June 16, 1936. E. O'TOOLE 2,044,628

TREATING COAL, ORE, GRAIN, AND SIMILAR MATERIALS

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Fig. 1.

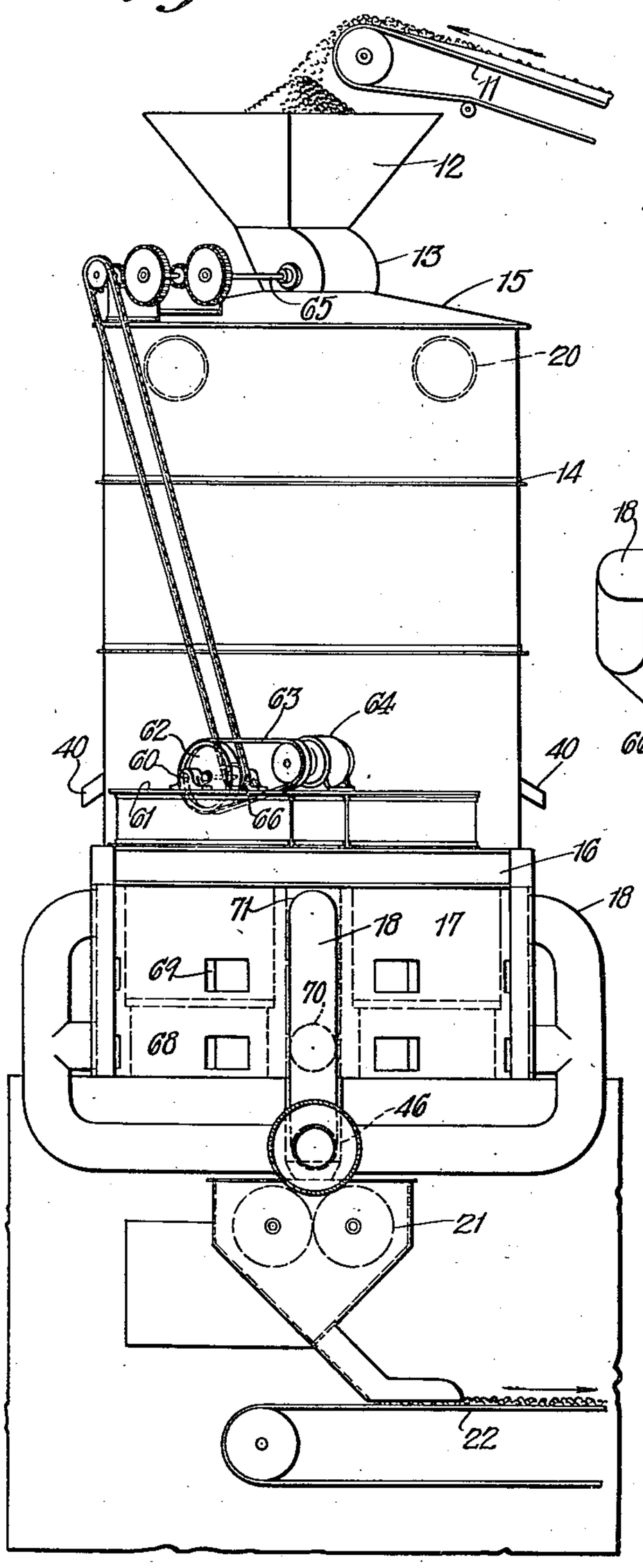
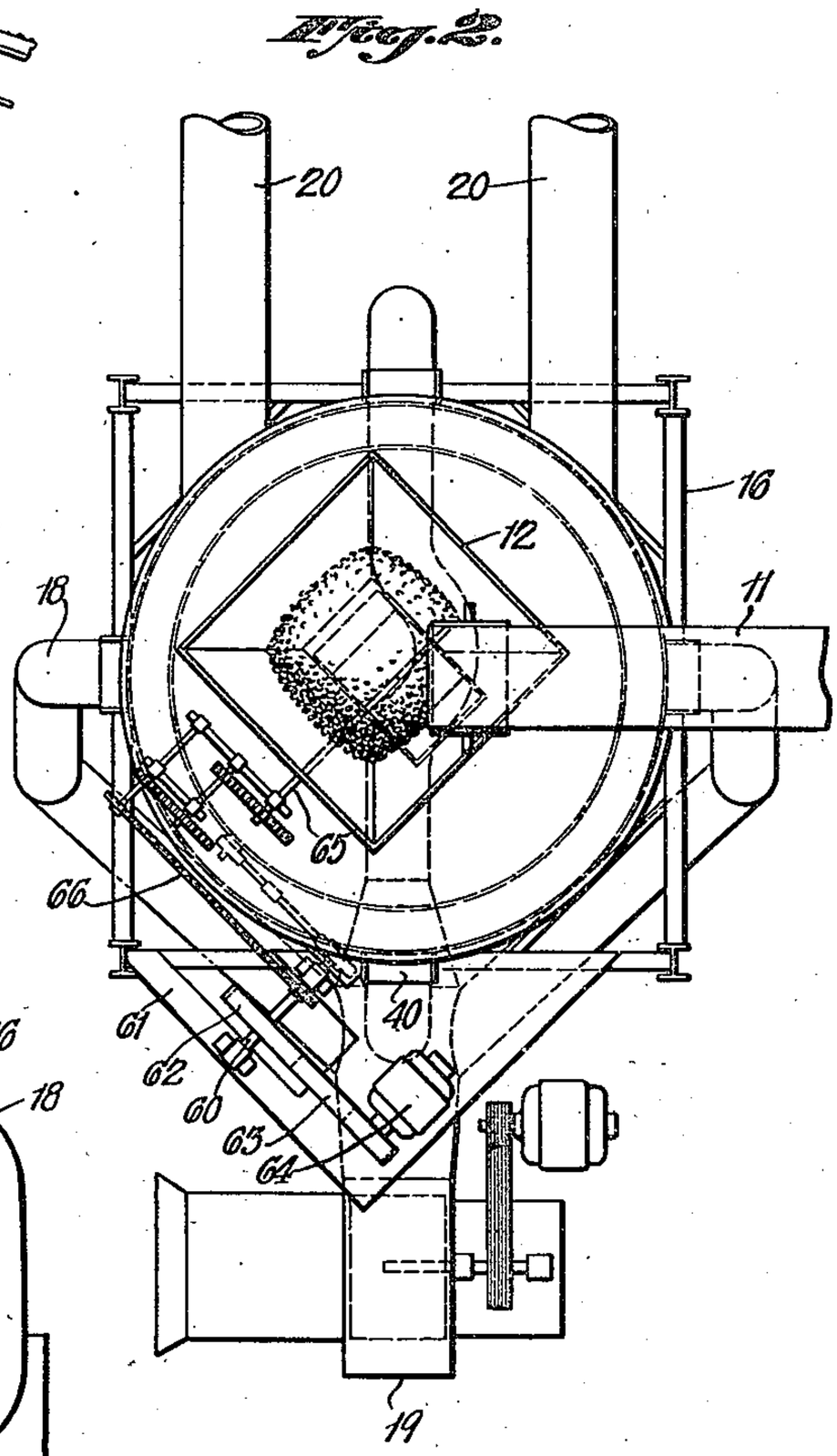


Fig. 2.



