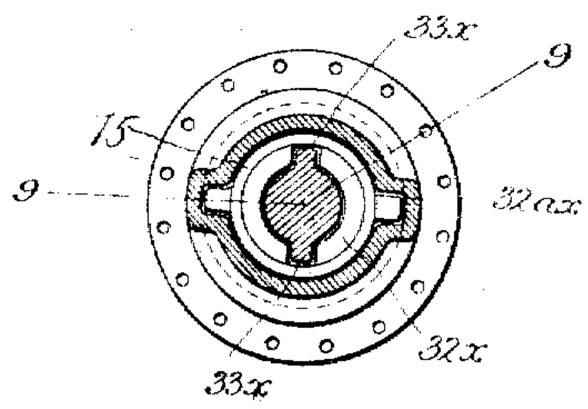
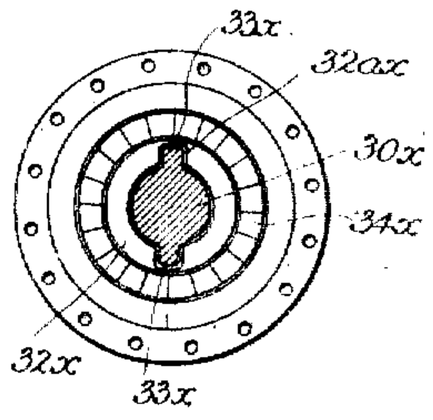


Fig. 12.



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5 SHEETS—SHEET 5.

Fig. 13.

