No. 703,356. Patented June 24, 1902.

R. E. & E. WAUGH.

DRY ORE CONCENTRATOR.

(Application filed May 27, 1901.)

(No Model.) 6 Sheets—Sheet 1.

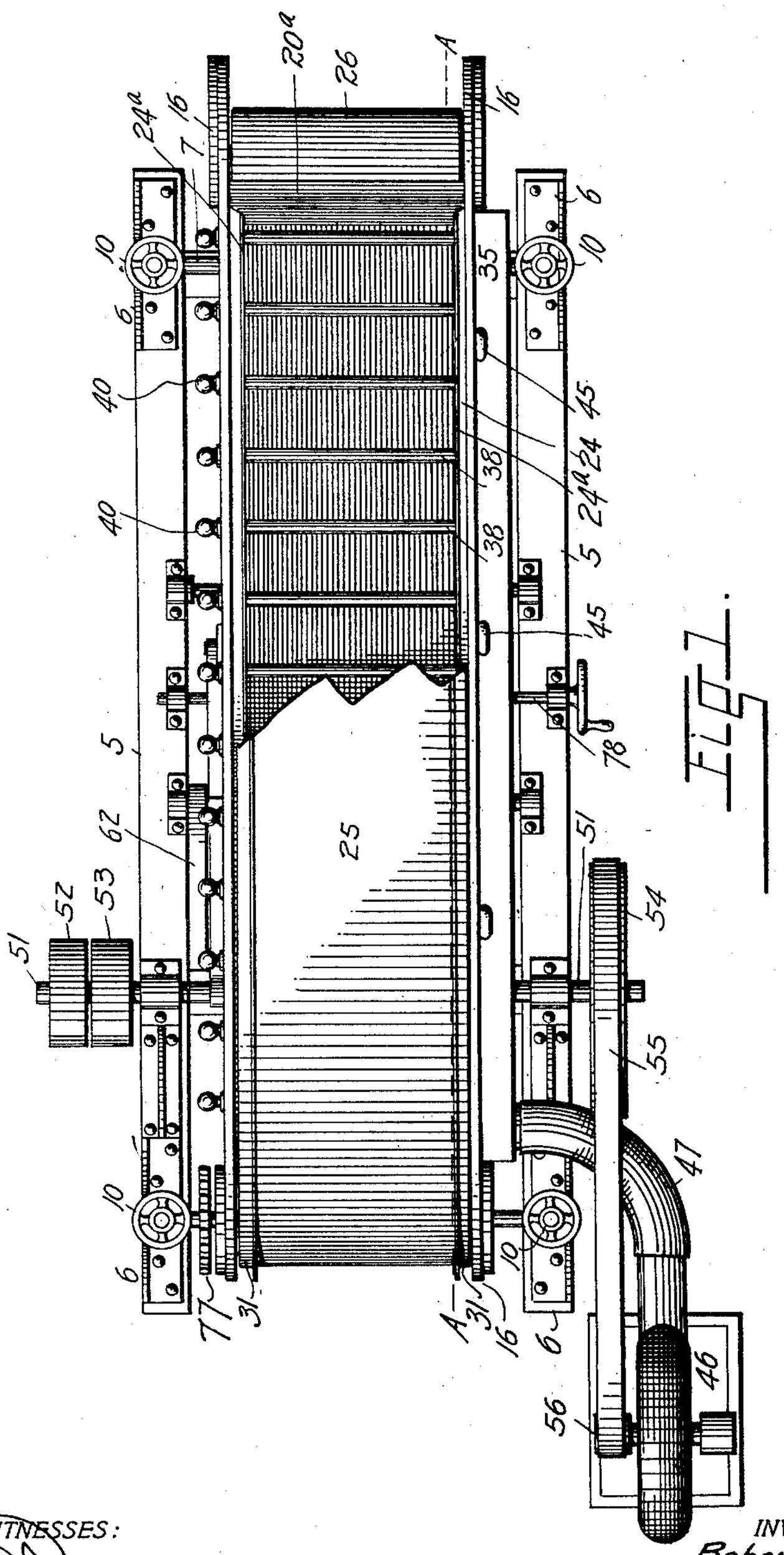

FIG. 1.

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Dora C. Shick.

INVENTORS
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Eugene Waugh.
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No. 703,356. Patented June 24, 1902.

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(No Model.) 6 Sheets—Sheet 2.

FIG. 2.

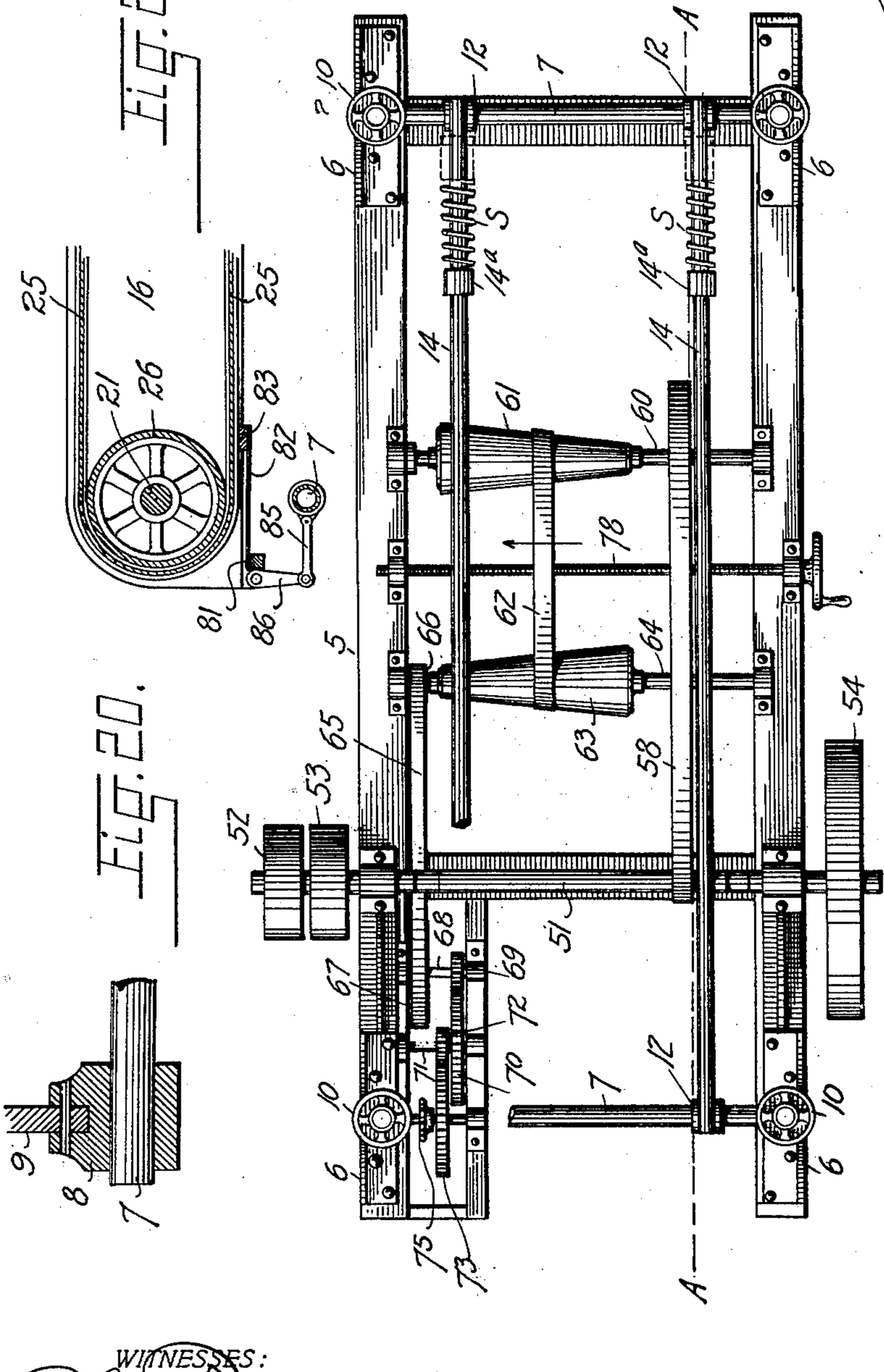


FIG. 2a.

