Oct. 12, 1937. F. R. McGEE 2,095,567

SINTERING

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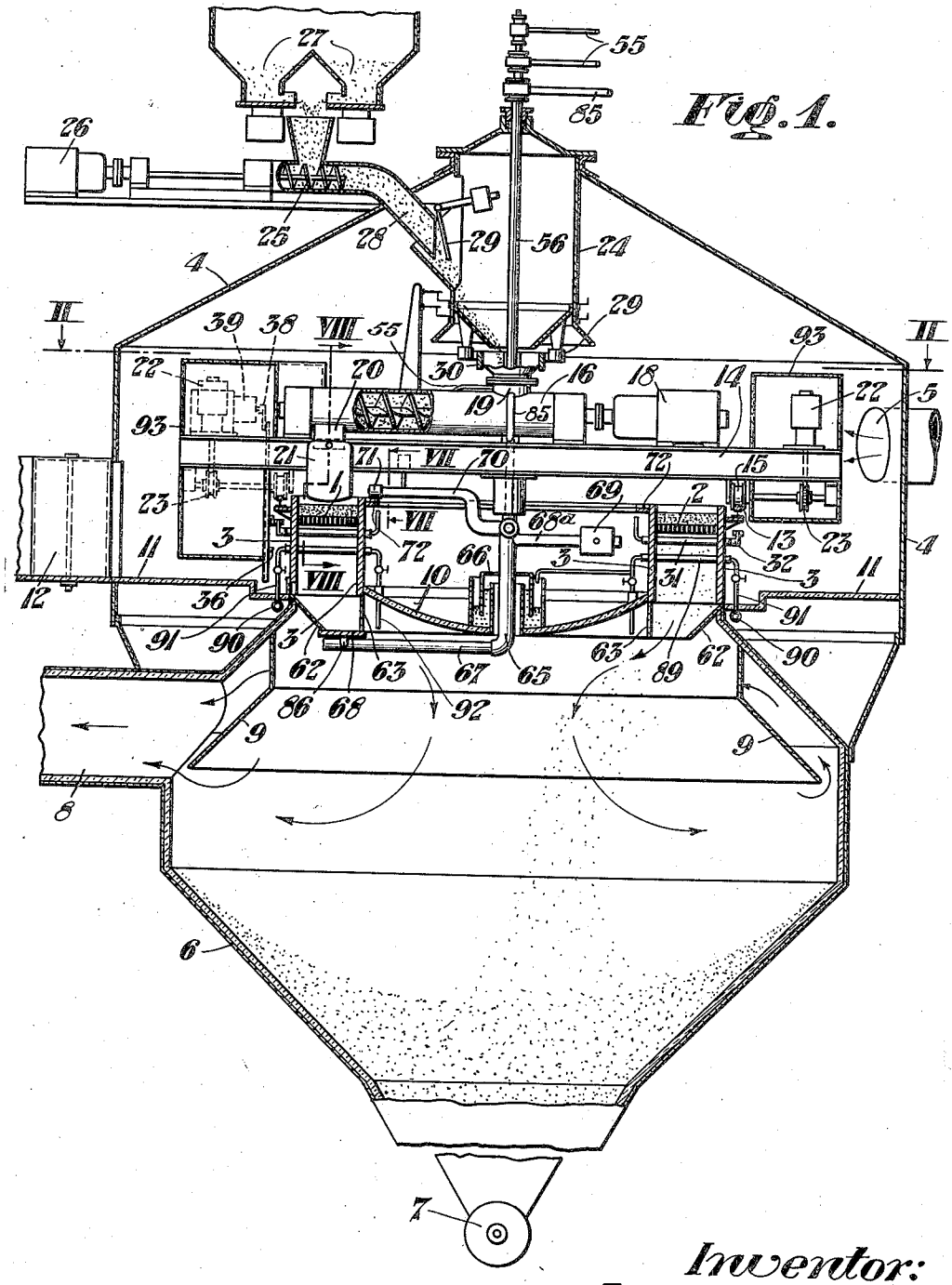


Fig. 1.

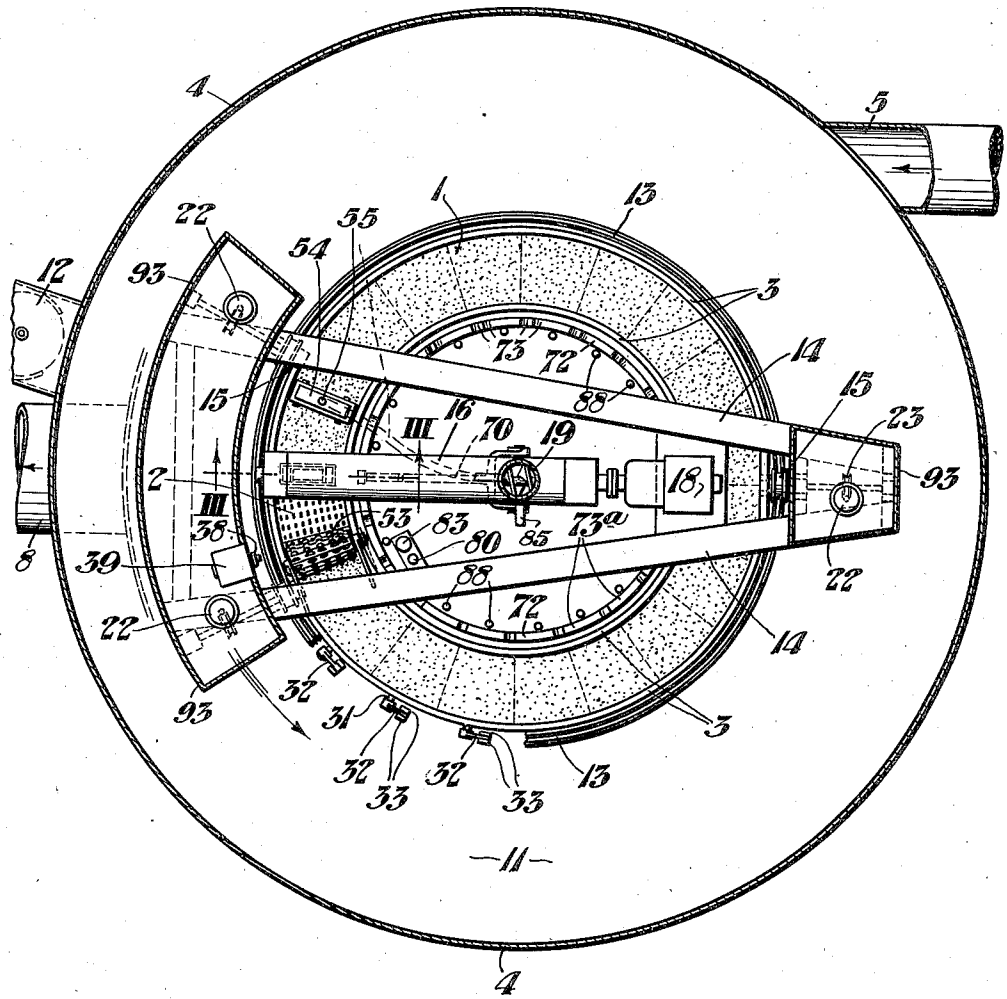
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Fig. 2.



