Dec. 13, 1938. M. E. HAWORTH 2,139,823

APPARATUS FOR MINERAL SEPARATION

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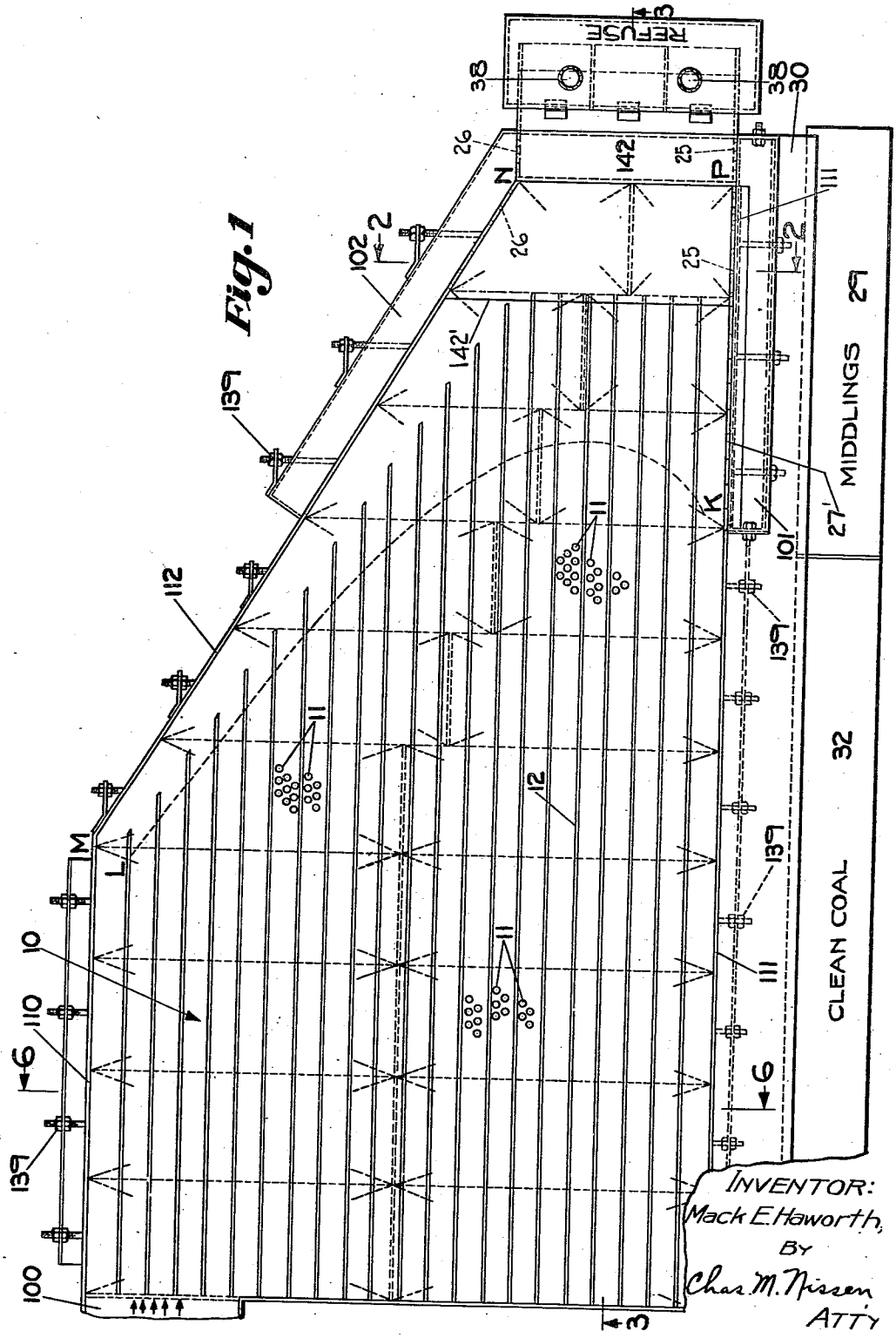