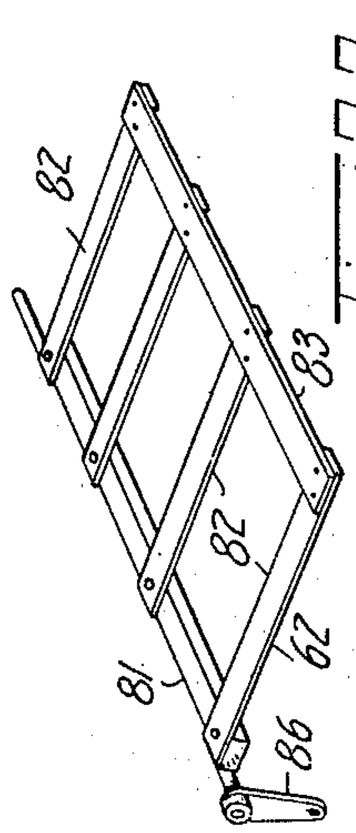


FIG. 2b.

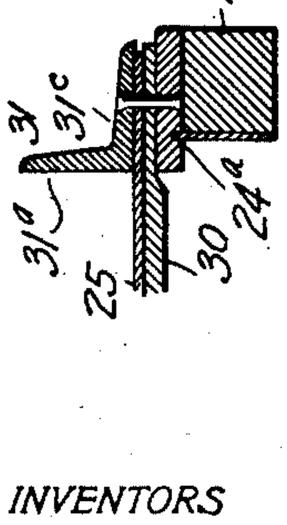
FIG. 2c.

FIG. 2d.

FIG. 2e.

FIG. 2f.

FIG. 2g.



WITNESSES:

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(Application filed May 27, 1901.)

(No Model.) 6 Sheets—Sheet 3.

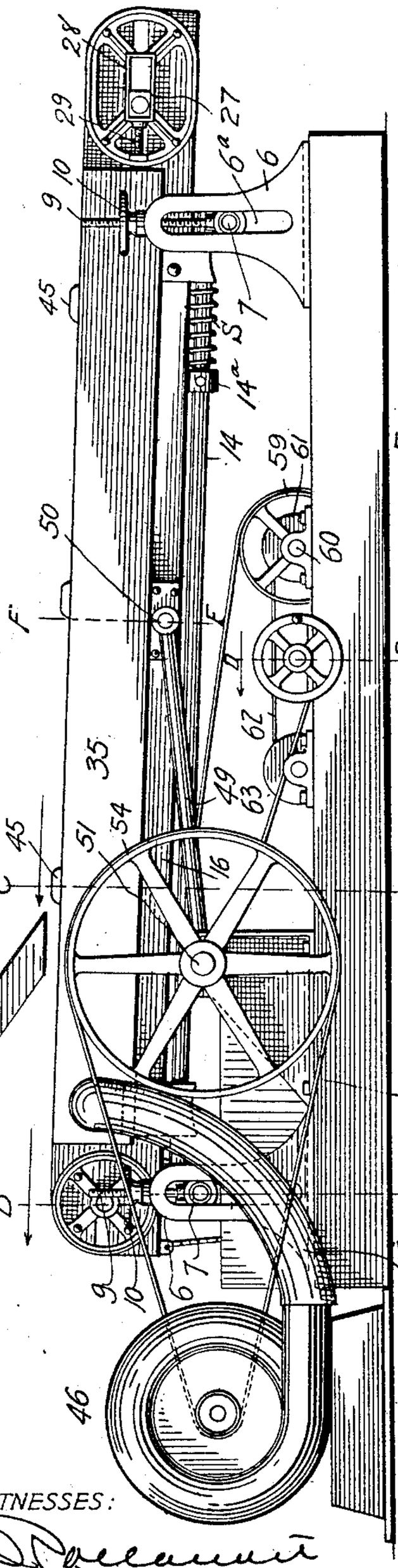

FIG. 3.

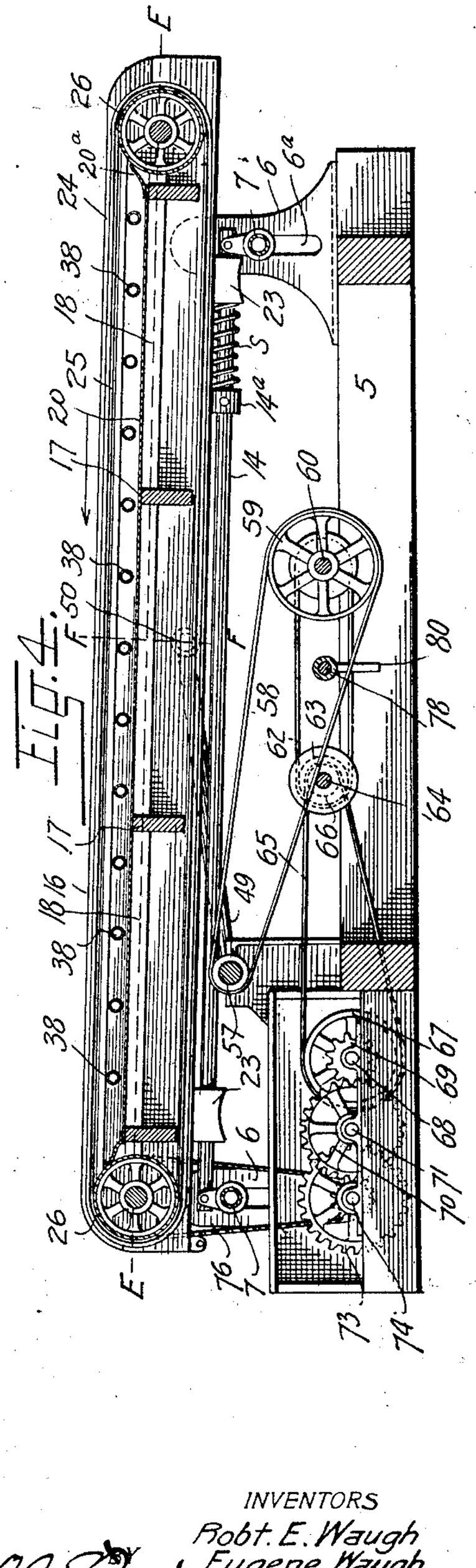

FIG. 4.

WITNESSES:

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(Application filed May 27, 1901.)