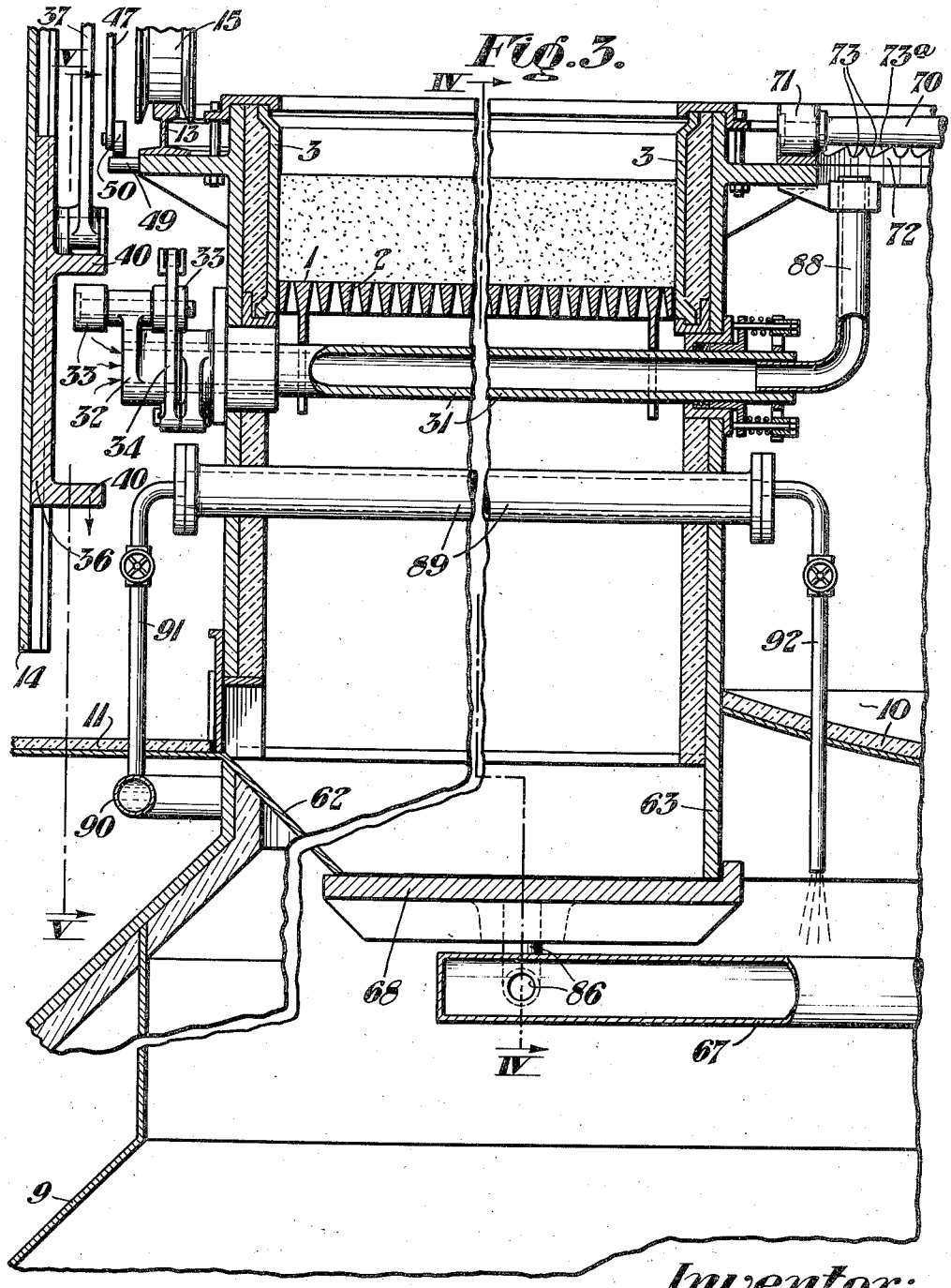

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SINTERING

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Fig. 3.