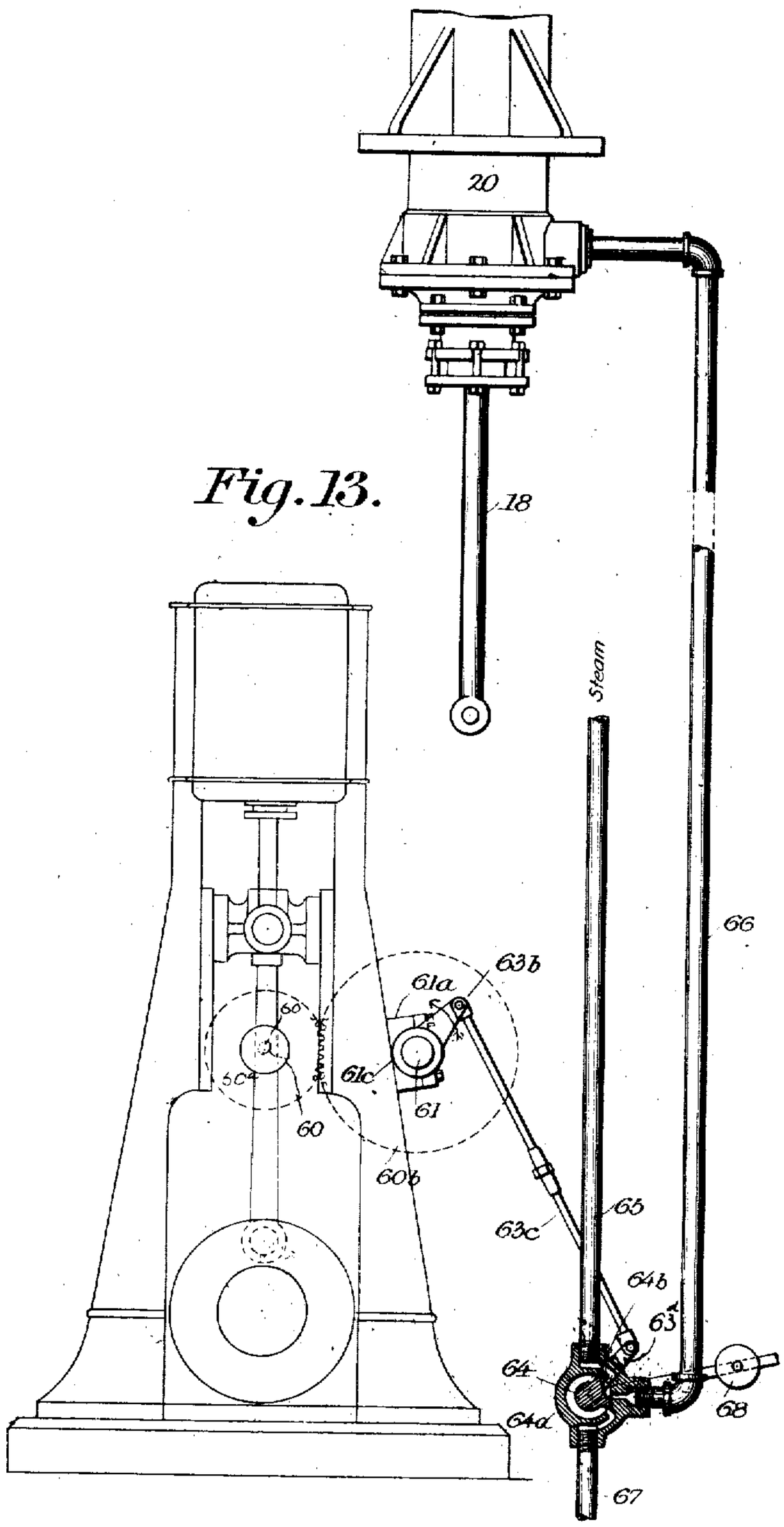
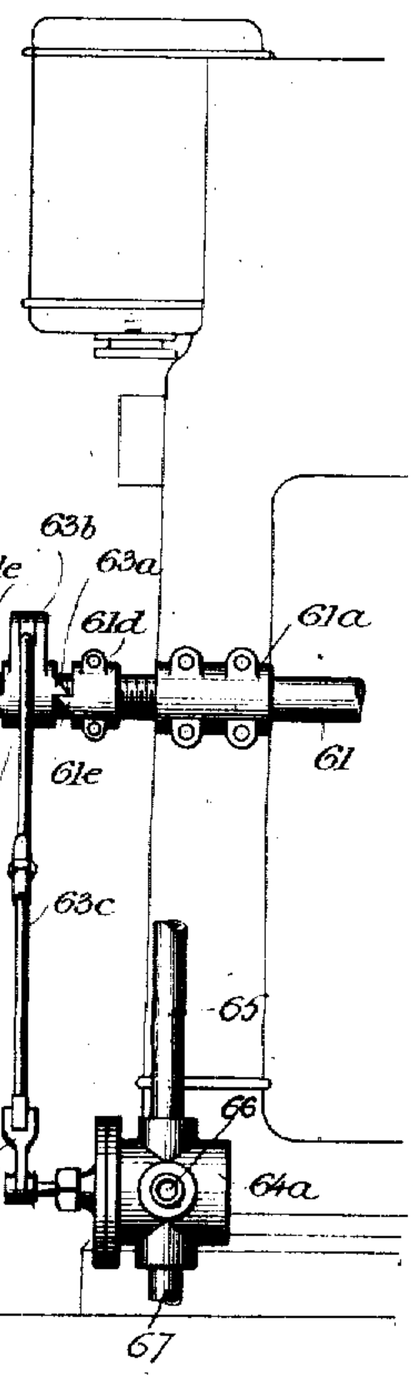


Fig. 14.



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UNITED STATES PATENT OFFICE.

DAVID BAKER, OF PHILADELPHIA, PENNSYLVANIA.

FURNACE-CHARGING MECHANISM.

No. 909,049. Specification of Letters Patent. Patented Jan. 5, 1909.

Application filed May 13, 1907. Serial No. 373,263.

To all whom it may concern:

Be it known that I, DAVID BAKER, of Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented a new and useful Improvement in Furnace-Charging Mechanism, of which the following is a specification.

This invention relates to mechanism for charging blast furnaces, the aim being to secure a uniform distribution of the stock as it is deposited in the furnace, so as to avoid the objections attending the sorting of the stock, that is, the separation of the "lumps" and "fines".

The present invention relates more particularly to that type of charging mechanism embodying a deflecting device, acting to direct the successive skip car loads of stock laterally to different points in the main hopper, and the invention consists in various improvements in mechanism of this character designed to render the distributing operation uniform and effective and automatically controlled by the skip car hoisting mechanism

This invention consists also in improved means for operating the deflecting device to vary the direction of flow of stock in its passage to the main hopper.

The invention consists also in improved means for supporting the main bell; and in improvements in the form of the superstructure, whereby it is adapted to give proper support to the operative parts of the mechanism at the top of the furnace.