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TREATING COAL, ORE, GRAIN, AND SIMILAR MATERIALS

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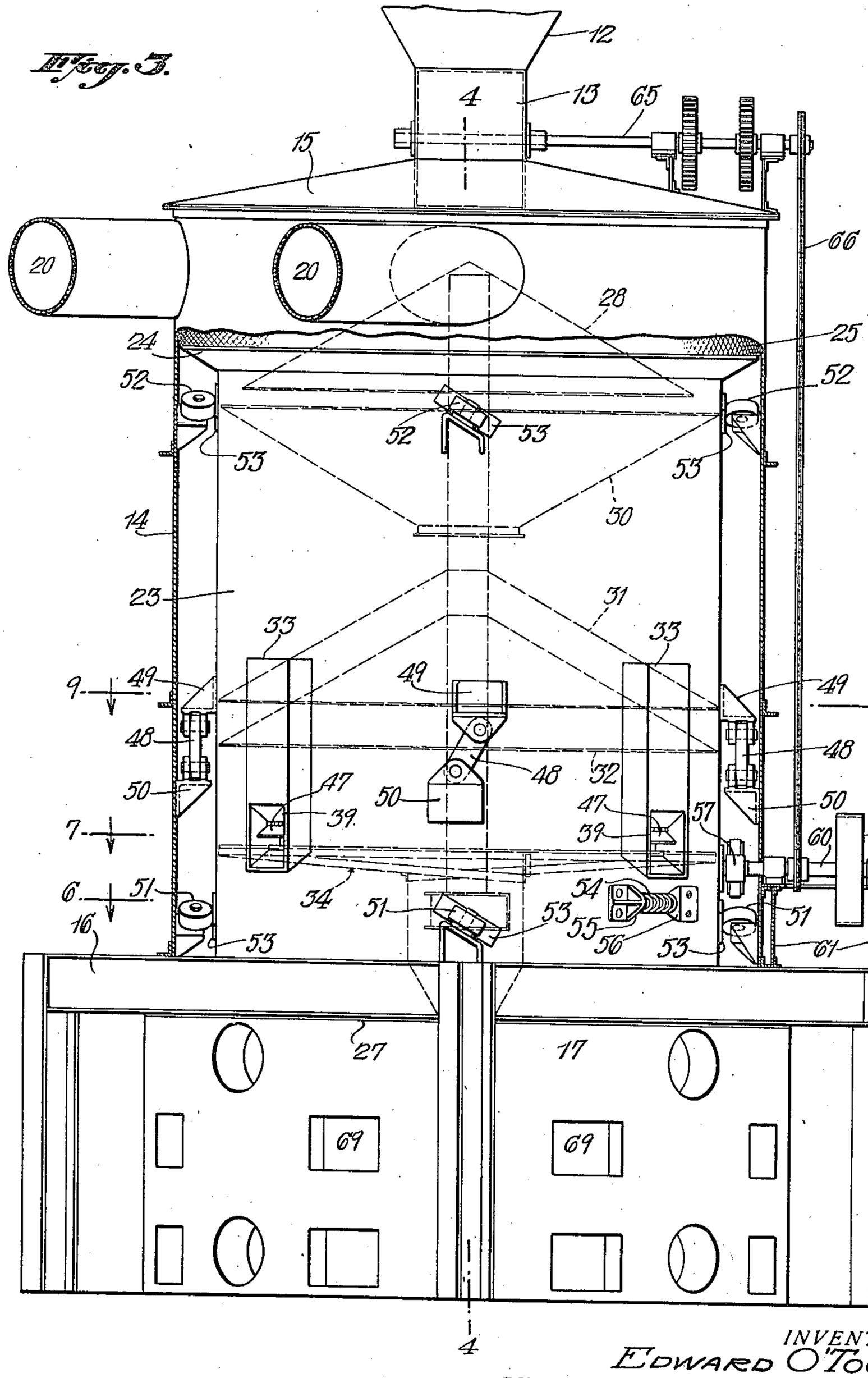
Fig. 3.