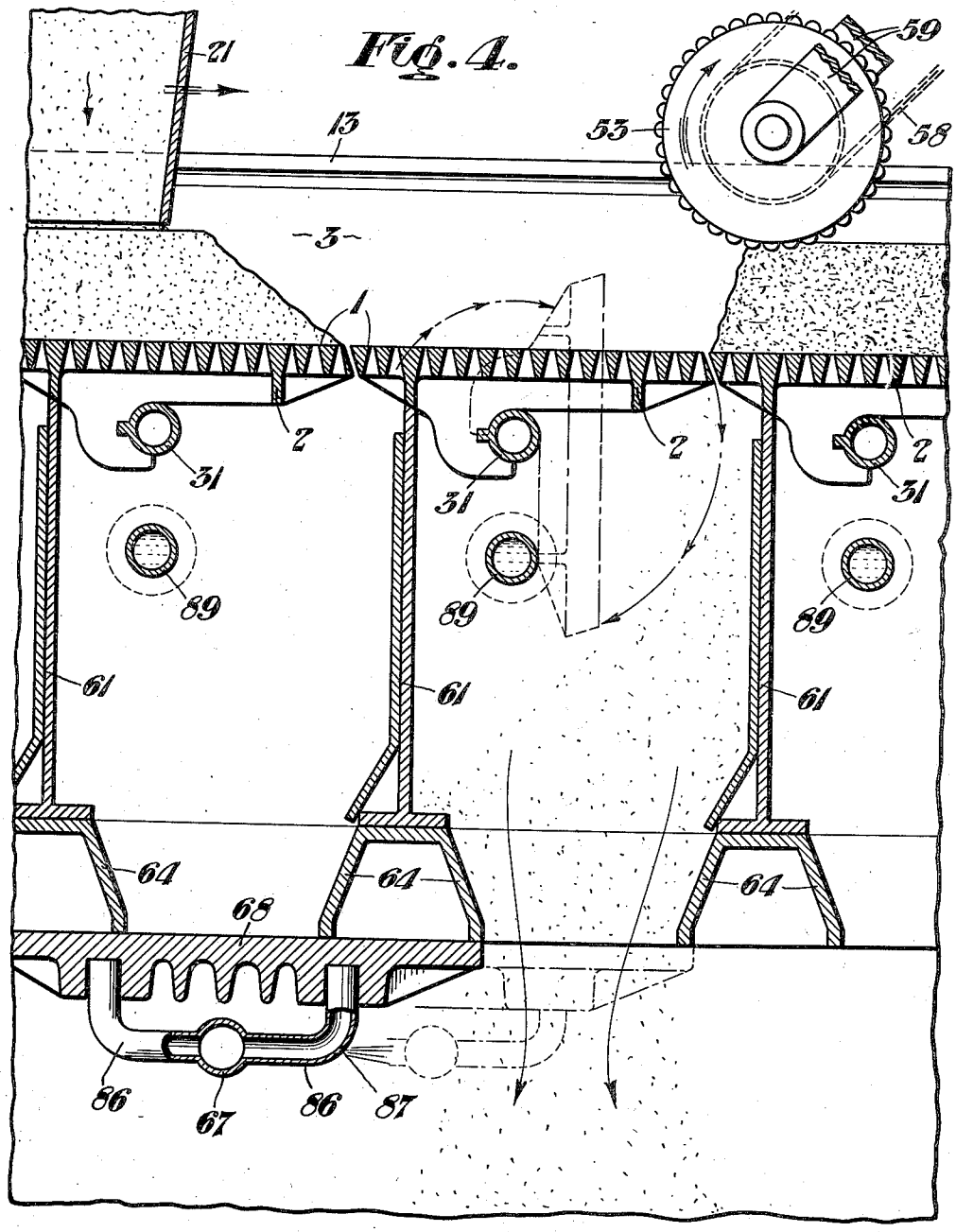

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Fig. 4.