In the accompanying drawings:—Figure 1 is a side elevation of the upper end of a blast furnace equipped with my improved distributing mechanism, parts being shown in vertical section. Fig. 2 is an elevation of the same as viewed from the side, looking in the direction of the arrow in Fig. 1. Fig. 3 is a top plan view of the same. Fig. 4 is a vertical sectional view through the preferred form of the cylinder for operating the deflecting plate and gas seal bell, the same being on an enlarged scale. Fig. 5 is a side elevation of the same. Fig. 6 is a top plan view. Fig. 7 is a horizontal sectional plan view through the same on the line 7—7 of Figs. 4 and 5. Fig. 8 is a similar view on the line 8—8 of Fig. 4. Fig. 9 is a vertical longitudinal section through an operating cylinder in modified form. Figs. 10, 11 and 12 are horizontal sectional plan views taken on the correspondingly numbered lines of Fig. 9. Fig. 13 is a side elevation of the hoisting engine and mechanism operated thereby, by which the action of the deflecting plate is automatically controlled. Fig. 14 is an end view of the same.

Referring to the drawings:—1 represents the upper or receiving end of a blast furnace provided with the usual main hopper 2, closed at its lower end by a main distributing bell 3, and at its upper end by a cover plate 4 containing a central opening, from which rises a receiving hopper 5, cylindrical at its lower end and having its forward upper portion inclined upwardly and widened, as at 6, where it receives the material from the skip car 7. The lower end of the receiving hopper, where it communicates with the main hopper, is adapted to be closed by a gas seal, in the form of a conical bell, 8 movable vertically to open and closed positions respectively, and also movable horizontally around a vertical axis for the purpose presently to be described. This gas seal bell is so operated, as will be more fully described later on, that it normally is in lowered and open position when the stock is charged into the receiving hopper, and is raised to closed position after the charge has entered the main hopper, and when the contents of the main hopper are discharged into the furnace by the opening of the main bell.

The gas seal bell 8 is so formed on its upper surface, that when the stock from the skip car falls on it, the stock will be directed to one side and will flow laterally into the main hopper and be accumulated at one side therein. This action is effected preferably by the provision of a deflecting plate 9 extending upwardly in an oblique plane from the apex of the bell from one side, and having its upper edge shaped to conform to the interior curvature of the cylindrical portion of the hopper, and extending upwardly within the hopper when the bell is in lowered position, as indicated in Fig. 1. The plate is braced and held firmly in position on the bell, by means of a web or bracket 10, extending upwardly from the surface of the bell and bearing against the under side of the plate. The deflecting plate thus arranged and disposed within the lower cylin-

drical portion of the receiving hopper, presents a downwardly inclined surface, which will act to direct the stock falling thereon from the skip car, to one side, and by turning the bell and plate around horizontally on a vertical axis, the plate occupying different positions in the hopper, will cause the stock to flow to correspondingly different parts of the main hopper.

The superstructure of the furnace, which gives support to the bell operating and supporting mechanism, the hoist sheave and skip car tracks, is formed mainly by two pairs of I-beam girders 12 and 13, the former extending from the forward side of the top platform upwardly at an inclination and terminating vertically over the center of the furnace, and the latter extending upwardly from the opposite side of the platform to the upper ends of the girders 12, to which they are firmly fastened by appropriate means, this arrangement constituting a frame or structure of A-form. The girders 12 are continued downward to the base of the furnace and give support to the usual track rails for the skip cars, which track rails are deflected laterally at their upper ends, as at 14, and terminate adjacent the front edge of the receiving hopper, so as to support the skip car in its dumping position, as shown in Fig. 1.

The upper sheave, over which the skip car hoisting rope passes, is indicated at 15, being arranged in a vertical position with its axle mounted in bearings 15^a sustained on parallel bars 15^b connected at their upper and lower ends respectively, to horizontal beams 15^c, fastened at their ends to the girders 12 near the upper ends of the same.

The main distributing bell 3, before alluded to, is suspended by means of two vertical rods 16 (Fig. 2) from the inner end of a rectangular frame comprising two horizontal parallel bars 16^a, connected together at their rear ends by a cross-piece 16^b, and extending at the outer sides of the girders 13, to which the frame is pivoted on a horizontal transverse axis, formed by a horizontal pivoting bolt 16^c extending through the two bars of the frame and through bearings 16^d sustained by strap bolts 16^e, fastened to the girders. The pivoting bolt 16^c is removable from the bearings and the frame, so that the latter may be readily removed when desired, for repairs, or for gaining access to the mechanism of the furnace, or for other purposes.