Fig. 1

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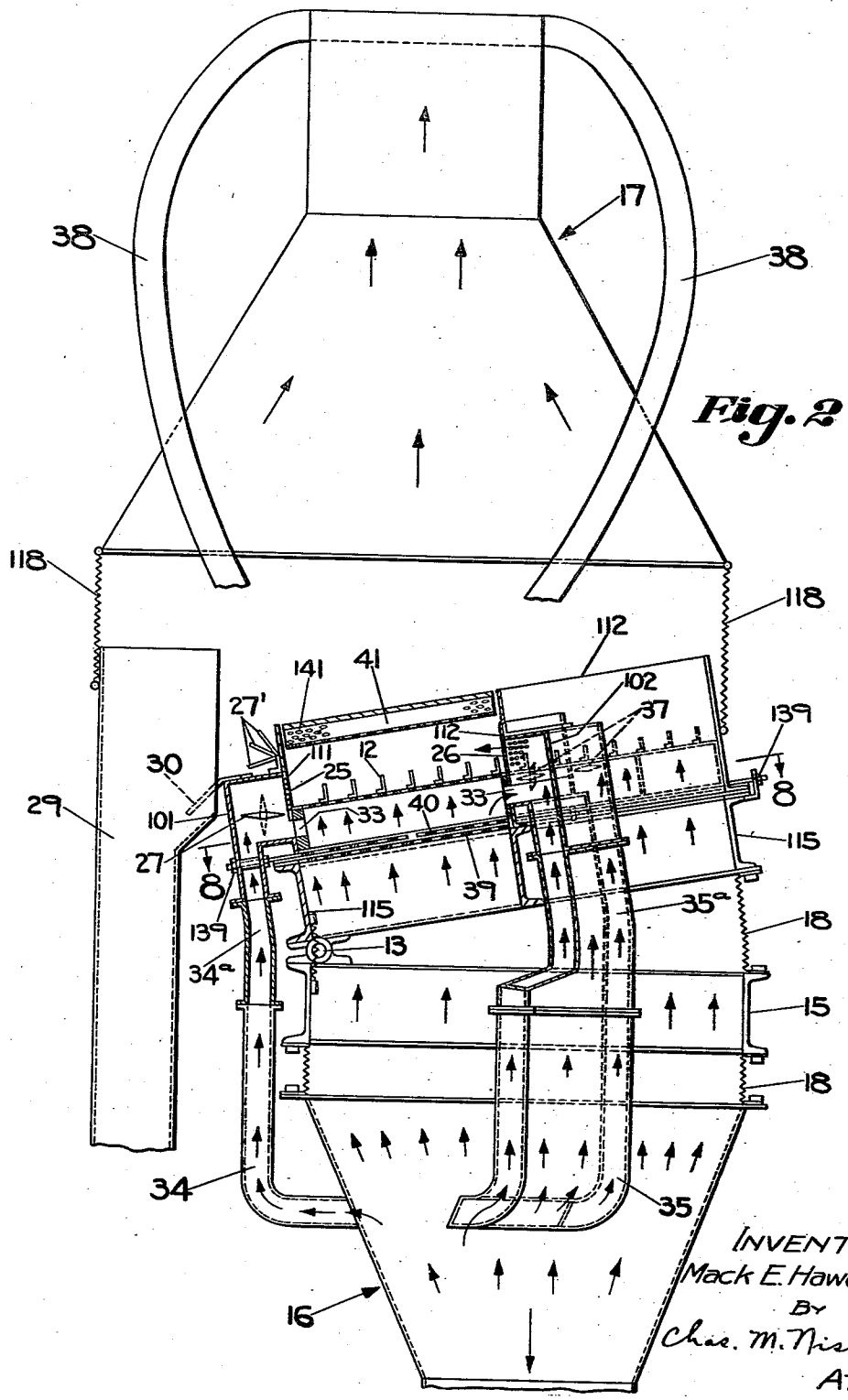


Fig. 2

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APPARATUS FOR MINERAL SEPARATION