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TREATING COAL, ORE, GRAIN, AND SIMILAR MATERIALS

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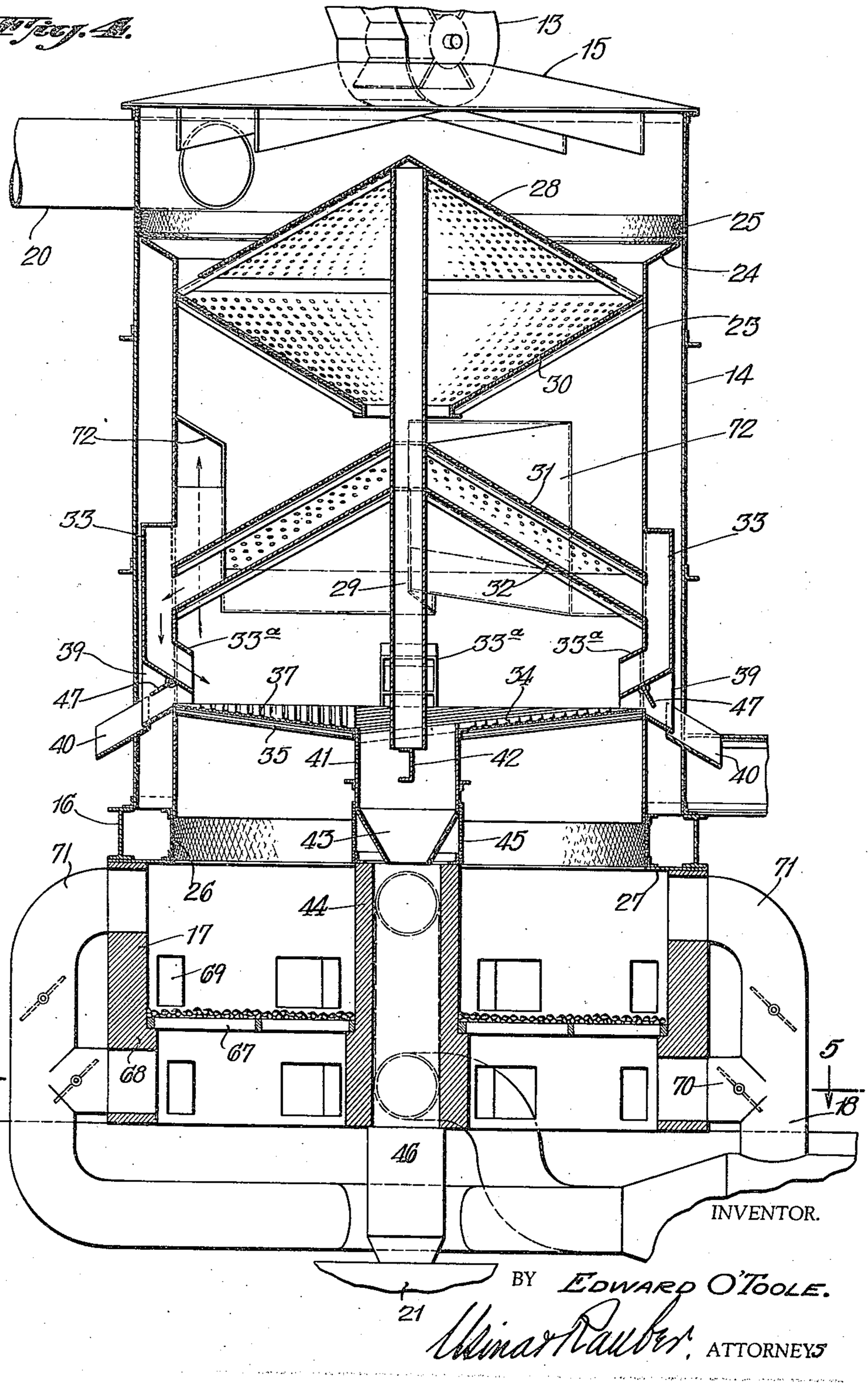
Fig. 4.



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TREATING COAL, ORE, GRAIN, AND SIMILAR MATERIALS

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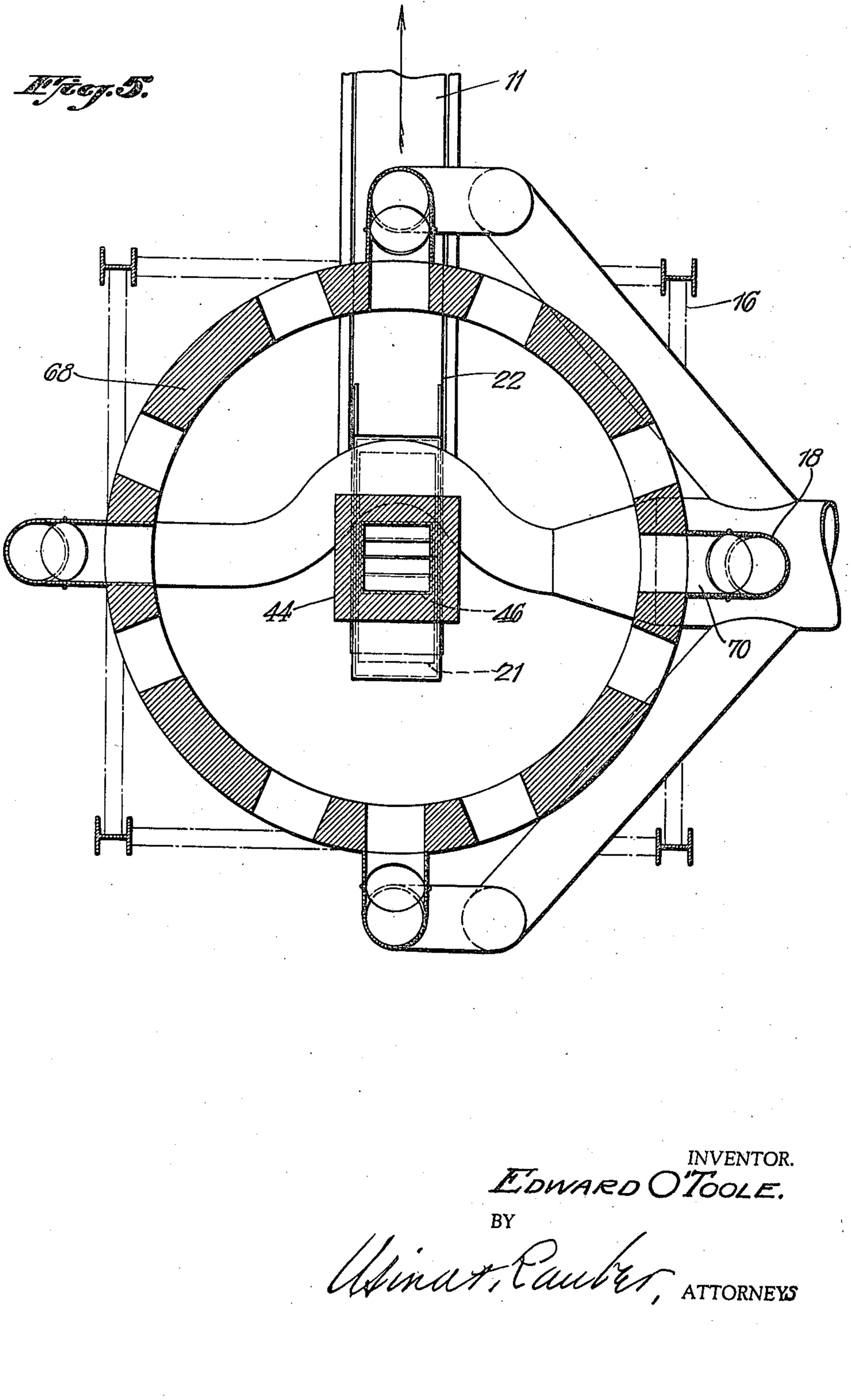
Fig. 5.



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TREATING COAL, ORE, GRAIN, AND SIMILAR MATERIALS

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Fig. 6.