The upper gas seal bell 8, carrying the deflecting plate, is fixed to the lower end of a stem or rod 17, extending vertically upward and connected with a piston rod 18, carrying a piston 19 (Fig. 4) mounted in a cylinder 20, sustained in a vertical position by two crossbars 21, seated upon two transversely arranged horizontal beams 22, extending between and connected at their ends to the inclined girders 12 and 13 of the A-frame. The beams 22 are supported in turn by two horizontal beams 23, extending beneath them at right angles and suitably supported at their ends from the platform of the furnace.

The piston is raised by the admission of pressure within the lower end of the cylinder, and acts to raise and close the gas seal bell against the lower end of the receiving hopper, the opening of the bell being effected by cutting off the pressure from the cylinder and opening the lower end of the same to the exhaust, with the result that the piston will move downward by the weight of the bell connected therewith.

The piston and cylinder are so constructed relatively, that on the downward movement of the former, when the bell is lowered to open position, the piston and its rod and connected bell, will be given automatically a partial revolution; and when the piston is raised to close the bell, it will be firmly and positively held against back movement, the result of these actions being that, by the successive opening operations of the bell, the deflecting plate will be shifted around with the bell to different positions in the receiving hopper, thus causing each discharge of material from the skip car to flow in different directions and to be accumulated at different and changing points in the main hopper. In the preferred form of the parts for thus causing the piston to turn automatically when it moves downward, the piston has extending from its upper side a tubular stem 30, projecting into a cylindrical surrounding casing 31, fixed to the upper end of the cylinder 20. The stem slides through a central opening in a nut 32 mounted so as to turn in the upper end of the cylinder 20, which opening is formed at diametrically opposite sides with radial grooves or recesses 32^a (see Fig. 8) in which slidingly fit spiral or inclined ribs 33, extending longitudinally from opposite sides of the stem. Means are provided for allowing the nut to rotate during the rise of the piston, and for holding it against rotation when the piston descends, with the result that during the latter movement, the piston will be revolved relatively to the nut by the passage of the spiral ribs through the same, so that the deflecting plate will be shifted horizontally; but it will not be changed in position horizontally when the piston rises. The means for effecting these actions comprises ratchet teeth 34, on the upper end of the nut, engaged by a number of vertically arranged gravitating pawls 35, in the present instance six, square in cross-section and mounted to reciprocate freely in correspondingly formed openings in swells or bosses 35^a, formed externally on the casing 20 at its base. The teeth 34 are formed each with an inclined face, and an abrupt vertical face, and the ends of the pawls are shaped so as to

coöperate with the teeth to hold the nut when the latter tends to move in one direction, and permit the nut to rotate in the opposite direction. The relation of the coöperating teeth and pawls to the direction of inclination of the ribs 33 is such, that when the stem moves downward through the nut, the pawls and teeth will interlock and form a clutch connection, holding the nut against rotation and causing a relative turning movement to be imparted to the stem and the piston and deflector plate connected therewith. When, however, the piston rises, the inclined faces of the teeth on the nut will ride beneath the end of the pawls and will lift the latter to disengaging position, and the nut being thus released, it will be turned around by the inclined ribs, and the piston will not be changed in position around a vertical axis.

The pawls are so spaced in relation to the teeth on the nut that they will drop into locking engagement with the teeth one after another or successively, consequently, there will be practically no back-lash in the movement of the nut; and being independent of each other, the clogging or sticking of one, and its failure to engage the teeth on the nut, will not interfere with the action of the others, hence, there will always be one or more of the pawls in operation.

In order that during the rise of the piston, it will be positively held against back movement, I mount in bearings at the upper end of the casing 31, a second rotatable nut 42 fixed to the upper end of a squared rod 42^a, extending downward within the casing and into the tubular stem 30, the upper end of the internal opening in the stem being squared so as to slidingly fit the rod, and the arrangement being such that the stem will slide up and down on the rod as the piston moves in corresponding directions. Ratchet teeth 42^b are formed on the upper side of nut 42 similar to those on the lower nut, but facing in the opposite direction, which teeth are engaged by a number of vertically arranged gravitating pawls 42^c similar in form and arrangement to those first described, which pawls are mounted in bosses 42^d formed externally on the casing at its upper end.