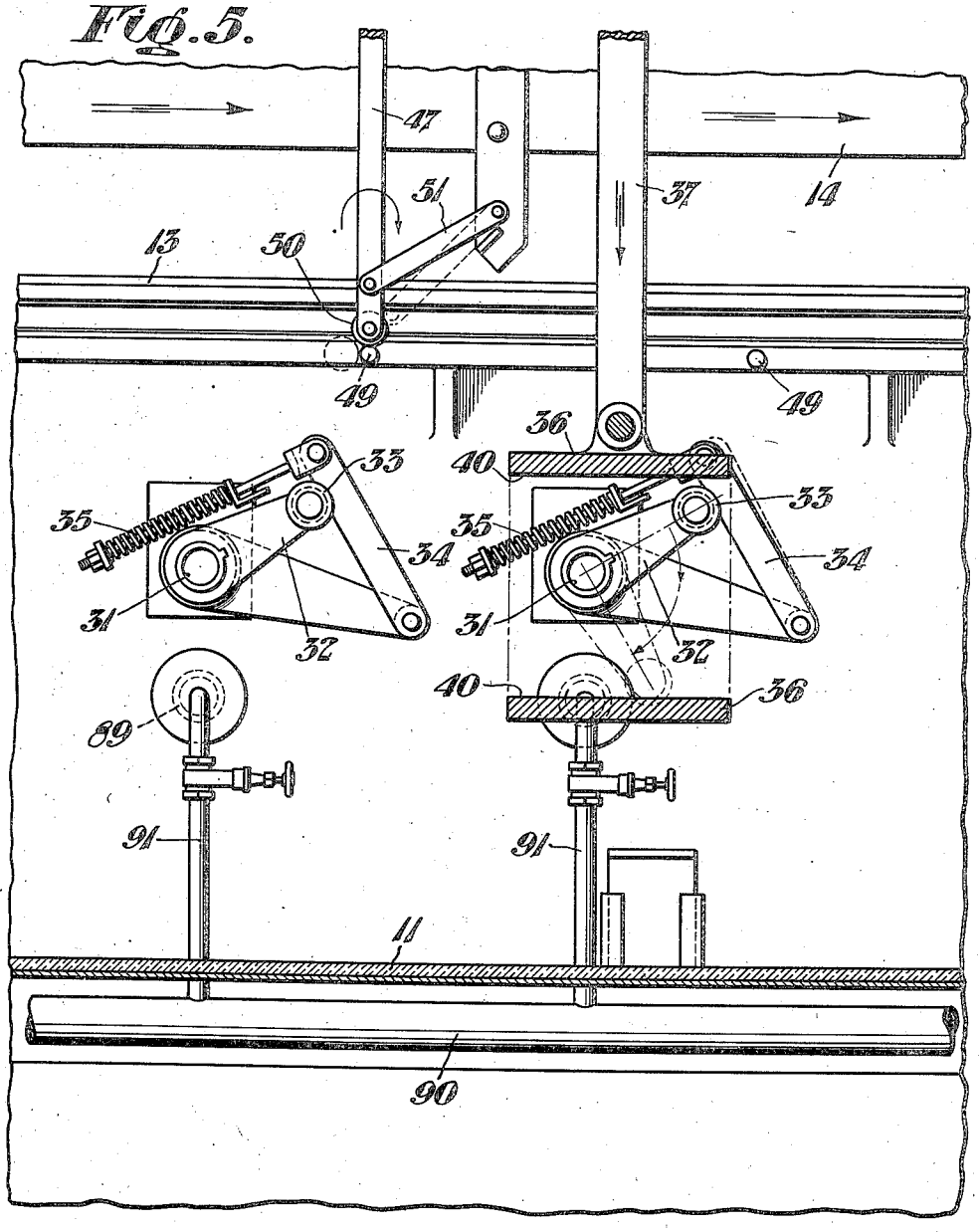

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Fig. 5.




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Fig. 6.

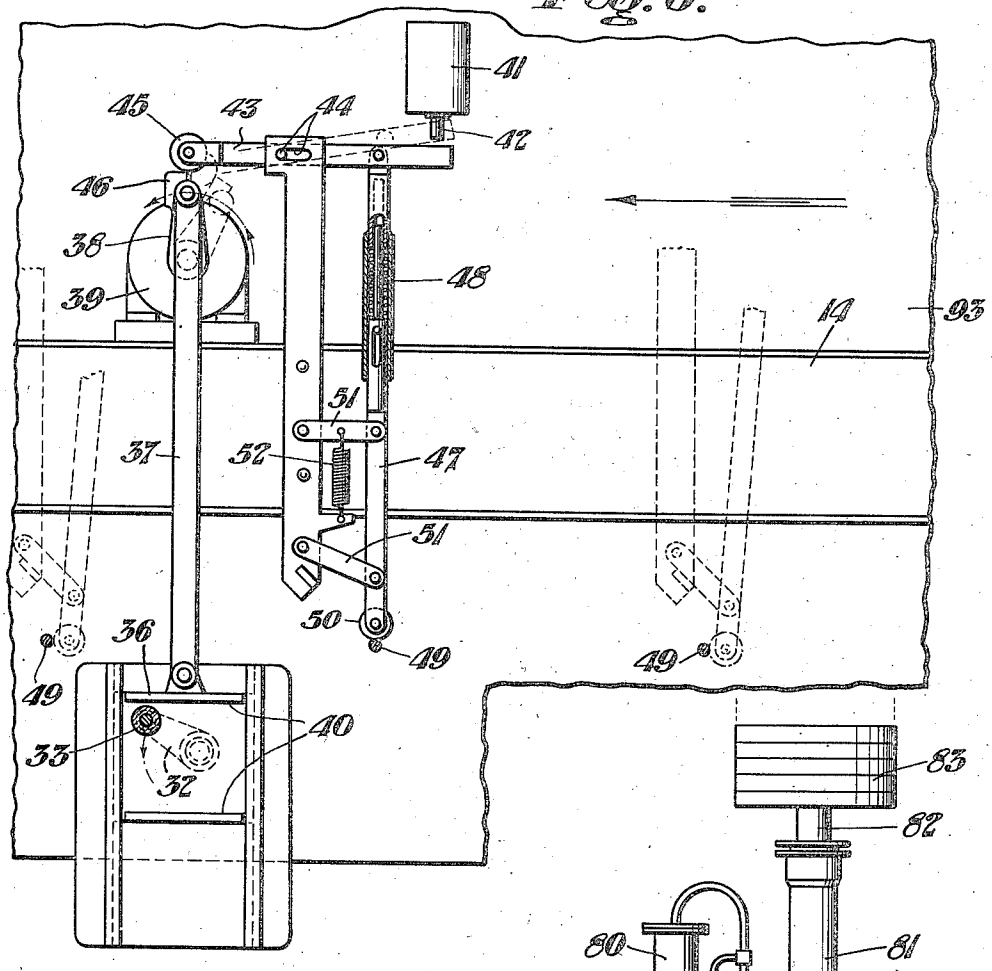
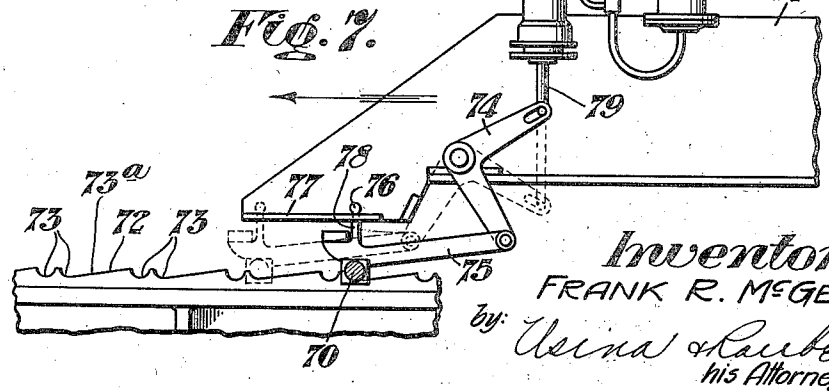



Fig. 7.