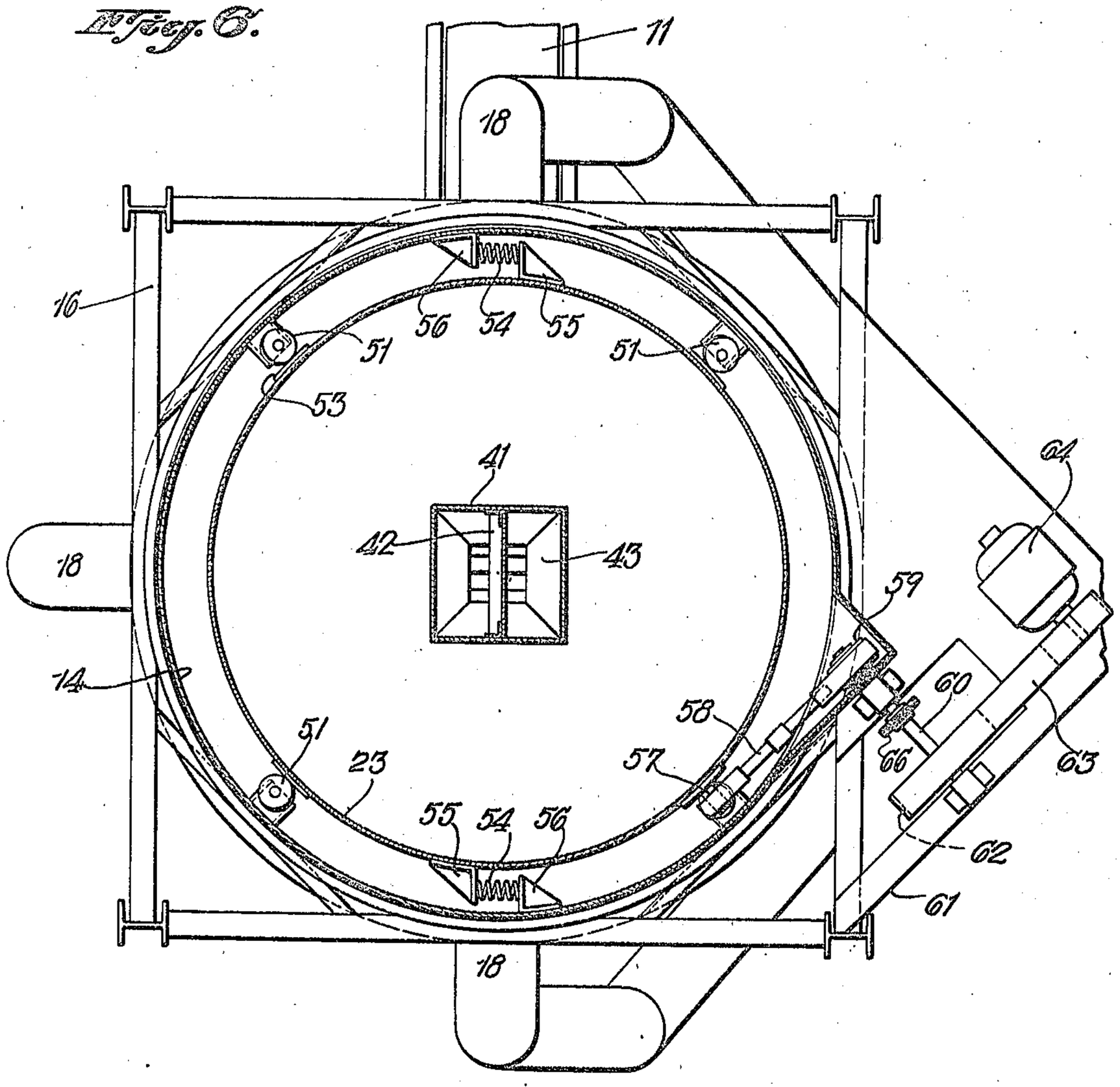

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Fig. 7.