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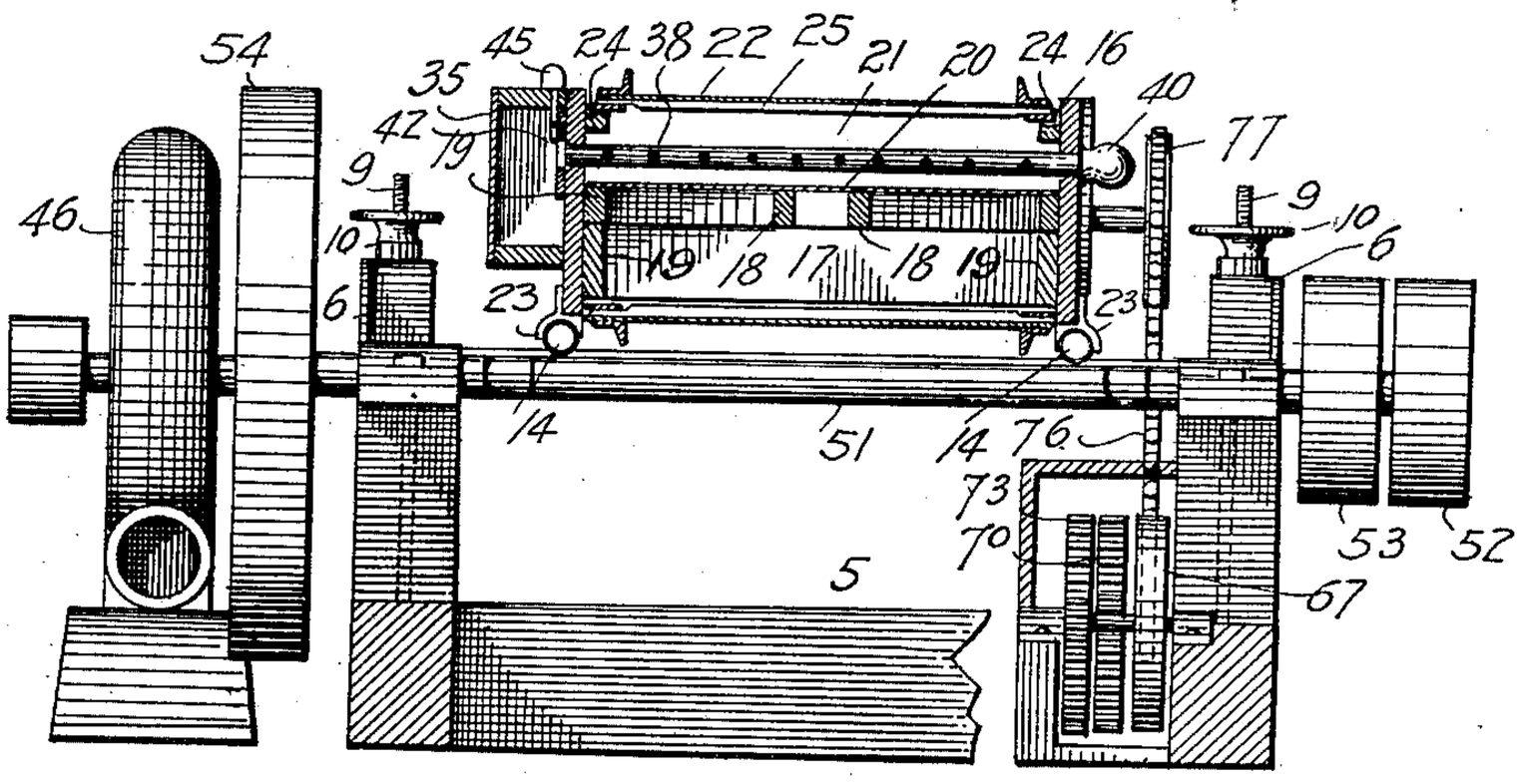

Fig. 5.

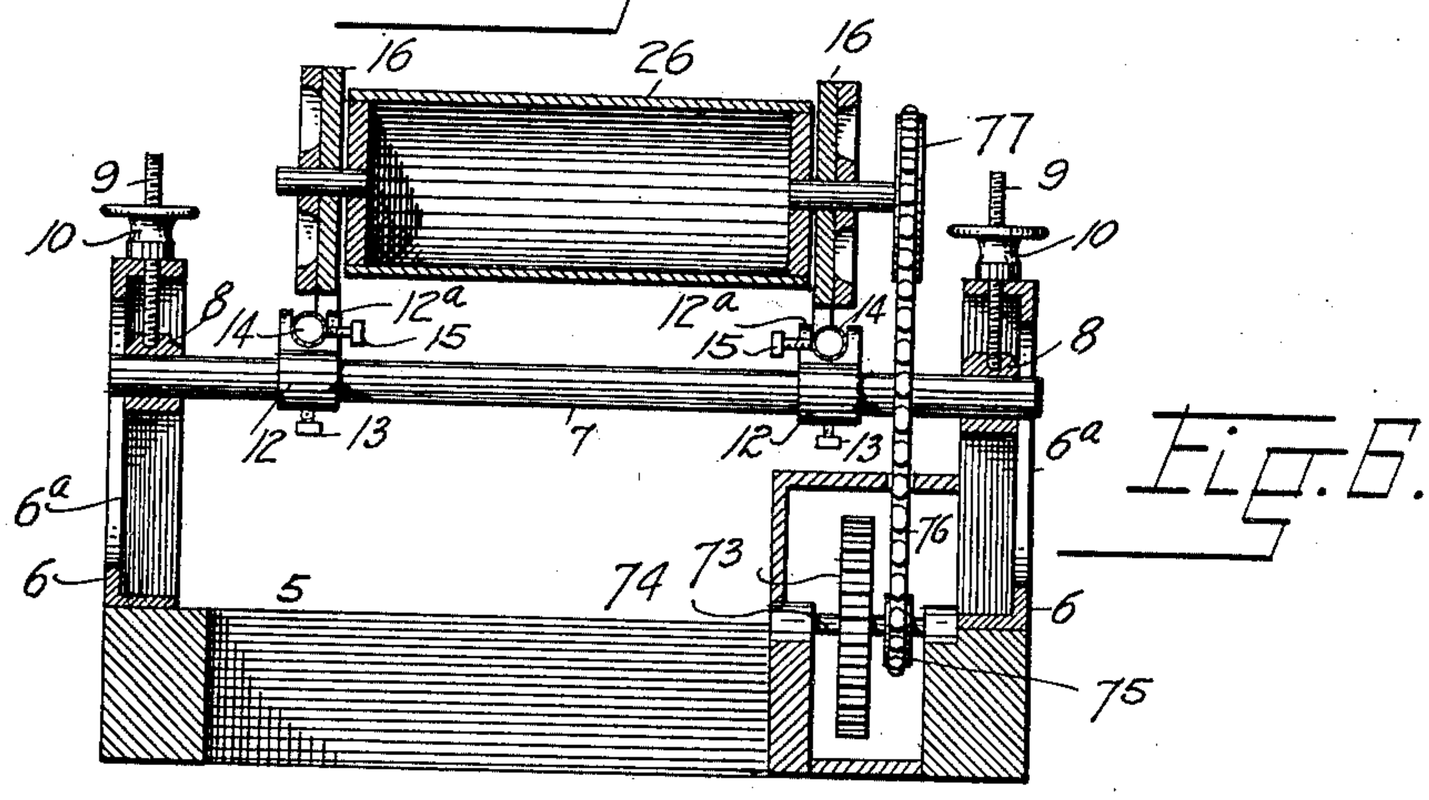

Fig. 6.

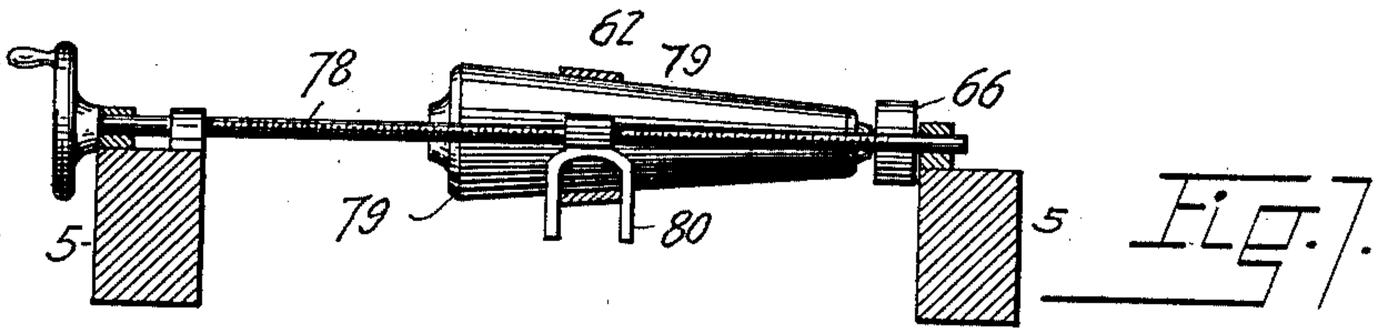

Fig. 7.