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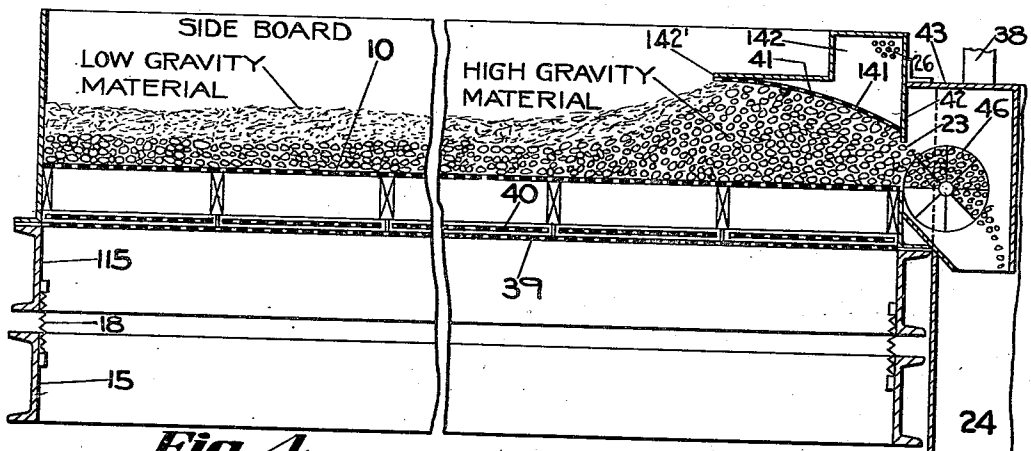