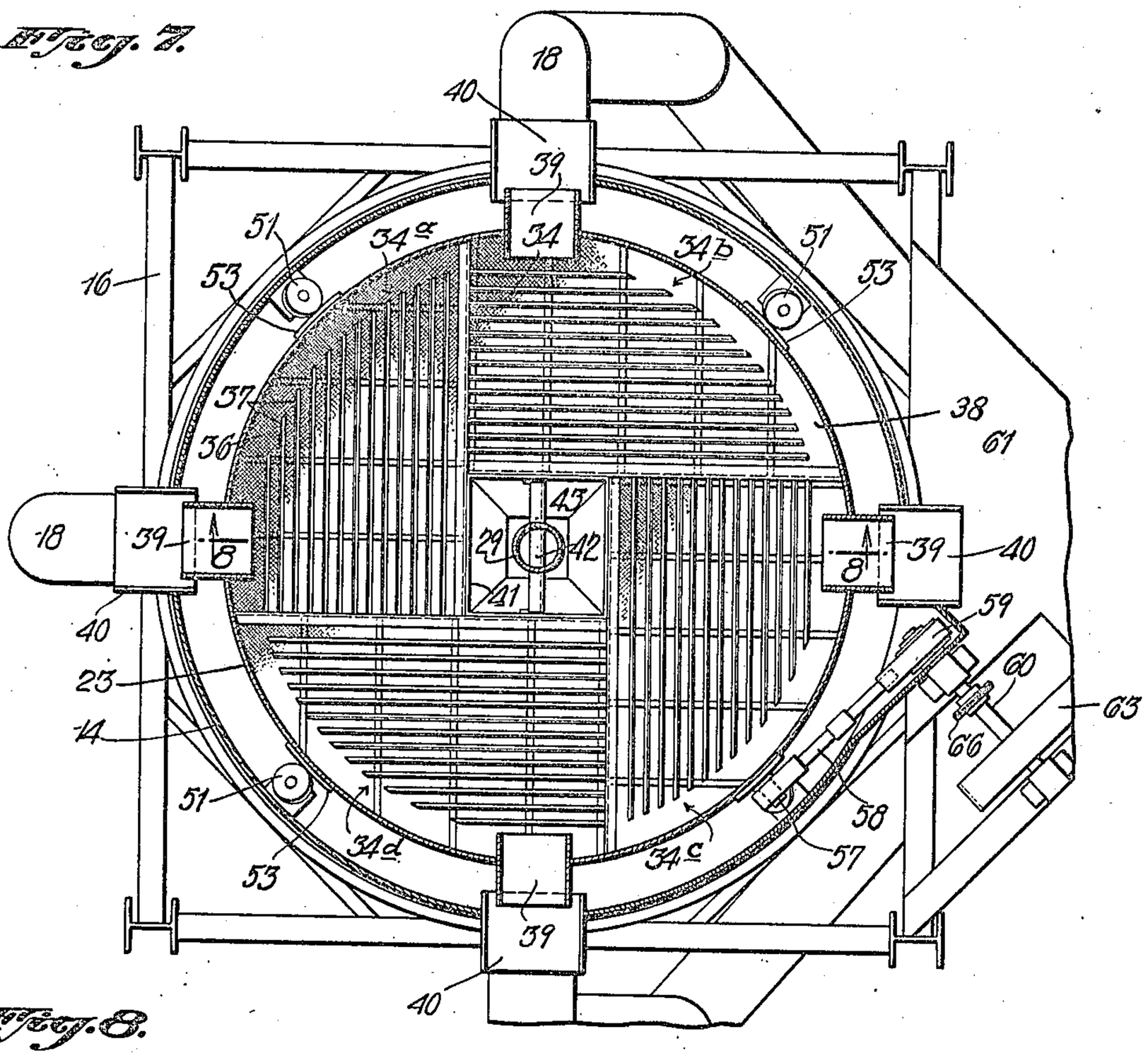
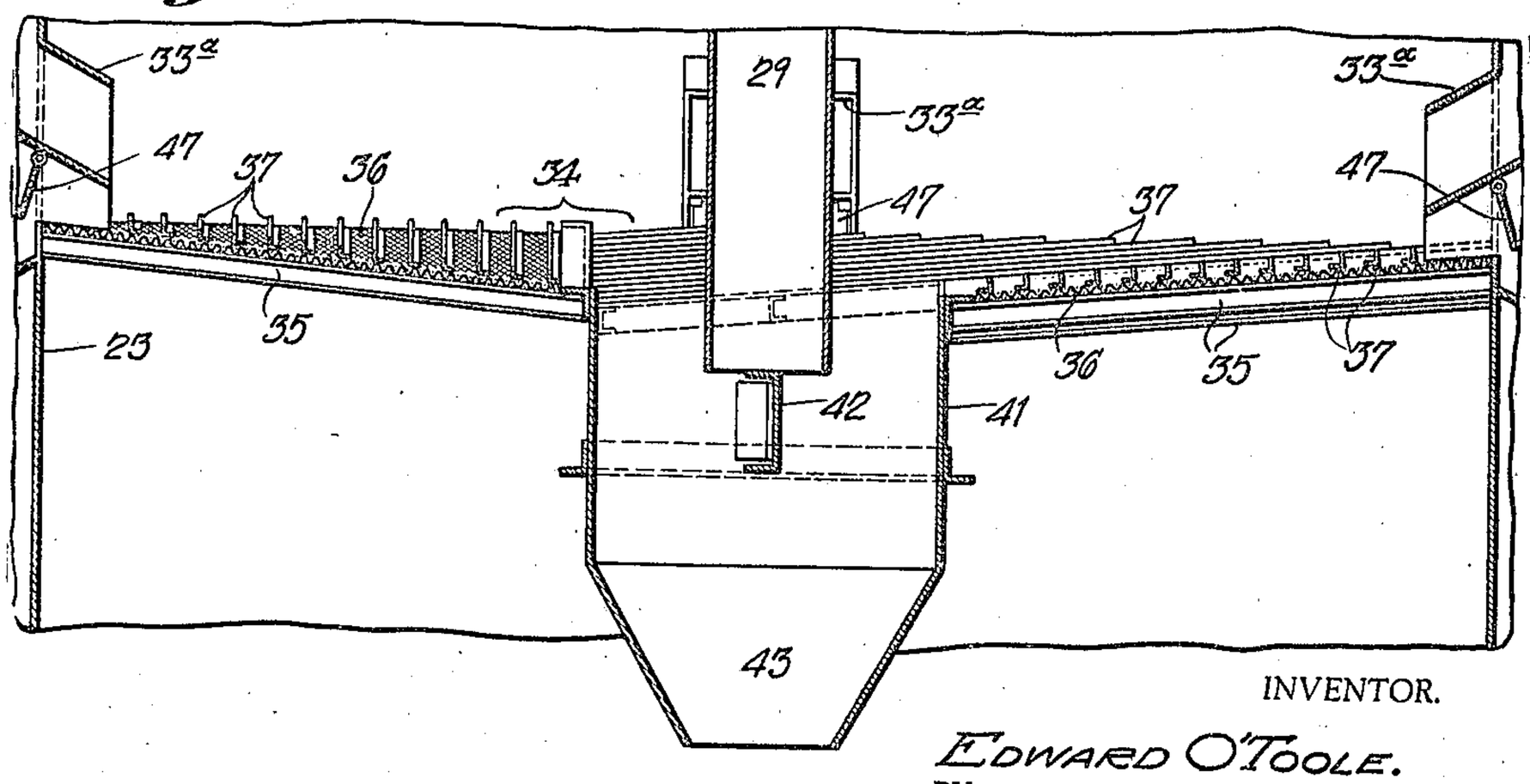


Fig. 8.