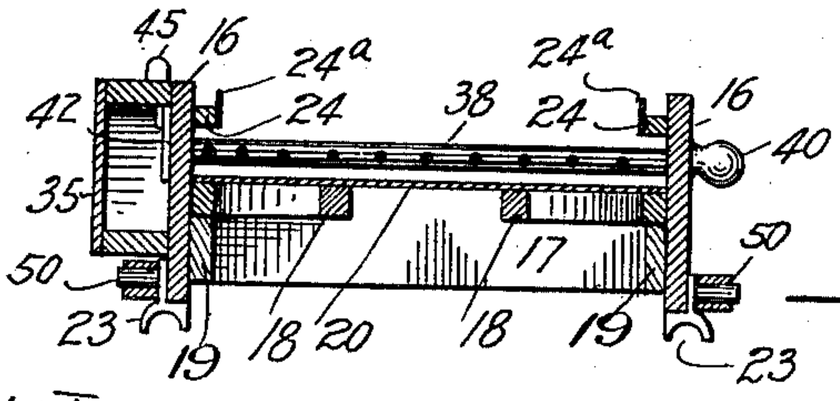

Fig. 8

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No. 703,356. Patented June 24, 1902.

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DRY ORE CONCENTRATOR.

(Application filed May 27, 1901.)

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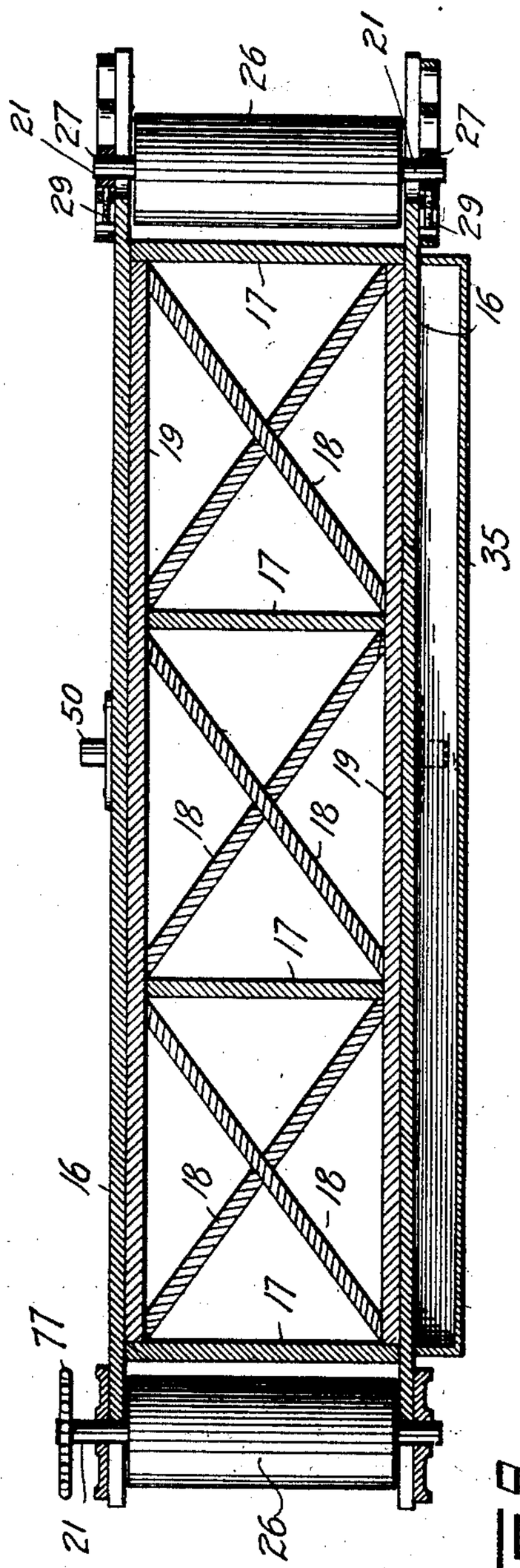

Fig. 9.

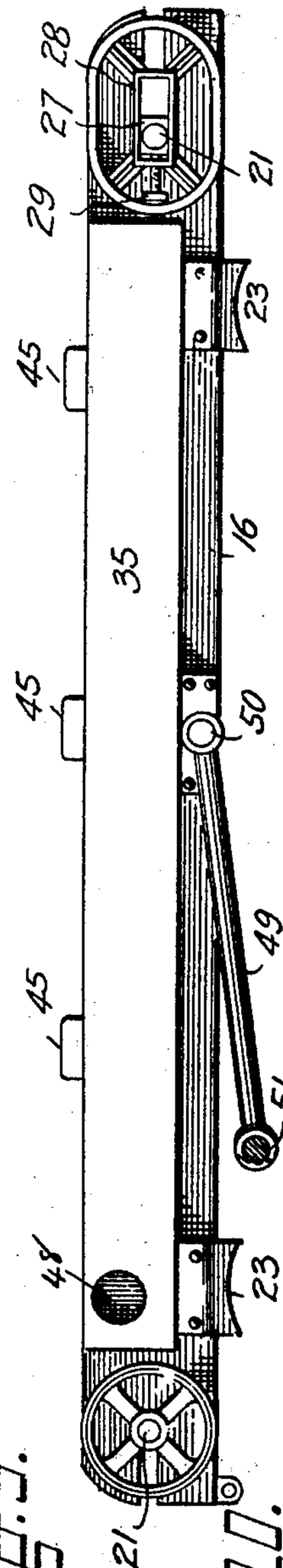

Fig. 10.

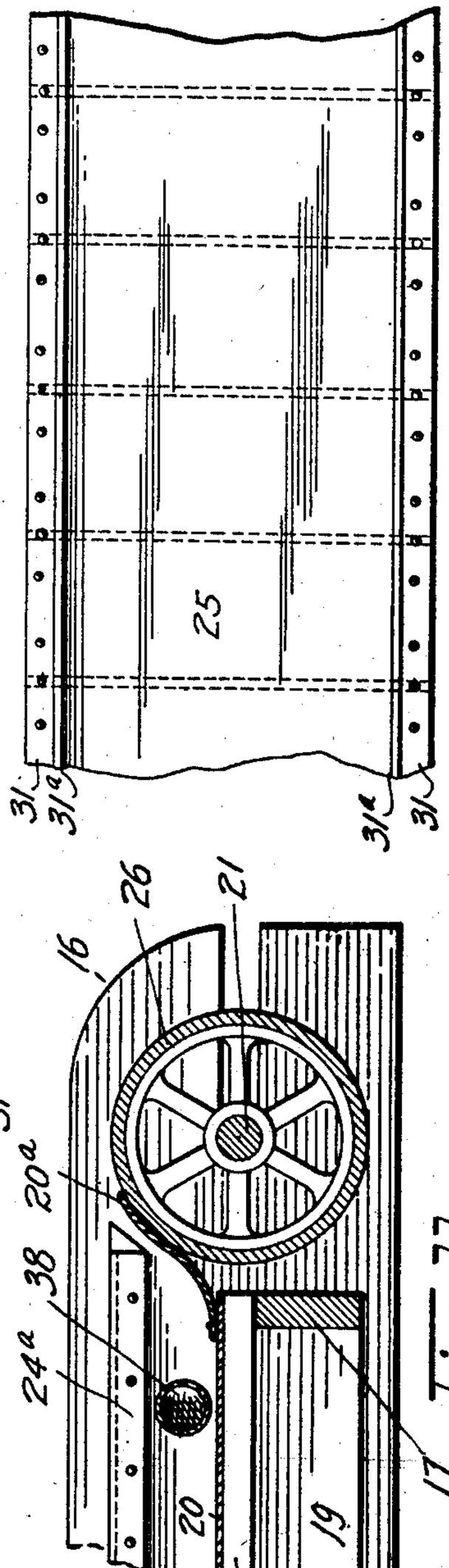

Fig. 12.