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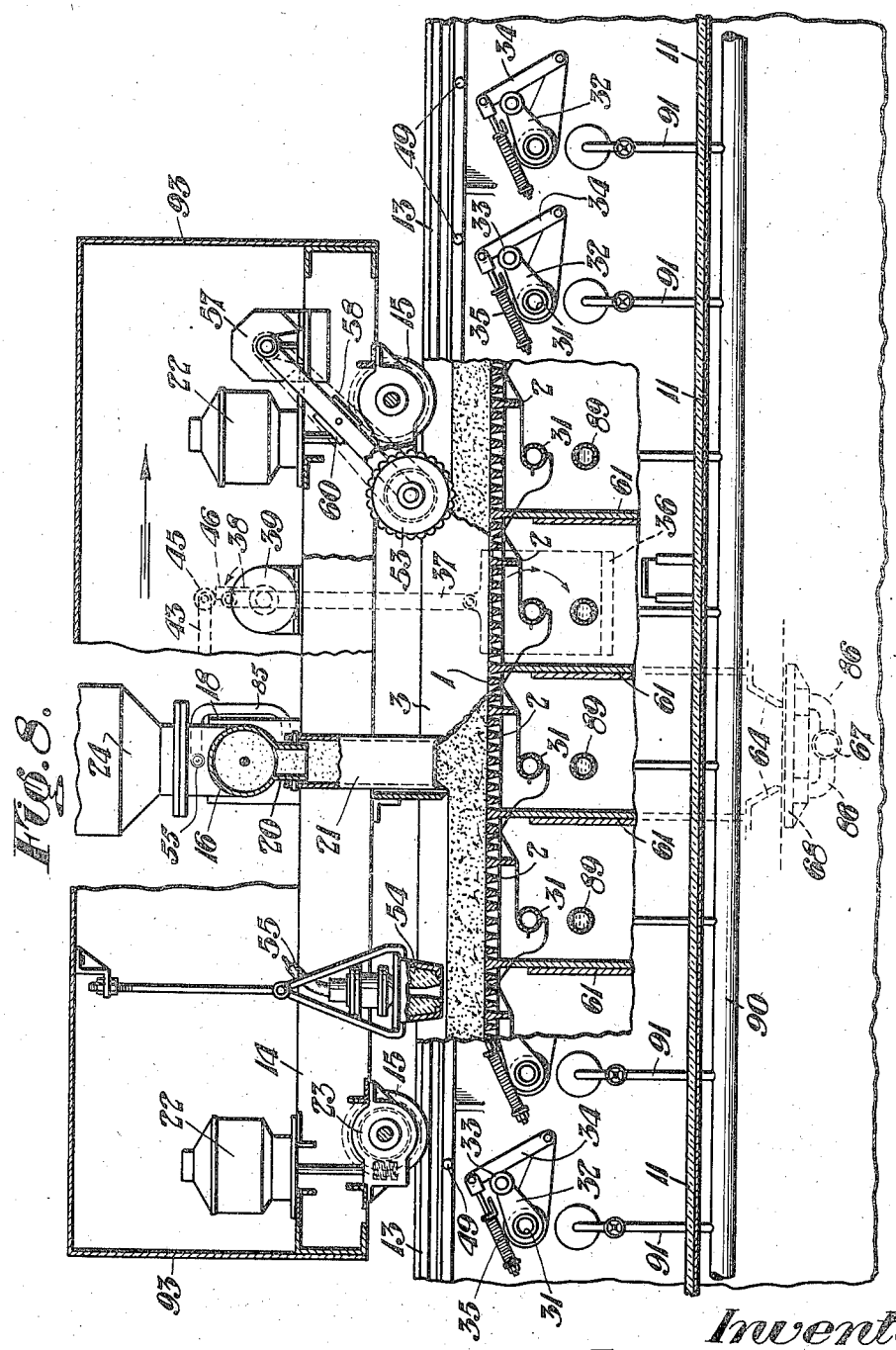


Fig. 8.

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# UNITED STATES PATENT OFFICE

2,095,567

## SINTERING

Frank R. McGee, Steubenville, Ohio

Application February 27, 1936, Serial No. 66,115

6 Claims. (Cl. 266—21)

This invention is concerned with the sintering or blast-roasting of ores or metallic compounds in general but particularly of light, dusty compounds.

One of the objects is to make the sintering of light dusty material, of which blast-furnace flue-dust is an excellent example, a more healthful and less unpleasant occupation. Another is to increase the efficiency with which material of this general character may be sintered. Still another is to sinter in such a manner that it is not necessary to force a draft fan to handle hot air carrying erosive particles. Other objects and advantages may, of course, be inferred from the following disclosure of a specific example of the invention. This example is illustrated by the accompanying drawings, in which:

Figure 1 is a sectioned elevation.

Figure 2 is a sectioned plan from the line II—II in Figure 1.

Figure 3 is a sectional enlargement from the line III—III in Figure 2.

Figures 4 and 5 are sectional enlargements from the line IV—IV and V—V in Figure 3.

Figure 6 shows the operating features of the elements of Figure 5 but looking in the opposite direction.

Figure 7 is a sectional enlargement taken from the line VII—VII in Figure 1.

Figure 8 is a sectional enlargement from the line VIII—VIII of Figure 1.

It is to be understood that these drawings take certain liberties with the strict rules of mechanical drafting in the interests of clarifying the structural and operating features of the invention.