By reason of the opposite arrangement of the ratchet teeth on the upper nut to those on the lower nut, the upper nut will be held against rotation by its pawls when the lower nut is turned, and the squared rod will also be held, so that while the stem may slide up and down on the rod, it will by reason of the squared form of the rod, be held against back movement. When, however, the piston descends and the lower nut is held, and there is imparted a rotary movement to the stem, the upper nut will be released and will not therefore interfere with the turning movement of the stem It will be seen, therefore, that while the ratchet mechanism at the lower end of the casing is engaged to cause the piston to turn, the ratchet mechanism at the opposite end of the casing is disengaged so as to admit of the free turning movement of the stem. When, however, the lower ratchet mechanism is disengaged on the rise of the piston, the upper mechanism will be engaged and will effectually prevent any back rotation of the stem. In this manner, the deflecting plate carried by the bell, will be positively rotated a partial revolution on each opening movement of the bell, and will be held against back motion between each turning movement.

In Figs. 9, 10, 11 and 12, I have shown an operating cylinder in slightly modified form embodying, as in the first instance, a rotating piston, and two ratchet mechanisms controlling the turning movements of the piston, the detailed form, however, of these parts being different. Referring to these figures, it will be seen that there projects from the upper side of the piston, a rod $30^\times$ projecting into a cylindrical surrounding casing $31^\times$, fixed to the upper end of the cylinder. The rod slides through a central opening in a nut $32^\times$ mounted so as to turn in the upper end of the cylinder, which opening is formed at diametrically opposite sides with radial grooves or recesses $32^{a\times}$, in which slidingly fit inclined ribs $33^\times$, projecting from opposite sides of the rod. The means for allowing the nut to rotate during the rise of the piston and for holding it against rotation when the piston moves downward, comprises ratchet teeth $34^\times$ on the nut, with which coöperate oppositely facing ratchet teeth $35^\times$ on the lower end of a collar 75 interlocked with the casing 31 so as to be capable of a slight vertical motion only sufficient to disengage the teeth. The relation of these coöperating teeth to the direction of inclination to the ribs $33^\times$, is such that when the rod moves downward through the nut, the teeth will interlock and form a clutch connection between the sleeve and nut, holding the latter against rotation and causing a relative turning movement to be imparted to the rod. When, however, the piston rises, the inclined faces of the teeth on the nut will ride beneath those on the collar and will lift the latter to disengaging position, and the nut being no longer held, it will be turned around by the inclined ribs, and the piston will not be changed in position around a vertical axis. The vertical movement of the collar is limited by a flange 76 on its lower end engaging a shoulder 77 on the casing. The means for holding the rod against back movement when the piston rises, comprises a collar 78 keyed to the rod and formed with a flange 79 having ratchet teeth on its upper face. Encircling this collar is a loose sleeve 80 provided on its lower end with ratchet teeth 81

to coöperate with those on the flange 79, the teeth facing in opposite directions, so that they will lock in one direction only. The sleeve 80 is formed on opposite sides with ribs 81[a], engaging slidingly in grooves in the casing, whereby the sleeve may slide up and down in the casing as the rod moves up and down, but will be prevented from turning around therein. The sleeve is capable of a slight vertical movement on the collar sufficient to disengage the teeth, which movement is controlled by the upper end of the sleeve encountering a stop washer 82 fixed to the rod. The relation of the parts is such that when the rod moves downward and is turned by the ratchet mechanism, first described, and opens the gas seal bell, the inclined faces of the teeth on flange 79 will act against the other teeth and lift the sleeve 80 to disengage the teeth, so that the teeth on the collar will click by those on the sleeve. When, however, the piston rises to close the bell, any tendency of the rod to move back will act to engage the teeth, and as the sleeve is held against rotative movement by ribs 82, it will act as a stop on the collar and will effectually prevent the same from turning around.