Fig. 11.

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No. 703,356. Patented June 24, 1902.

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DRY ORE CONCENTRATOR.

(Application filed May 27, 1901.)

(No Model.) 6 Sheets—Sheet 6.

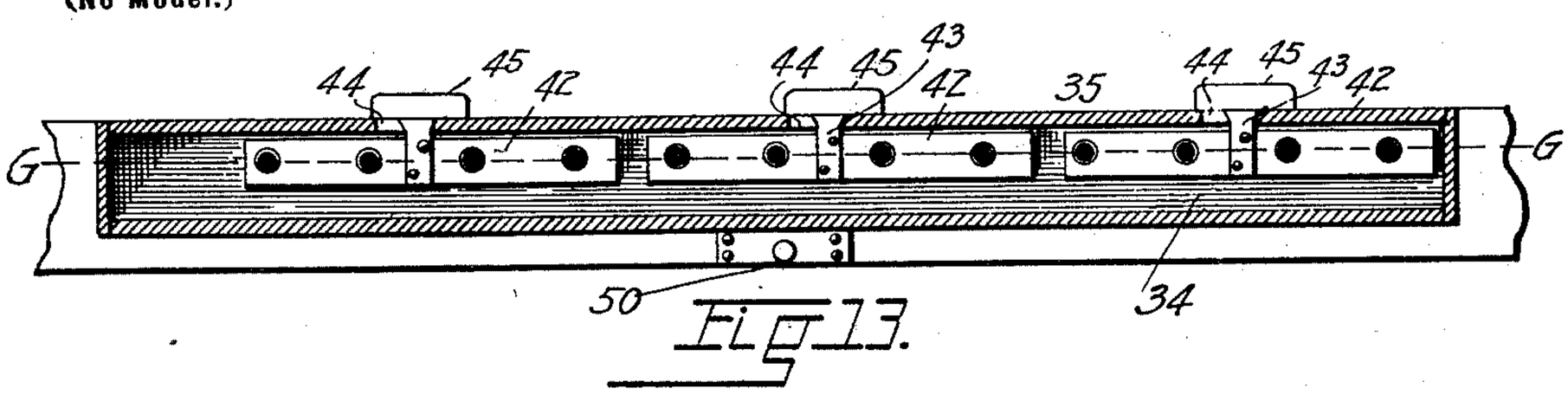

Fig. 13.

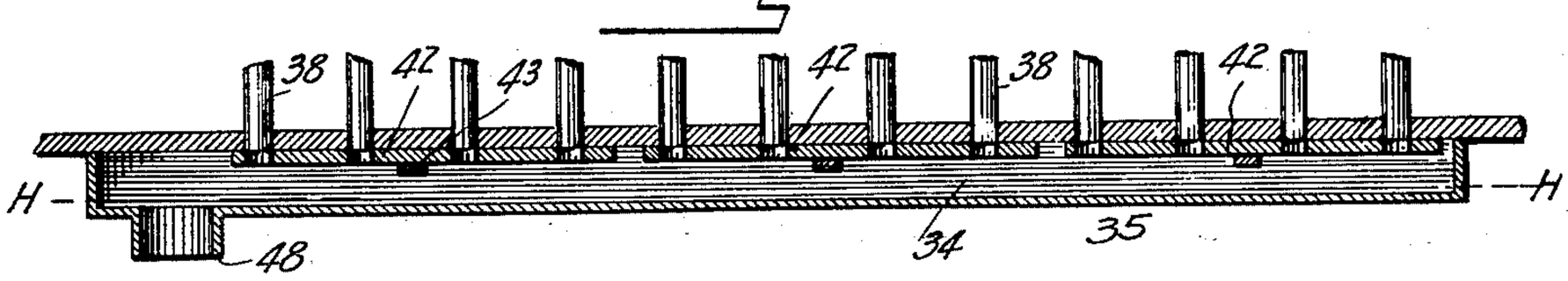

Fig. 14.

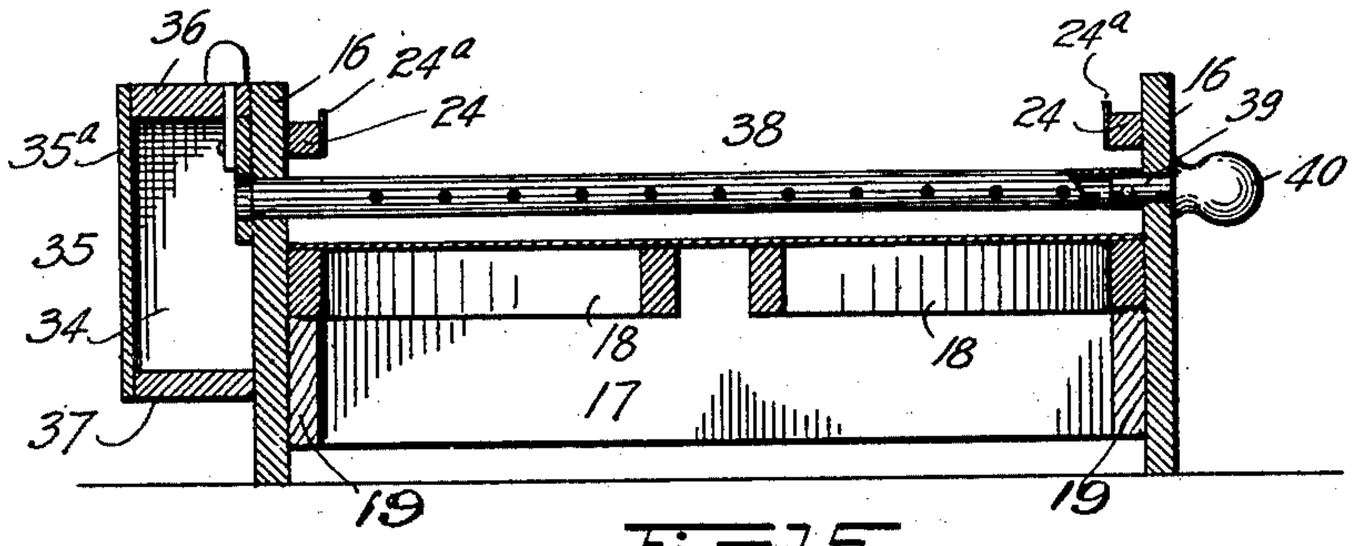

Fig. 15.

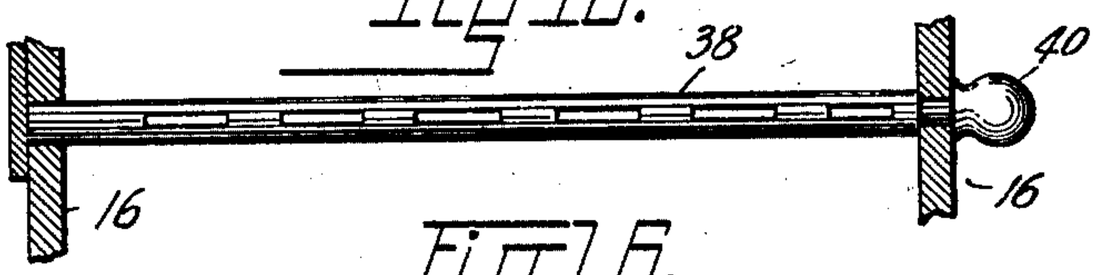

Fig. 16.