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TREATING COAL, ORE, GRAIN, AND SIMILAR MATERIALS

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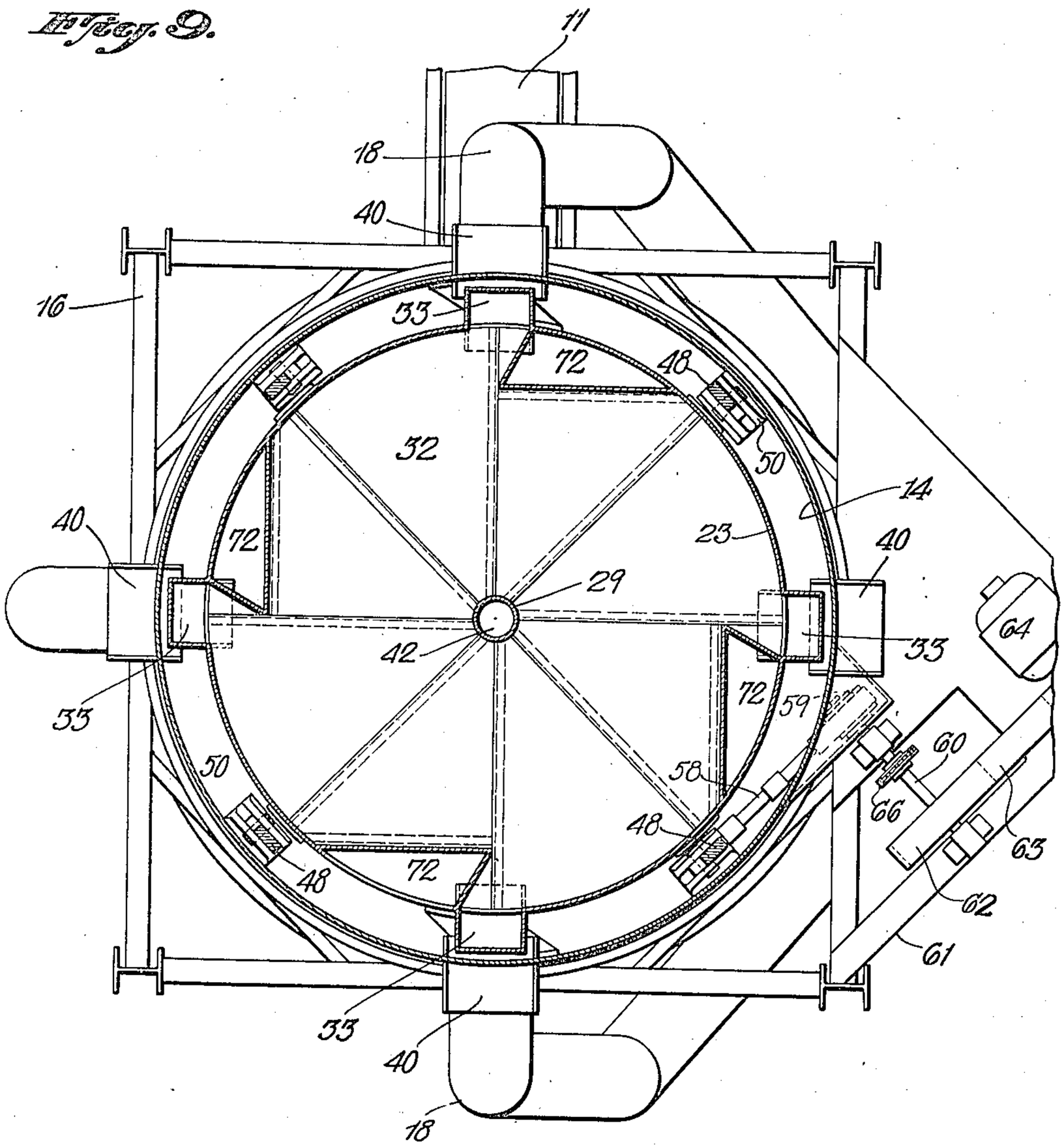
Fig. 9.



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Patented June 16, 1936 2,044,628

UNITED STATES PATENT OFFICE

2,044,628

TREATING COAL, ORE, GRAIN, AND SIMILAR MATERIALS

Edward O'Toole, Gary, W. Va.

Application April 22, 1933, Serial No. 667,313

2 Claims. (Cl. 34—38)

In my Patent No. 1,888,636 of November 22, 1932, I have described an apparatus for screening and cleaning coal and similar materials having a large capacity and of low construction and operating costs.

The present invention utilizes some of the features of the patented machine and provides also for drying, heating and de-dusting the material so as, in the case of coal or ore, to adapt it to subsequent briquetting or sintering and, in the case of grain, to adapt it to transportation and subsequent use.

The invention provides a compact unitary apparatus in which the steps can be carried out at considerable saving in space and expense compared with other apparatus. In the case of grains, such as wheat, oats, corn, etc., the original material carries foreign matter of all sorts which we can refer to generally as gangue or refuse, the particles of which are of different specific gravity from the clean grain. Such particles may be dirt, cockle, wild rice (in wheat) and other materials.

The accompanying drawings illustrate one embodiment of the invention.

Figs. 1 and 2 are respectively a side elevation and a plan of the complete apparatus;

Fig. 3 is a side elevation of the principal parts, taken at right angles to Fig. 1;

Fig. 4 is a central vertical section on the line 4—4 of Fig. 3;

Fig. 5 is a horizontal section on the line 5—5 of Fig. 4;

Fig. 6 is a horizontal section on the line 6—6 of Fig. 3;

Fig. 7 is a horizontal section on the line 7—7 of Fig. 3;

Fig. 8 is a vertical section on the line 8—8 of Fig. 7;

Fig. 9 is a horizontal section on the line 9—9 of Fig. 3.

Referring to the drawings, the coal or other material to be treated is brought from the source of supply in its raw condition by a conveyor 11, deposited in a small hopper 12 and fed therefrom by a rotary feeder 13 to the upper end of a vertical cylinder 14 which, except for the feed opening, is closed by a top 15.

Within the cylinder 14 the coal is cleaned and exposed to hot air to dry it. The cylinder is supported on a frame 16 within which is located a heating furnace 17 which is supplied with air under pressure through piping 18 and a supply fan 19 (Fig. 2). The air passing up through the cylindrical casing 14 is discharged through pipes 20 near its upper end, either to the atmosphere or to a dust collector. The refuse from the cleaned material is discharged through chutes at the sides of the cylinder and the cleaned product is discharged at the center, freed from its excessive moisture and heated to a softening temperature so as to be in condition for pressing into briquettes in the briquetting machine 21, (Fig. 1), whence it is carried by a conveyor 22 directly to bins or to cars for shipment.

In the case of coal and iron ore, the cleaned material may be so heated in the apparatus as to be adapted for briquetting without the use of an additional binder.

As an alternate arrangement, the air instead of being forced into the pipes 18 and thus into and through the heater, may be drawn in through suitably valved openings by the provision of suction fans located in the pipes 20 leading out of the upper end of the casing.

Within the stationary cylinder 14 is a concentric cylinder 23 which is adapted to be given a spiral movement about its axis by combined oscillation and vertical reciprocation. The cylinder 23 has an outward flange 24 at its upper edge extending approximately to the outer casing 14 and connected to the latter by a flexible packing, such as the strip of asbestos 25. Similarly the lower edge of the cylinder 23 is connected by a flexible packing of asbestos 26 to the top plate 27 of the furnace 17. The inner cylinder 23 extends below the cleaning deck 34. The packing ring cuts off any escape of the hot air or gases into the space between the inner and outer cylinders and thus retains it all within the inner cylinder.

Located within the upper end of the cylinder 23 is a receiving cone 28 consisting of a perforated plate pointed upward in position to receive the crude material from the rotary feeder 13 which serves practically as an air seal. The cone 28 is supported on a central hollow steel post 29. It is perforated with openings which permit some of the material to pass through. The remainder passes down through the space between the edge of the cone and the cylinder 23. For coal, the openings in the cone may be, for example, round openings of one to one and one-half inches in diameter. This spreads the material and exposes it evenly to the hot air.