I propose to control the opening and closing movements of the gas seal 8, and the shifting of the same to vary the position of the deflector plate, by automatic means operated from the hoisting mechanism, the parts being so timed in their actions that the seal will be raised to closed position just before the skip car reaches the bottom of the hoist, and will be lowered to open position, and the deflector plate turned, when the car with its load begins to ascend. As a result, the bell will be opened when the contents of the car are discharged into the receiving hopper, and it will be closed when the skip car is receiving its load, at which time the main bell may be opened to discharge the contents of the main hopper into the furnace. I prefer to effect these operations by a clutch mechanism actuated by the hoist engine or motor, and operatively connected with valve mechanism controlling the admission of pressure to and the exhaust from the operating cylinder 20. This controlling mechanism is illustrated in Figs. 13 and 14, where it will be seen that the hoist-engine operating shaft 60 has geared to it, by gears 60[a] and 60[b], a horizontal shaft 61, mounted in bearings 61[a] on the engine frame, and having its end extended outward and formed with a feed screw 61[b], carrying an outer fixed sleeve 61[c] and an inner fixed sleeve 61[d], provided each with a tooth or shoulder 61[e]. Mounted on the feed screw between the two fixed collars, is a traveling nut 63, adapted by the rotation of the shaft, to travel to the right or left according to the direction of rotation, and provided on its side with a tooth or shoulder 63[a] arranged to coöperate with the tooth on the fixed nut 61[d], for the purpose presently to be described The traveling nut is formed with an arm 63[b], connected by link 63[c] with the outer end of an arm 63[d], whose inner end is fixed to an oscillating valve 64 arranged in a valve casing 64[a]. The valve casing communicates by pipe 65 with the source of pressure, in the present instance steam; by pipe 66 with the lower end of the operating cylinder 20; and by pipe 67 with the external atmosphere to exhaust the cylinder. The valve is formed with a port 64[b], which when the valve is in one position, will establish communication between the source of pressure and the operating cylinder, and when in another position will establish communication between the operating cylinder and the external atmosphere. The valve is acted on by a weight 68 on an arm fixed to the same, which weight tends to hold the valve in such position that the source of pressure will be cut off and the cylinder will be opened to exhaust, in which position of the parts, the bell will be opened.

The form, construction and relation of the parts described are such that the traveling nut 63 will reach the fixed lug 61[d], which rotates in the direction of the arrow in Fig. 8, just before the skip car arrives at the bottom of the hoist, and the lug 61[e] on the fixed collar 61[d] will engage the lug 63[a] on the traveling nut, with the result that the latter will be turned on the feed screw in the direction of movement of the collar, which action will move arm 63[b] in the direction of the arrow in Fig. 13, and this movement will, through the medium of the link 63[c] and arm 63[d], oscillate the valve 64 against the influence of the weight 68, carrying it to the position where its port will establish communication between the source of pressure and the lower end of the operating cylinder 20, resulting in the rise of the piston and the closing of the gas seal. By the time these operations are completed, the hoist mechanism has come to a rest and the skip car is receiving its load. The hoist engine is now started in reverse direction to carry the car to the top of the furnace, and as it begins to move, the shaft 61 will be turned in a direction opposite to its movement when the car descended, and as it begins its movement, the lug 61[e], on fixed collar 61[d], disengages and releases lug 63[a] on the traveling nut 63, thereby permitting the weight 68 to automatically throw the oscillating valve downward to a position where the source of pressure is cut off and the cylinder is opened to exhaust through pipes 66 and 67, the result being that the piston will be moved downwardly by the weight of the bell and the latter opened. During the rotation of the feeding screw, as

the car ascends, the traveling nut moves to the left, the bell remaining opened, and the valve being held in the position described by the weight 68. When the car arrives at the top of the furnace and runs onto the track 14 to discharge its contents into the receiving hopper, the operation of the hoist engine is stopped, and on being reversed, the car descends and the traveling nut moves again to the right, and just before the car reaches the bottom of the hoist, the nut is operated by the fixed collar and the valve again shifted to admit pressure to the cylinder and closes the bell, as before described. These operations are repeated, the bell being automatically closed and opened as the car reaches the bottom of the hoist, and as it begins its ascent with its load.

The main bell is opened while the skip car is receiving its load and while the gas seal bell is closed. It may be either operated between each discharge of the skip cars into the main hopper, or it may be operated after a number of loads have been accumulated in the main hopper.

The operation of the main bell may be effected in any appropriate manner, but I prefer to employ an air cylinder 70, sustained near the base of the furnace and containing a piston 71 connected by vertical rod 72 with the cross-bar 16^b, at the rear end of the rectangular frame, from which the main bell is suspended, the admission of pressure above the piston causing the bell to be raised to closed position, and the exhaust of the cylinder permitting the bell to be opened by its own weight.

Having thus described my invention, what I claim is:—

1. In a furnace charging device, the combination of a hoist mechanism, a gas-seal bell movable vertically to open and closed positions and movable also horizontally around a vertical axis, a deflector plate carried by the bell, power means for moving the bell vertically and horizontally, and means operated by the hoist mechanism for controlling automatically the actuation of the power means.