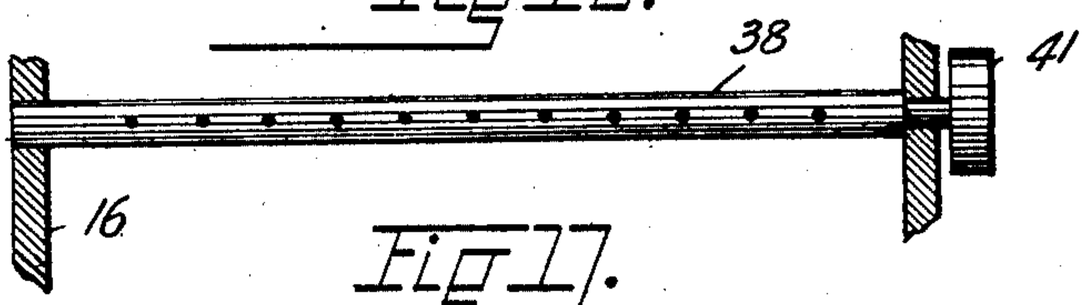

Fig. 17.

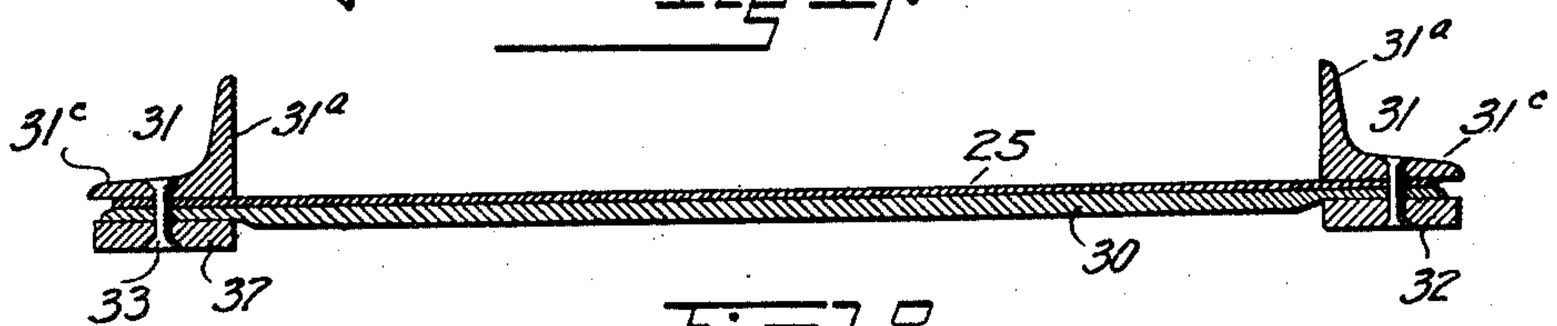

Fig. 18.

WITNESSES:
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INVENTORS
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Eugene Waugh.
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ATTORNEY.

UNITED STATES PATENT OFFICE.

ROBERT E. WAUGH AND EUGENE WAUGH, OF DENVER, COLORADO.

DRY ORE-CONCENTRATOR.

SPECIFICATION forming part of Letters Patent No. 703,356, dated June 24, 1902.

Application filed May 27, 1901. Serial No. 62,153. (No model.)

To all whom it may concern:

Be it known that we, ROBERT E. WAUGH and EUGENE WAUGH, citizens of the United States of America, residing at Denver, in the county of Arapahoe and State of Colorado, have invented certain new and useful Improvements in Dry Ore-Concentrators; and we do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

Our invention relates to improvements in dry ore-concentrators, our object being to provide a thoroughly practicable machine of this class which shall be comparatively simple in construction, economical in cost, reliable, durable, and efficient in use; and to these ends the invention consists of the features hereinafter described and claimed, all of which will be fully understood by reference to the accompanying drawings, in which is illustrated an embodiment thereof.

In the drawings, Figure 1 is a top or plan view of our machine, the endless apron being partly broken away. Fig. 2 is a top view of the frame and operating parts, the air-chamber, the endless apron, and the drums being removed and certain elements being partly broken away. Fig. 3 is a side elevation of the machine. Fig. 4 is a section taken on the line A A, Figs. 1 and 2. Fig. 5 is a section taken on the line C C, Fig. 3, looking toward the left, as indicated by the arrow. Fig. 6 is a section taken on the line B B, Fig. 3, looking toward the left, but not showing the blower or the conduit leading therefrom to the air-box or auxiliary chamber. Fig. 7 is a section taken on the line D D, Fig. 3, viewed in the direction of the arrow. Fig. 8 is a section taken on the line F F, Figs. 3 and 4, looking toward the left. Fig. 9 is a section taken on the line E E, Fig. 4, looking downward. Fig. 10 is a side elevation of the air-chamber and the vibratory apron-frame. Fig. 11 is a fragmentary vertical section taken through one end of the machine cutting a drum, the parts being shown on a larger scale. Fig. 12 is a top or plan view of the apron shown on a larger scale. Fig. 13 is a vertical section taken through the air-chamber on the line H H, Fig. 14. Fig. 14 is a horizontal section of the same, taken on the line G G, Fig. 13. Fig. 15 is a vertical cross-section taken through the air-chamber and the apron-frame, showing one of the perforated pipes. Fig. 16 is a section showing a similar pipe having elongated openings. Fig. 17 is a section of the frame, showing a perforated pipe provided with a pulley at one extremity. Fig. 18 is a cross-section taken through the apron, which is shown in detail and on a larger scale. Fig. 19 is an enlarged fragmentary view of the apron and its supporting-track. Fig. 20 is an enlarged sectional detail. Fig. 21 is a section taken through one of the end drums, illustrating the apron-beater. Fig. 22 is a perspective view of the apron-beater.

The same reference characters indicate the same parts in all the views.

Let the numeral 5 designate a suitable supporting-frame provided with slotted uprights or standards 6. Into the slots 6^a of the standards project the extremities of transverse bars 7, which are made fast to vertically-movable blocks 8, which are secured to the lower extremities of vertical jack-screws 9, which pass through plain or unthreaded openings formed in the flanged top parts of the standards. To these screws above the standards are applied adjusting-nuts 10, whereby the position of the bars 7 may be vertically adjusted at will. As shown in the drawings, there are four standards 6 and two bars 7, though a greater number may be employed, if desired.

Upon each bar 7 are mounted and made fast two sleeves 12, which are held in place by set-bolts 13, whereby their position on the bar may be regulated at will. The tops of these sleeves are provided with forked projections 12^a, forming seats for the longitudinal bars 14, which are secured thereto by set-bolts 15. The bars 14 form supports upon which the apron-frame is slidably mounted. This frame is composed of two side pieces 16, arranged edgewise and suitably separated. The side pieces are connected by cross-pieces 17, strengthened by diagonal braces 18. The

extremities of the cross-pieces are secured to cleats 19, made fast to the pieces 16 on the inside.

To the top of the pieces 17 and 18 is secured a bottom 20 for an air-chamber 21, which is closed at the top by the apron 22. The latter will be hereinafter more particularly described. The bottom 20 is preferably composed of a plate of sheet metal. To the lower edge of each side piece 16 is made fast a number of shoes 23, shaped to engage or embrace the bars 14 and slide freely thereon during the vibration of the apron-frame. As shown in the drawings, each piece 16 is provided with two shoes 23. It is evident, however, that any other desired number may be employed.