This example of the invention is in the form of a complete sintering plant built around a circular grate 1 having a series of dumping segments 2 and bounded by cylindrical walls 3 provided with suitable refractory protection. An air-tight cylindrical-walled conical-roofed enclosure 4 having a tangential inlet 5 in its wall is built over the grate 1, while an air-tight chamber 6 is built beneath the bottom of the grate so that dumping of the latter's segments 2 results in a discharge into this chamber. This chamber 6 is built like a blast-furnace dust-catcher in that it is provided with suitable refractory protection, has a tapered material-receiving section provided with a standard motor-operated discharging gate 7 of the rotating type, an outlet 8 and a downwardly flaring baffle 9 for retarding the escape of dust by way of this outlet.

The present invention is characterized in that sintering is carried out by forcing air at a pressure greater than atmospheric downwardly through the grate 1. This is accomplished by introducing air at a pressure greater than atmospheric to the enclosure 4 by way of the tangential inlet 5, this air forcing its way downwardly through the grate 1 to effect the desired sintering, and discharging into the chamber 6 from whence it leaves by the latter's outlet 8, the baffle 9 retarding the escape of dust. Dumping of the segments 2 discharges sintered material into the chamber 6, the gate 7 being operated as desired to remove this material.

Since the chamber 6 is constructed in the manner of a dust-catcher its top tapers, and its general proportions are such that this tapered top meets the outer one of the walls 3, these walls being of sufficient depth to not only bound the grate 1 but to also provide an annular passageway leading into the top of the chamber 6. The space within the inner one of these walls is closed by a refractory protected partition 10.

The enclosure 4 is of sufficient diameter to provide a reasonable working space around the periphery of the grate 1, and is provided with a working floor 11 on which operators may stand, the enclosure also being provided with a revolving door 12 for permitting the entrance of these operators without allowing air to escape. This floor 11 should also be provided with a suitable refractory covering for protecting the feet of operators against the heat.

Although automatic machinery will presently be described, it might be well at this point to note that the operators who must always be on hand in any plant to see that things are going well are working under reasonably healthful and comfortable conditions. Instead of the usual objectionable conditions prevalent in conventional sintering plants, these operators are working in a relatively clean, cool atmosphere of slightly compressed air which is constantly exiting through the grate 1 and thus automatically keeping the chamber 4 cleared of dust and, to a considerable extent, heat. The automatic machinery just mentioned will now be described.

A circular track 13 encircles the outer one of the walls 3 that bounds the circular grate 1, and a turntable 14 rides this track on wheels 15. This turntable mounts a pug mill 16 powered by a suitable unit 18. This pug mill is provided with an inlet 19 that is arranged at the axis of rotation of the turntable 14, and with an outlet 20 arranged over the circular grate 1 to feed into the same by way of a swinging spreader 21.

When this pug mill is operated and the turntable 14 is rotated, a means traveling over the circular grate 1 for feeding material to the same is thereby provided. Rotation of the turntable 14 may be effected by motors 22 suitably connected to the wheels 15 by way of gearings 23.

A hopper 24 is built in the conical top of the enclosure 4 so as to empty into the inlet 19 of the pug mill 16, and this hopper is in turn fed through this conical roof by a suitable conveyer 25 powered by a motor 26 and receiving material from bins 27. This conveyer includes a conduit 28 which passes through the conical roof of the enclosure 24 and which is closed by a gravity operated door 29, this door being forced open by the advancing material during feeding operations. The escape of air by way of the conduit 28 is prevented by the material in the same and by the action of this gravity operated door.

As a means for bracing the turntable 14 the hopper 24 is made relatively strong and mounts a series of rollers 29 which ride against a ring 30 carried by the inlet 19 of the pug mill 16, the latter also being made relatively strong and being firmly fixed to the turntable 14. This feature also prevents the wheels 15 from jumping the track 13.

It has been previously mentioned that the circular grate 1 has a plurality of dumping segments 2. These are fixed to hollow shafts 31 that are journaled in the walls 3 so that turning of the shafts results in dumping of the segments. In each instance the outer ends of these shafts 31 are provided with operating levers 32 whose ends are provided with pairs of rollers 33. When the grates 1 are horizontal the inner ones of these rollers 33 are engaged by latches 34 operated by springs 35, it being possible to force these levers 32 out of their latched positions. To do this the end of the turntable 14 most adjacent the outlet 20 of the pug mill 16 carries a cross-head 36 powered through a connecting rod 37 by a crank 38 operated by an electric motor unit 39. This cross-head 36 is provided with bearing surfaces 40 of sufficient lengths to permit their operating the levers 32 while the turntable continues to travel, the outer ones of the rollers 33 on the ends of these levers 32 rolling on one or the other of the surfaces 40 at such times.

The motor unit 39 is controlled by a push-button 41 through a conventional electric system, the button 42 of this switch being operated by one end of a two-armed lever 43 provided with a shifting fulcrum 44 and having a roller 45 on its other end, which is normally engaged by a cam 46 carried by the crank 38. The button-operating end of this lever 43 is pivoted to a depending rod 47 that includes a spring arrangement 48 that continuously urges the lever 43 towards the button 42, movement of this lever being normally prevented by the cam 46 which prevents its other end from moving downwardly. A series of fixed pins 49 project horizontally from adjacent the base of the circular rail 13, and the lower end of the rod 47 is provided with a roller 50 which strikes these pins and rides up over them as they are successively encountered.

The lower end of this rod 47 is mounted by a lever system 51 of such character that when it is swung backwardly by momentary contact with one of the pins 49 it causes the fulcrum 44 to shift sufficiently to permit the roller 45 to slide off of the cam 46, this allowing the spring arrangement 48 to thrust the lever 43 upwardly so as to operate the button 42 and start the motor unit 39. Since the turntable is continuously moving the roller 50 eventually clears whichever one of the pins 49 it may have ridden over, and a spring 52 is fixed in the lever system 51 to cause the fulcrum 44 to then shift back towards its normal position, whereby movement of the cam 46 during rotation of the crank 38 eventually brings the cam 46 against the roller 45 and lowers the button contacting end of the lever 43, whereupon the motor unit 39 stops operating. This motor unit 39 should include the conventional quick-stopping brake.