2. In a furnace charging mechanism, the combination of a receiving hopper, a deflector plate movable horizontally around a vertical axis and adapted to direct the charging materials entering the hopper to one side, a cylinder sustained in vertical position above the hopper, a piston therein operatively connected with the deflector plate, and means for positively moving said piston around a vertical axis to vary the position of the deflector plate.

3. In a furnace charging mechanism, the combination of a receiving hopper, a deflector plate movable around a vertical axis and adapted to direct the charging materials entering the hopper to one side, an operating cylinder sustained in a vertical position over the hopper, a piston therein movable vertically and connected with the deflector plate, and means controlled by the vertical movement of the piston for turning the same around horizontally.

4. In a furnace charging mechanism, the combination of a receiving hopper, a deflector plate adapted to direct the charging materials to one side and movable around a vertical axis, a cylinder arranged vertically over the hopper, a piston therein movable vertically, connections between the piston and the deflector plate, means controlled by the vertical movement of the piston for imparting to the same a partial revolution around a vertical axis, and means for positively holding the piston against back movement.

5. In a furnace charging mechanism, the combination of a receiving hopper, a deflector plate adapted to direct the charging materials to one side and movable around horizontally to vary the direction of flow, a cylinder arranged in a vertical position above the hopper, a piston movable vertically therein, a piston rod connected with the piston and with the deflector plate, a stem extending from the piston upwardly and provided with an inclined longitudinally extending rib, a rotative nut sustained against vertical movement and formed with an opening to receive the stem and with a recess to receive the rib on the stem, means for holding said nut against rotation when the stem moves in one direction, and means for permitting the nut to rotate when the stem moves in the opposite direction; whereby during the movement of the stem in one direction, it will be turned automatically a partial revolution, and when moved in the opposite direction, it will not be changed in position around a vertical axis.

6. In a furnace charging mechanism, the combination of a receiving hopper, a deflector plate adapted to direct the charging materials to one side and movable around horizontally to vary the direction of flow, a vertically arranged cylinder, a piston movable therein, a depending piston rod connected with the deflector plate, a stem extending vertically from the opposite side of the piston, an inclined rib extending longitudinally on the stem, a rotative nut sustained against vertical movement and provided with an opening to receive the stem and with a recess to receive the rib, means for holding the nut against rotative movement when the stem moves in one direction; whereby the latter will be automatically turned a partial revolution, means for releasing the nut when the stem moves in the other direction, and means for holding the stem against back rotative movement when the nut is released.

7. In a furnace charging mechanism, the

combination of a receiving hopper, a deflector plate adapted to direct the charging materials to one side and movable around horizontally to vary the direction of flow, a vertically arranged cylinder, a piston, a depending piston rod connected with the deflector plate, a stem extending upwardly from the piston and provided with inclined ribs, a rotative nut having an opening to receive the rod and a recess to receive the rib, ratchet teeth on the nut, and a series of vertically arranged gravitating pawls adapted to engage the ratchet teeth.

8. In a furnace charging mechanism, the combination of a receiving hopper, a deflector plate adapted to direct the charging materials to one side and movable around horizontally to vary the direction of flow, a vertically arranged cylinder, a piston, a depending piston rod connected with the deflector plate, a stem extending upwardly from the piston and provided with inclined ribs, a rotative nut having an opening to receive the stem and recesses to receive the ribs, ratchet teeth on the nut, and a series of vertically arranged gravitating pawls spaced with relation to the teeth so as to interlock with the same in succession.

9. In a furnace charging mechanism, the combination of a receiving hopper, a deflector plate adapted to direct the charging materials to one side and movable around horizontally to vary the direction of flow, a vertically arranged cylinder, a piston, a depending piston rod connected with the deflector plate, a stem extending upwardly from the piston and provided with an inclined rib, a rotative nut having an opening to receive the stem and a recess to receive the rib, means for locking the nut against rotative movement in one direction only, a depending rotative rod slidingly interlocked with the stem, and means for locking the rod against rotative movement in one direction only.

In testimony whereof I hereunto set my hand this 19th day of April, 1907, in the presence of two attesting witnesses.

DAVID BAKER.

Witnesses:

LOUISE B. MORRIS,

C. B. BROWN.