To the side of each piece 16 is secured a horizontal track 24 for an endless apron 25, which at the ends of the apron-frame passes around drums 26, journaled in the extremities of the side pieces 16 beyond the rubber flaps 20^a, which are attached to the bottom 20 and close the extremities of the air-chamber 21. One of the end drums (being that farthest to the right in Fig. 9) is journaled in boxes 27, movable in longitudinal openings formed in keepers 28, suitably mounted on the frame. These boxes are adjusted in their keepers by means of set-bolts 29 or in any other suitable manner. The function of the movable drum is to regulate the tension of the endless traveling concentrating-apron, which by the adjustment of this drum may be maintained sufficiently taut for the proper performance of its function. This apron is preferably composed of canton-flannel or some other suitable fibrous material through which the air may pass from below when introduced into the chamber 21. The canton-flannel is preferred, because it has a long normally flat lying nap on one side, which is made the concentrating-surface of the apron. Nothing is claimed, broadly, on the nap feature in this application, as this feature was broadly claimed in Patent No. 570,831, dated November 3, 1896. This apron is supported on the under side by transverse pieces 30, preferably composed of metal rods whose extremities are flattened and riveted to the apron near its outer edges. To the outer edge of the apron is also made fast a strip 31, preferably composed of rubber and provided with two flanges 31^a and 31^c, extending at right angles to each other. Underneath the apron and engaging the flattened extremities of the rods 30 are two strips 32, preferably composed of leather. These strips or straps are sufficiently flexible and durable for the purpose. Rivets 33 are passed through the flanges 31^c of the rubber straps, the outer edge of the apron, the flattened extremities of the rods, and the leather strips 32, whereby these parts are firmly secured together. The flanges 31^a are of sufficient width to maintain the ore at a suitable depth on the apron by preventing it from passing over its edges. The tracks 24 are provided with metal projections 24^a, arranged to engage the leather straps of the apron and form grooves therein, whereby an air-tight joint is formed. (See Fig. 19.)

At one side of the apron-frame is formed a box 35, forming an auxiliary air-chamber 34, having a part 16 of the frame on one side, a side wall 35^a on the opposite side, and top and bottom walls 36 and 37. The extremities of this air-chamber are also closed. The wall 16 of the auxiliary air-chamber is provided with openings leading into the chamber 21 and in which are inserted the extremities of transverse pipes 38, whose opposite extremities are closed by plugs 39, which are made fast to the ends of the pipes and provided with knobs 40 on the outside, whereby the pipes may be turned, if desired. These pipes are provided with openings for the escape of air. These openings may be of any desired shape. In Figs. 15 and 17 they are shown as ordinary perforations, while in Fig. 16 the openings are elongated. By turning these pipes the air may be delivered to the apron at any desired angle. If desired, the said pipes may be continuously rotated. In this event a pulley 41 may be connected with the extremity of each pipe. (See Fig. 18.) Slidably mounted on the wall of the chamber 34, containing the outlet-openings, are a number of cut-off slides 42, each of which is attached to an arm 43. The necessary air for effecting the concentrating function is conducted from a blower 46 by way of a flexible conduit 47 to the auxiliary chamber 34 through an opening 48, formed in the side of the box 35.

The apron-frame is downwardly inclined from the left toward the right. (See Figs. 3 and 4.) Each bar 14 is provided with a stop 14^a, against which one extremity of a coil-spring S bears, the opposite extremity of the spring being engaged by the shoe 23 of the apron-frame. The vibratory movement is imparted to the apron-frame by means of two pitmen 49, each of which is connected at one extremity with one of the side pieces 16, as shown at 50, and at the opposite extremity with an eccentric on the main operating-shaft 51. One extremity of this shaft 51 is provided with the usual fast and loose pulleys 52 and 53, which may be connected, by means of a belt, with a line-shaft (not shown) or any other suitable motor for operating the machine. On the opposite extremity of the shaft 51 is made fast a large pulley 54, which is connected, by means of a belt 55, with a small pulley 56 on the blower-shaft, whereby as the shaft 51 is rotated a relatively high speed will be imparted to the blower-shaft. A small pulley 57, fast on the shaft 51, is connected, by means of a belt 58, with a larger pulley 59, fast on a shaft 60, provided with a conical pulley 61, connected by a belt 62 with a similar pulley 63, but oppositely arranged. This pulley 63 is made fast to a shaft 64, journaled in the framework of the machine. A small pulley 66, fast on the shaft 64, is connected by a belt 65 with a larger pulley 67, fast on a shaft 68.

A pinion 69, fast on the shaft 68, meshes with a larger gear 70, fast on a shaft 71, which is provided with a pinion 72, meshing with a larger gear 73 on a shaft 74, provided with a small sprocket-wheel 75, connected, by means of a chain 76, with a large sprocket-wheel 77, fast on the journal of one of the drums. It will thus be seen that while a rapid movement is imparted to the blower-shaft a relatively slow movement is imparted to the apron through the instrumentality of a system of speed-reducing pulleys, belts, and gears. The speed of the apron may be regulated by shifting the belt 62 on the cone-pulleys 61 and 63. This belt is shifted by means of a screw-shaft 78, whose extremities are journaled in the stationary frame. This screw-shaft is threaded in a nut 79, provided with a depending forked belt-shifting device 80, which straddles the belt 62. This screw-shaft 78 is provided with a crank-wheel at one extremity to facilitate the turning of the screw-shaft when it is desired to shift the belt. When the belt 62 is in the position shown in Fig. 2, the shafts 60 and 64 will rotate at the same speed, it being assumed that the belt engages the two conical pulleys where they are of equal diameters. Now if the belt be shifted in the direction indicated by the arrow in Fig. 2 the speed of the apron will be increased, while if the belt be shifted in the opposite direction the speed of the apron will be diminished.

There is a beater or whipping device located underneath the apron at the head of the table whose function is the removal of the concentrates caught by the apron after the latter passes below the air-chamber. This beater, as shown in the drawings, is composed of a transverse bar 81, whose extremities are journaled in suitable bearings attached to the side pieces 16 of the apron-frame. To this bar are attached rearwardly-extending slats or pieces 82, to which is secured a device 83, preferably composed of a number of thicknesses of canvas or some other fibrous material. To the bar 7 at the head of the machine is attached a forwardly-projecting link 85, pivotally connected with a crank-arm 86, made fast to the bar 81. Then as the apron-frame vibrates during the operation of the machine an oscillating movement will be imparted to the beater, when its part 83 is made to strike the apron from below, thus causing the concentrates to drop therefrom.

When the machine is in use, the blower is operated at a high rate of speed and the apron relatively slowly through the instrumentality of the mechanism heretofore described. The apron travels upwardly on the inclined apron-frame, as indicated by the arrow in Fig. 4. The material to be treated is fed to the slowly-traveling apron in any suitable manner. A conventional feed-chute is shown in Fig. 3 and designated by the numeral 84. The compressed air acting on the under side of the apron from the chamber 21 the air-jets from the pipes 38 being delivered directly against the under side of the apron, forces the air through the apron and up through the bed of material on the apron. The gangue, which is of less specific gravity than the mineral, is raised upwardly by the force of the air-pressure, while the mineral is allowed to settle to contact with the upper surface of the apron, which retains it, whereby the mineral values or concentrates are carried upwardly with the apron, while the gangue travels downwardly and is discharged at the lower extremity or tail of the machine. The mineral after passing with the apron over the head-drum has a tendency to drop and free itself therefrom; but only a portion of it will be removed by gravity alone. The beater device heretofore described and which acts continually on the apron during the operation of the machine removes the balance of the concentrates by repeated upward blows or strokes.