Below the conical receiving plate 28 is an inverted conical plate 30 similarly perforated, fixed at its outer edge to the cylinder 23 and opening at the center to leave a space around the post 29.

Below the perforated inverted cone 30 is an-

other perforated cone 31, with its apex upward, on which the material falls through the perforations and the central opening of the cone 30. And shortly below the cone 31 is the parallel cone 32 of solid plate which directs the material to outlets through the wall of the cylinder 23.

At four points around the cylinder 23 there are located chutes 33 (Fig. 9) having their upper ends open to the space within the cylinder at the levels of the edges of the cones 31 and 32 so that the coal from both these plates will be discharged into the chutes 33.

In the lower part of the cylinder is a cleaning deck indicated at 34 (Fig. 4), and consisting of four sections 34^a, 34^b, 34^c and 34^d, Fig. 7. This is a standard type of pneumatic cleaner. The material treated above and passed down into the chutes 33 is discharged from the latter on to the cleaning deck through the inward extensions 33^a of such chutes.

The deck consists of ribs 35 (Fig. 8) which support sheets of wire cloth 36 upon which are riffles 37, those in one section being at right angles to those in the next. The cleaning deck is carried by the cylinder 23 and is given a sort of jigging motion, at the same time that air is blown upward through the wire cloth.

The heavier refuse accumulates in the unobstructed annular passage 38 around the ends of the riffles and is discharged by centrifugal action through openings in the cylindrical casing and into chutes 39 (forming downward extensions of the chutes 33) and thence out into suitable refuse receptacles by chutes 40 extending through the outer casing.

At the center of the cleaning deck there is a square opening which leads to a vertical casing 41 which is bridged near its upper end by a beam 42 which supports the central post 29 while leaving space for the downward passage of the cleaned coal. The casing 41 terminates in a downwardly tapering extension 43 which leads to a vertical passage through a hollow central member 44 of the furnace; the casing 41 being connected by a flexible strip 45 of asbestos or the like with the top of the portion 44 of the furnace. Thus the cleaner separates the refuse from the good treated coal and discharges the latter either directly to a conveyor or through the hollow member 44 and extension 46 to the briquet former 21.

The entrances to the refuse chutes 39 are fitted with gates 47, one or more of which may be closed to cause the refuse to be discharged at one, two or three points only if desired.

A middlings product consisting partly of refuse and partly of good material passes from one section of the cleaning deck to the adjacent section; for example, from 34^a to 34^b, and continues to be treated until the separation is effected.

The inner cylinder 23 is supported at four points in its circumference by sloping toggle links 48 (Fig. 3) attached by pivot pins at upper and lower ends respectively to a bracket 49 on the inner cylinder and a bracket 50 on the outer, stationary, cylinder.

The movement of the inner cylinder within the outer one is guided by rollers 51 and 52 at the bottom and top, which are arranged obliquely and mounted on pivots attached to the fixed cylinder 14. Wearing bars 53 on the inner cylinder bear against the rollers.

The inner cylinder is oscillated by means of an eccentric drive, Figs. 3 and 6. The driving mechanism rotates the cylinder and the supporting toggles convert the rotation into a helical movement. Compression coil springs 54 are located near the base of the inner cylinder. They assist the forward and upward stroke and absorb the shock of the return. The springs are carried between blocks 55 attached to the inner cylinder and blocks 56 attached to the outer stationary cylinder.

The driving mechanism consists of a flanged trunnion pin 57 mounted on the inner cylinder and connected by an adjustable driving rod 58 to an eccentric 59 which is driven by a shaft 60 mounted on supports 61 carried on the framework 16. The shaft 60 in turn carries a flywheel pulley 62 which is driven by means of a belt 63 from a motor 64.

The rotary feeder 13 is driven from a shaft 65 mounted on the top of the apparatus and driven in turn by a sprocket chain 66 extending down to the shaft 60.

Various other arrangements may be used for driving the parts described. Both cylinders 14 and 23 are supplied with manholes and other openings, as usual in such apparatus for access to parts requiring attention. These openings are closed while the machine is in operation and the flexible connections between the inner and the outer cylinders are also substantially air-tight.

The air which is blown or drawn through the apparatus is taken from the surrounding atmosphere under the general atmospheric conditions and is delivered through air ducts 18 to the furnace.

The furnace consists of an annular grate 67 extending over the space between the central wall 44 and the surrounding wall 68. There are the usual doors 69, or other arrangements, for feeding the coal to the grate. The air may pass by the branches 70 to the lower part of the furnace and through the burning coal, or by branches 71 to the space above the burning coal.

Dampers are provided in the two branches for regulating the proportions of air so as to provide a temperature sufficient to ensure the drying and softening of the material to the extent desired. This temperature would be approximately 600 degrees F. for bituminous coal, and higher for some materials.

On account of the increased temperature of the air its humidity is lowered and its affinity for moisture increased. As it passes up through the apparatus it supplies a dehydrating atmosphere throughout the cylinder 23. From the furnace it passes first through the wire cloth of the cleaning deck lifting the lighter particles over the ribs 37 and gradually moving them toward the center to the exit point.

From the space between the cleaning deck and the solid plate 32, air ducts 72 (Figs. 4 and 9) extend upward and open into the space above the cone 31 and below the inverted cone 30. The damp mass of material is broken up by the shaking and passage of it over the perforated plates so that practically each particle of it is exposed to the dehydrating air which fills the cylinder 23 and escapes near the top by the pipes 20. Thus the product is dried in the upper part of the cylinder; is cleaned and the refuse ejected at the cleaning deck, and the dried cleaned product is discharged through the center of the apparatus.

Particular attention is directed to the fact that as shown in the drawings (Figure 4) the coal falls on the center of the perforated cone 28 and that the upward air pressure is through this perforated cone thus disturbing the coal as it flows

and spreads over the said plate and this air disturbs the particles of the material so that the smaller heavy particles flow through the said plate onto the cone 30 below it while the larger heavy particles flow down over the said perforated plate and through the space between its edge and the inner periphery of the cylinder 22 and these heavier particles flow down the perforated cone 30 and these are disturbed again by the air flowing through the perforated plate, and these particles then flow through the opening in the center of the perforated cone or plate 30 and fall on the upper pointed end of the perforated cone 31 when these particles spread out over the said cone 31. It will thus be seen that the perforated cones 28 and 30 act as means to first separate the particles according to size and break them up and secondly to break up the larger particles flowing around the periphery of the cone 28 and that the upward pressure of air through the three separating and breaking cones 28, 30 and 31 serve to cause the particles to spread out and the said particles to be individually heated and the smaller lighter particles to be carried upward to and to be discharged through the pipe 20, such for instance as the dust caused by this breaking up etc.