In this manner the cross-head 36 is forced through one complete reciprocative cycle every time one of the pins 49 is passed. This dumping action occurs in such a manner that the grate segments 2 are successively dumped slightly in advance of the previously described feeding means, thus leaving empty grate segments to be filled by the latter. Another way of saying it is that the described elements provide a means operated by the approach of the feeding means for successively dumping the grate segments 2.

Before leaving this phase of the invention a further detail is to be noted, namely, that the turntable 14 also mounts a breaker wheel 53 in front of the material feeding apparatus and a burner 54 behind this apparatus, the breaker functioning to prepare sintered material for the dumping operation and the burner functioning to fire newly fed material. More specifically, the breaker 53 may consist of a wheel of suitable strength having a toothed periphery, while the burner or ignition means 54 may be of the conventional type and provided with the required air and gas by way of pipes 55 which extend downwardly through a vertical shaft 56 that passes concentrically down through the hopper 24, and which communicate with the burner in any suitable fashion. The breaker 53 may be rotated by contact with the material or, and this is illustrated, it may be powered by a motor 57 through a suitable chain drive 58. This breaker is further illustrated as being carried by the turntable 14 on the end of a lever 59 that pivots about the shaft of the motor 57 and which carries an adjustable weight 60 whereby the weight applied to the material by the breaker may be varied.

Returning to the grate 1, it is to be noted that the annular space beneath the dumping segments 2 is divided by walls 61 to form separated passageways through which the dumped material is discharged. Furthermore, a downwardly converging deflector 62 extends from the outer one of the walls 3 bounding the grate so as to deflect dumped material inwardly towards the center of the chamber 9, which it will be remembered is essentially a dust-catcher, whereby the discharge of dust or the like through this chamber's outlet 8 is more effectively retarded.

A cylindrical wall 63 extends downwardly from the inner one of the walls 3 to the horizontal plane of the lower edge of the deflector 62, and the walls 61 which divide the annular space between the walls 3 are provided with extensions 64 which also reach to the plane just mentioned. It is now obvious that each of the dumping segments 2 dumps into its own individual passageway and that the various boundaries of this passageway are in the same horizontal plane.

From what has already been said it is apparent that a draft is constantly passing from the enclosure 4 to the chamber 6 by way of the grate 1. Now it is apparent that a large amount of material will be blown down through the grate

during the time it is being fed by the previously described feeding arrangement and possibly, to some extent, prior to its ignition by the burner 54.

A tubular shaft 65 pivotally depends from the center of the turntable 14 through a liquid seal 66 and terminates in a right angularly extending arm 67 that carries a door 68 at its end, this door being positioned to slide along the lower edges of the various boundaries of the passageways beneath the dumping grates. The depending shaft 65 is provided with another but oppositely extending arm 68a which carries a weight 69 that more than counter-balances the weight of the arm 67 and door 68, whereby this door is constantly frictionally pressed into engagement with the lower edges of the previously mentioned boundaries. If the shaft 65 were rotatively fixed respecting the turntable 14 it would result in the door 68 being moved successively past the various passageways so as to thus cut off the draft through them. Although this would serve to prevent the material being fed to the various segments from being carried through by the draft before it could be ignited, it would necessitate a rather long door whereby the burner 54 would have to be positioned rather far from the rear of the feeding means. An arrangement that obviates this somewhat objectionable feature is provided.

Instead of being rotatively fixed respecting the turntable 14 the shaft 65 rotates freely respecting the same at least through somewhat of an arc, and although it is turned by the turntable this is done through a lever 70 having a roller 71 on its end that rides a circular cam 72 fixed adjacent the top of the inner one of the walls 3. This cam 72 has notches 73 between which relatively long declining portions 73a are interposed.

A part of the turntable 14 pushes the lever 70 around with it through a bell-crank 74 and a connecting rod 75, the end of this connecting rod being provided with a bumper 76 that contacts an abutment 77 formed on this part of the turntable upon slight rising of the lever 70. This end of the connecting rod is also provided with an extension 78 that rides in a slot formed in the abutment 77 to maintain accurate alinement of the various parts. As the drawings show, this connecting rod 75 is pivoted to one end of the bell-crank 74, the other end of the latter being connected through a suitable slip joint to the piston rod 79 of a fluid motor 80 powered by a second fluid motor 81 whose piston rod 82 is constantly urged downwardly by a weight 83. A suitable system of valves 84 is provided for interconnecting these two fluid motors, and both motors are carried by the turntable 14.

Now when the turntable 14 revolves the shaft 70 will stand still until sufficient force is created by displacement of the weight 83 to overcome the restraining effect exerted by the roller being in one of the notches 73. When this occurs the weight 83 will fall and drive the shaft 70 ahead of it, the roller 71 on the end of this shaft quickly riding down one or another of the declining portions 73a of the circular cam 72 until it catches in the next of the notches 73. Double notches are illustrated because of the added stopping security they afford.

The above action results in the advance of the door 68 in a series of jerks with pauses between jerks. The contour of the cam surfaces of the cam 72 and the arrangement of the other parts connecting the pieces of the invention under discussion are such that the weight 83 is being raised during the time the grate segments are being dumped in the already described manner and so that this door is quickly advanced to close the passageway beneath a just-dumped segment, whereby the feeding means may deposit material onto this segment while the draft is shut off through the same. It is in this manner that the draft is stopped during the feeding of the material to the grate segments in the case of the illustrated example, but it should be remembered that other, though possibly less efficient, elements may be substituted.