Fig. 4

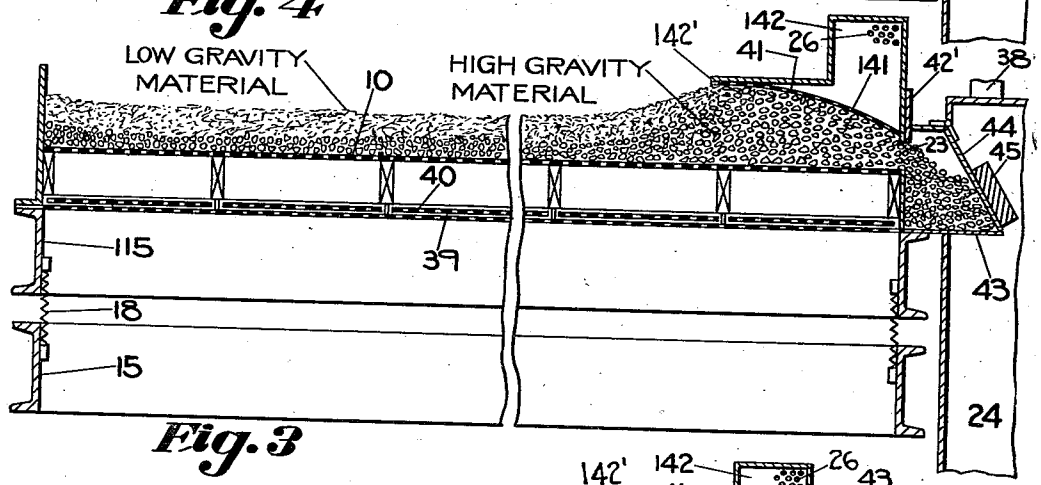


Fig. 3

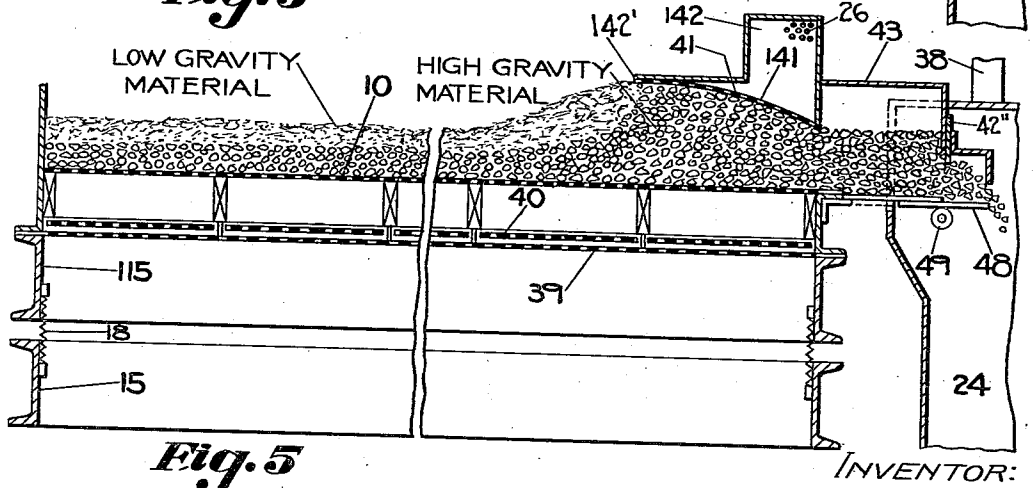


Fig. 5

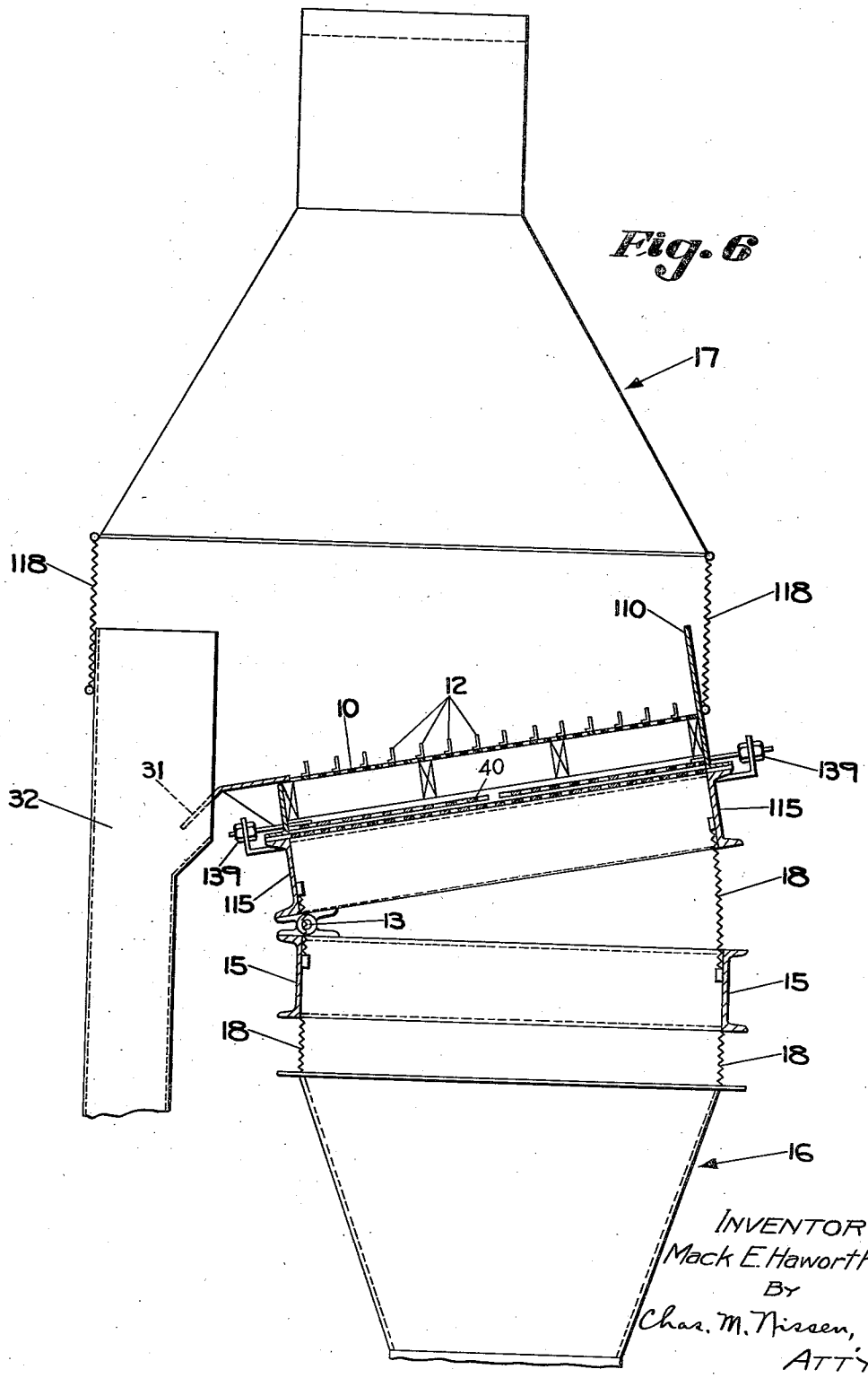
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APPARATUS FOR MINERAL SEPARATION