Attention is also directed to the fact that this cleaning and separating machine has its base portion formed of an annular furnace 67 and that the center of this annular furnace is provided with a central tube that extends through it to the center coal discharge 43 for the separator 35. Attention is also directed to the fact that the furnace is in open communication with the lower end of the cylinder 23 so that all of its heat flows freely to the separator immediately above. According to this arrangement the coal is first broken and separated and its individual parts heated and the particles thus heated and broken are fed to the separator where they are subjected to the greatest amount of heat serving to put the coal in a soft condition for being formed into briquettes or the separated coal to be discharged through the central tube 44 of the said furnace.

When it is desired to remove dust from the material being treated, the air may be made to serve as a de-dusting medium to a greater or less extent. For this purpose the air should be passed through the apparatus at such a velocity as to carry out of the discharge pipes 20 a considerable quantity of dust. In this case it will generally be advisable to arrange some form of dust collector in series with the discharge conduits so as to pass the dust laden air through them. The quantity and size of the particles of dust removed can be governed by the velocity of the air.

My present apparatus has several advantages over that described in my previous Patent 1,888,636. It is more compact. It uses only three cones and one cleaning deck. It is better adapted to the drying operation contemplated because each of the three cones 28, 30 and 31 is perforated so as to spread the material and expose the particles while thus separated to the upward current of air and the current of air passes through the holes in the screens; whereas in the prior patent the first and third cones fed the material in a fairly solid stream around their outer edges. In fact the earlier apparatus is not designed for drying the coal.

In the new machine a damp matted mass of material is broken up on each screen and each particle is exposed to contact with the dehydrating column of air, and the column of air is continuously of the full cross section of the inner cylinder. This construction is designed also to secure the desired heating effect, which is particularly important with material that is to be briquetted. The flexible packing rings 25 and 26 retain the hot air column within the inner cylinder. No such packings are described in the prior patent nor would they be of any special importance there.

The present invention makes a double use of the air in providing the desired flotation on the cleaning deck and then in drying the material which is separated into small particles by the conical screens; and makes a third use of the same column of air when de-dusting is practiced.

The differences in construction, therefore, serve functions and purposes in the present invention which were not intended nor accomplished by the earlier machine.

The screens separate the materials chiefly according to size. The cleaning table or deck 34 separates them according to specific gravity. The particles of coal are lighter than the particles of slate and other refuse accompanying it and are lifted by the air and gradually fed to the central chute 41 and out through the bottom of the apparatus while the refuse moves outward and is ejected through the lateral chutes 40. Grain is generally heavier than the particles of refuse to be rejected. The apparatus, therefore, will discharge the grain through the lateral chutes and the refuse at the bottom of the apparatus. Where the refuse is of two kinds, one heavier and the other lighter than the grain, the clean grain may be obtained in two operations. In the first operation the grain and the lighter refuse (or a part thereof) will be discharged at the bottom of the apparatus and this will be passed through the apparatus in a second operation which will discharge the lighter refuse at the bottom and the clean grain at the sides.

The apparatus can also be used to classify materials which are originally a mixture of heavier and lighter grains or particles. For example, wheat is classified as No. 1, containing sixty pounds or more to the bushel, and No. 2 containing less than sixty pounds to the bushel. The original grain passed through the machine will be separated into No. 1 discharged through the side chutes and No. 2 discharged through the bottom of the apparatus.

In treating grain there will also be an advantage in the removal of moisture which is generally found on the surface and also within the grains. The temperature will be regulated so as to remove as much of the moisture as possible without being high enough to cook or injure the grain. The removal of moisture is desirable in that it saves cost of transportation.

The size and proportions of the apparatus may be modified to best fit it for the material to be treated and the cleaning, classifying, drying and dusting functions desired.

As previously stated herein the air passing through the cylinder 23 is heated to a temperature approximately 600° F. when treating coal, and the air therein is heated to a high temperature and the air is drawn through the exit pipes 20 by means of a suitable fan. The coal being treated flows through the hopper 12 into the upper end of the cylinder 14. The individual

particles therefore when falling through this space onto the perforated cone surface 28 are subjected to the high temperature in the said apparatus and the individual particles thereby heated before and after reaching the perforated cone 28 and the same is true before and after reaching the perforated cone 31 and the particles while on the separators 34. This heated air being drawn through the apparatus rapidly heats the individual particles and withdraws the moisture from the apparatus through the pipes 20 as well as the dust. This rapidly moving hot air at the rate say from 500 to 1200 feet per minute subjects the individual particles of coal in this current of hot air for about one minute, which means that there is a stream of hot air from 500 to 1200 feet long passing by and surrounding the individual particles of the said coal. The temperature and also the speed of the air through the apparatus is controlled by suitable gates (as previously stated) located in the air inlets and outlets (as heretofore stated), thus varying the speed as well as the temperature.

Various modifications may be made by those skilled in the art without departure from the invention as defined in the following claims.

What I claim is:

1. An apparatus for treating material in the form of a damp mass of grains or particles including in combination a closed casing through the top of which the material is admitted, a succession of perforated inclined drying plates within said casing over and through which the material passes downward and is spread out and exposed in separated small particles, a cleaner to which the material passes from said plates and means for passing heated air in a continuous stream through said cleaner and said succession of plates to dry and heat the material, said plates and cleaner being carried fixedly by an inner casing lying within the closed casing, the inner casing being open only at the upper and lower ends and being connected by substantially tight flexible connections to the outer casing and means for giving a jigging motion to the inner casing.

2. An apparatus for treating material in the form of a damp mass of grains or particles including in combination a closed casing through the top of which the material is admitted, perforated drying plates within said casing through which the material passes downward and is exposed in separated small particles, a cleaner to which the material passes from said plates, means for giving a jigging motion to the inner casing, a device for providing a continuous supply of heated air, the inner casing being open at its upper and lower end said lower end extending below said cleaner and being connected by substantially air tight joint to said device for supplying heated air so as to prevent such air from passing between the two casings and to pass it in a continuous stream through the cleaner and through said succession of plates to dry and heat the materal.

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