Having thus described our invention, what we claim is—

1. In a dry ore-concentrator, the combination with a suitable stationary frame, of a vibratory apron-frame constructed to form an air-chamber, an endless traveling apron through which the air from the chamber passes, the apron closing said chamber at the top, an auxiliary air-chamber arranged in suitable proximity to the main air-chamber, means for introducing air under pressure to the auxiliary chamber, and means for vibrating the apron-frame.

2. In a dry ore-concentrator, the combination with a stationary frame, of an apron-frame mounted to vibrate thereon, means for vibrating the apron-frame, an endless traveling apron mounted on the frame which is constructed to form an air-chamber beneath the apron which closes the said chamber at the top, an auxiliary air-chamber mounted on the apron-frame in proximity to the main air-chamber, delivery-pipes communicating with the auxiliary chamber and projecting into the main chamber below the apron, the said pipes having openings for the escape of air to the main chamber, and means for introducing air under pressure to the auxiliary air-chamber.

3. The combination of an endless traveling apron constructed to allow an air-blast to pass therethrough, a vibratory apron-frame having an air-chamber closed at the top by the apron, means for vibrating the apron-frame, an auxiliary air-chamber mounted on the vibratory frame, means for delivering air from the auxiliary chamber to the main chamber below the apron, and means for introducing air under pressure to the auxiliary air-chamber.

4. The combination of an apron-frame mounted to vibrate and provided with an air-chamber, means for vibrating the apron-frame, an endless traveling apron mounted on the frame and closing the air-chamber at the top, the apron being composed of suitable material to allow the air to pass there-

through, an auxiliary air-chamber, means for introducing air under pressure to said auxiliary chamber, and pipes leading from the auxiliary chamber and provided with openings for the escape of air below the apron, the said pipes being rotatable whereby the angle of the delivered air-jets may be varied at will.

5. The combination with a stationary frame, of a vibratory apron-frame mounted thereon and provided with an air-chamber, means for vibrating the apron-frame, an endless traveling apron mounted on said frame and closing the air-chamber at the top, an auxiliary air-chamber mounted on the apron-frame, means for introducing air under pressure to said auxiliary chamber, outlets from the auxiliary chamber to the main chamber, and means for controlling and regulating the exit of the air from the auxiliary chamber to the main chamber.

6. The combination with a stationary frame, of an apron-frame mounted to vibrate thereon, and provided with an air-chamber, means for vibrating the apron-frame, an endless traveling apron mounted on the vibratory frame, the apron being arranged to close the air-chamber at the top and constructed to allow air to pass therethrough, an auxiliary air-chamber provided with outlets to the main chamber, means connected with the auxiliary chamber for forcing air thereinto, and slides located in the auxiliary chamber and adapted to be actuated from the outside of the chamber, for regulating the escape of air from the auxiliary to the main chamber.

7. The combination with a suitable stationary frame, of a vibratory frame, means for vibrating the last-named frame, longitudinal bars, means located at the extremities of the bars for adjusting the latter vertically, shoes attached to the vibratory frame in sliding engagement with the bars, and buffer-springs mounted on the bars and engaging one pair of shoes.

8. The combination with a suitable stationary frame, having slotted standards mounted thereon, of longitudinal bars, cross-bars to which the longitudinal bars are secured, vertically-movable boxes in which the cross-bars are mounted, the extremities of the cross-bars protruding into the slots of the standards, screws connected with the boxes of the cross-bars, nuts applied to the screws and engaging the top of the standards, a vibratory frame slidably mounted on the longitudinal bars, and means for vibrating said last-named frame.

9. In a dry ore-concentrator, the combination with a stationary frame, of an apron-frame mounted to vibrate thereon, means for vibrating the apron-frame and composed of two side pieces, cross-pieces connecting the side pieces, a plate attached to the cross-pieces and forming a bottom for an air-chamber, tracks attached to the side pieces above the bottom and forming a support for the apron, end drums journaled in the side pieces beyond the air-chamber, yielding flaps attached to the bottom plate and overlapping the drums for closing the air-chamber at the ends, and an endless concentrating-apron passing around the end drums and closing the air-chamber at the top.

10. The combination with a suitable stationary frame, of an apron-frame mounted to vibrate thereon, means for vibrating the last-named frame, a shaft journaled in the stationary frame, pitmen operated from the shaft and connected with the apron-frame, drums journaled in the apron-frame at the extremities of the air-chamber and around which the apron passes, a blower connected with the air-chamber to deliver air thereto, an operating-shaft, a connection between said shaft and the blower for operating the latter at a high rate of speed, and a speed-reducing connection between the operating-shaft and one of the end drums for operating the apron at a comparatively lower rate of speed.

11. The combination with a suitable stationary frame, of a vibratory frame mounted thereon, means for vibrating the last-named frame, and provided with an air-chamber, drums journaled in the frame at the ends of the air-chamber, an endless traveling apron passing around the drums and closing the air-chamber at the top, a blower, a flexible connection between the blower and the air-chamber, an operating-shaft, a connection between said shaft and blower for operating the blower at a high rate of speed, and a speed-reducing and speed-regulating connection between the shaft and one of the end drums for operating the apron, said connection including two oppositely-arranged conical pulleys, a belt connecting said pulleys, and suitable means for shifting the belt on the pulleys and maintaining it in the adjusted position.

12. The combination of a stationary frame, an apron-frame mounted to vibrate thereon and provided with an air-chamber, means for vibrating the apron-frame, end drums journaled in the frame, yielding flaps attached to the extremities of the air-chamber bottom and engaging the drums to close the air-chamber at the ends, and an endless traveling belt or apron engaging the drums and closing the air-chamber at the top, said apron being composed of material adapted to allow air under pressure to pass therethrough from the air-chamber below.

13. In a dry ore-concentrator, the combination with an air-chamber, of an endless apron arranged to close said chamber at the top, said apron comprising a body part of fibrous or other material adapted to allow air to pass therethrough under pressure, rubber strips attached to the edges of the apron, each of said strips having two flanges extending approximately at right angles to each other, one of which flanges projects above the concentrating-surface of the apron and maintains the ore thereon, the other flange being se-

cured to the edge of the apron, rods or reinforcing-pieces extending transversely across the apron on its inner surface, their extremities being attached to the outer edges of the apron, and straps composed of leather or other suitable material attached to the edges of the apron on its inner surfaces.

14. In a dry ore-concentrator, the combination with a stationary frame, an apron-frame mounted to vibrate thereon, means for vibrating the apron-frame, an endless traveling apron mounted on the last-named frame, and an oscillatory beater device engaging the concentrating-surface of the apron during its rearward travel, to remove the concentrates, said device being mounted on the vibratory frame, and a stationary part with which a part of the said device is connected for operating purposes.

15. In a dry ore-concentrator, the combination with a stationary frame, of an apron-frame mounted to vibrate thereon, means for vibrating the apron-frame, an endless traveling apron mounted on said last-named frame, a beater arranged to engage the concentrating-surface of the apron during its rearward travel for the purpose of removing its concentrates, said device including a transverse bar pivotally connected with the vibratory frame, a crank-arm attached to said bar, and a link attached to the stationary frame and connected with the arm of the beater-bar for operating purposes.

16. In a dry ore-concentrator, the combination with a stationary frame, an apron-frame mounted to vibrate thereon, means for vibrating the apron-frame, an endless traveling apron mounted on the last-named frame, and an oscillatory beater device engaging the concentrating-surface of the apron during its rearward travel, to remove the concentrates, said device being mounted on the vibratory frame, and suitable means for operating the beater device.

In testimony whereof we affix our signatures in presence of two witnesses.

ROBERT E. WAUGH.
EUGENE WAUGH.

Witnesses:
D. C. SHICK,
MARY C. LAMB.