An endeavor has been made in this specification to describe the operation of the illustrated example during the course of the description of the various details. It is hoped that this has been done so well that a lengthy description of the operation of the plant in toto is unnecessary and such is accordingly not given. There are various subsidiary details that are illustrated and which have not been described. These are hereinafter mentioned in the interests of disclosing what is obviously a completely operative plant in every detail.

The hollow shaft 56 that carries the gas and air supply pipes for the burner 54 is also adapted to carry water which may be introduced by way of an inlet 85. This and the inlets 55 all connect with the shaft 56 through suitable connections that permit rotation of this shaft. At least some of the water thus introduced to the plant is passed through the tubular shaft 65 that depends from the turntable 14 and thus to the tubular arm 67 carried by this shaft.

The end of this tubular arm mounts the door 68 by means of right angularly extending arms 86 and the front one of these arms is provided with an orifice 87 through which the water sprays on the material falling through the immediately preceding passage from that being closed by the door 68 and through which, as has been described, the material is being dumped. The door itself is illustrated as being constructed from cast iron in view of the heavy service it performs.

It has previously been described that the grate segments 2 are keyed to hollow shafts 31, and it is possible to air-cool these shafts by rotatively connecting them with upturning stacks 88 which function to induce drafts through the same. The arrangement is shown particularly well by Figure 3. This figure also shows a further feature, namely, that each of the dumping segments 2 strikes pipes 89 when at the extreme of their dumping motions and thus relieve the cross-head 36 and its associated elements from the task of so doing. Since this pipe will receive considerable heat and since it is conveniently located, it is water-cooled, the water being introduced from a circular header 90 that encircles the top of the chamber 6 at a point just beneath the floor 11 on which the operators stand, by way of valved pipes 91. The inner ends of these pipes are provided with depending outlet pipes 92 that empty into the top of the chamber 6 close to the lower edge of the wall 63, whereby sintered material collecting in this chamber is constantly cooled from the moment it begins its entrance to the same. The resulting steam is, of course, blown through the outlet 8 of this chamber by the constantly exiting air.

It will be appreciated by anyone familiar with sintering that the turntable 14 revolves very slowly, since time must be permitted for complete sintering. In the interests of safety, the ends of the turntable 14 are provided with housings 93

that enclose the various motorized elements mounted there. Still in the interests of safety, there should be clearance between these housings and the cylindrical wall of the enclosure 4 so that the operators will not have to keep moving with the turntable. Thus, in the case of the disclosed example, air is forced downwardly through the grate at a pressure greater than atmospheric but many of the advantages of the various operating mechanisms are retained if this feature is substituted by a draft induced by evacuation. As a matter of fact, it may be desirable to operate the plant so that the pressure in the chamber beneath the grate is less than atmospheric even when the enclosure above is supplied with air under pressure.

Although the invention has been disclosed in the form of a specific example of a sintering plant, it is to be understood that it is not intended to thereby limit its various features except in the manner defined by the appended claims.

I claim:

1. Sintering apparatus including a grate, means for feeding material to said grate, an enclosure for said means and the top of said grate and means for introducing air to said enclosure at a pressure greater than atmospheric.

2. Sintering apparatus including a circular grate, means above said grate for effecting localized feeding of material thereto, means for effecting localized ignition of said material and means for causing relative rotation between said grate and the first and second named means, a substantially air-tight enclosure being arranged over said grate and the first and second named means to which air may be introduced at a pressure greater than atmospheric.

3. Sintering apparatus including a circular grate having a series of dumping segments, means traveling over said grate for feeding material thereto, ignition means traveling over said grate behind the first named means, means for dumping said segments in advance of the first named means, a substantially air-tight enclosure for the top of said grate and the first and second named means to which air at a pressure greater than atmospheric may be introduced, a substantially air-tight chamber for the bottom of said grate adapted to receive material dumped from said segments and having an outlet through which air passing downwardly through said grate may exit, and means for stopping the draft from said enclosure to said chamber through said segments while they are being fed material by the first named means.

4. Sintering apparatus including a circular grate having a series of dumping segments, means traveling over said grate for feeding material thereto, ignition means traveling over said grate behind the first named means, means for dumping said segments in advance of the first named means, a substantially air-tight enclosure for the top of said grate and the first and second named means to which air at a pressure greater than atmospheric may be introduced, a substantially air-tight chamber for the bottom of said grate adapted to receive material dumped from said segments and having an outlet through which air passing downwardly through said grate may exit, and means for stopping the draft from said enclosure to said chamber through said segments while they are being fed material by the first named means, the third and fourth named means being automatically operatively responsive to movement of the first and second named means.

5. Sintering apparatus including a circular grate having a series of dumping segments, means traveling over said grate for feeding material thereto, ignition means traveling over said grate behind the first named means, means operated by the approach of the first named means for successively dumping said segments, an air-tight enclosure for the top of said grate and the first and second named means to which air at a pressure greater than atmospheric may be introduced, an air-tight chamber for the bottom of said grate adapted to receive material dumped from said segments and having an outlet through which air passing downwardly through said grate may exit, means operated by the approach of the first named means for stopping the draft from said enclosure to said chamber through said segments that are being fed material by the first named means, means for feeding material through said enclosure to the first named means in an air-tight manner, means for removing material from said chamber in an air-tight manner and baffle means for retarding the escape of dust from said chamber by way of said outlet.

6. Sintering apparatus including a circular grate having dumping segments, and a dust-catcher of the blast-furnace type into the top of which the bottom of said grate concentrically opens, said dust-catcher spreading downwardly from said grate to provide a chamber of a diameter substantially greater than said grate, and which is concentric therewith, converging downwardly from said chamber to provide a collector for dust and the sintered material and having an outlet for gaseous products from said grate.

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