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Fig. 6



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Filed May 27, 1936 6 Sheets-Sheet 5

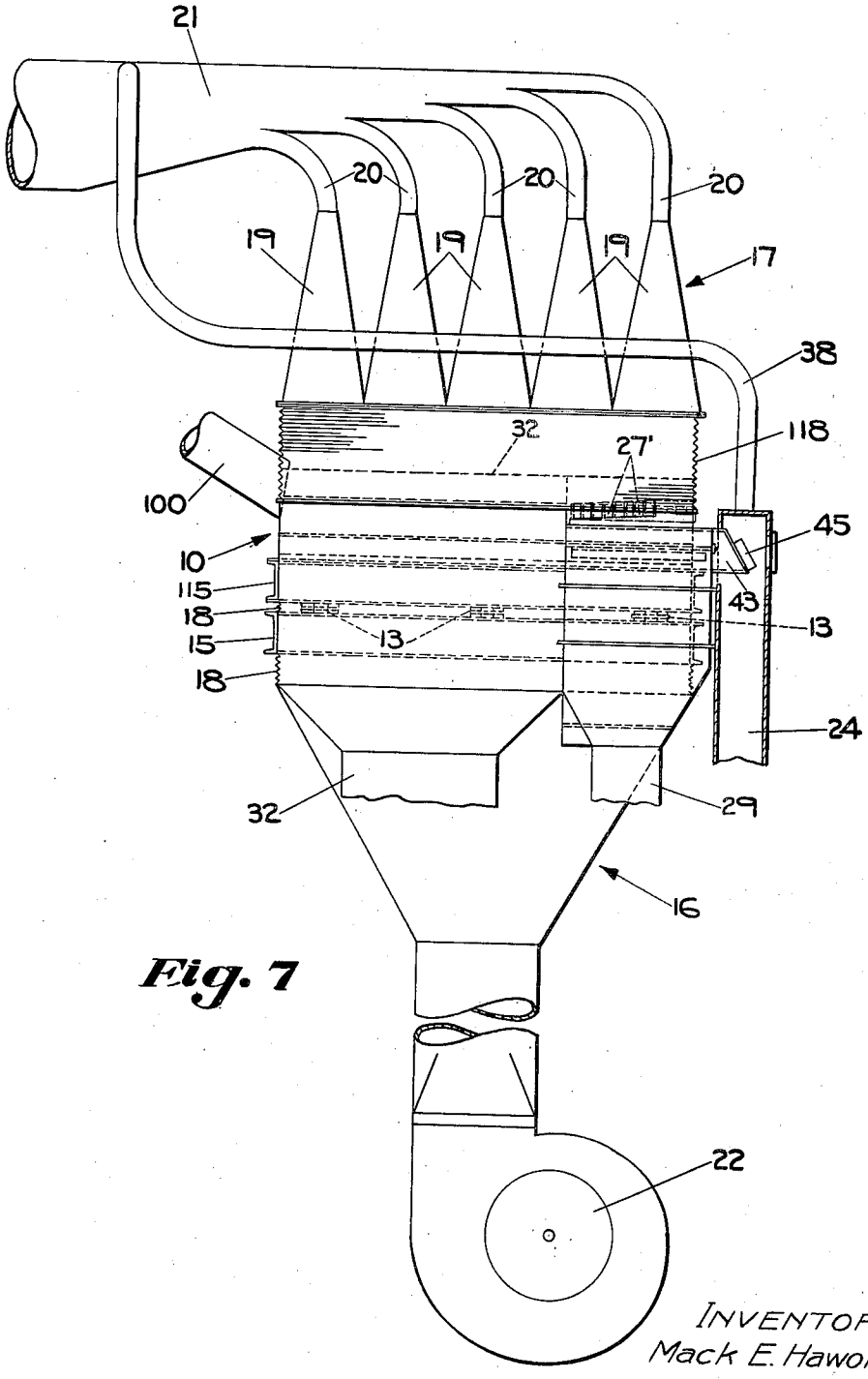


Fig. 7

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APPARATUS FOR MINERAL SEPARATION

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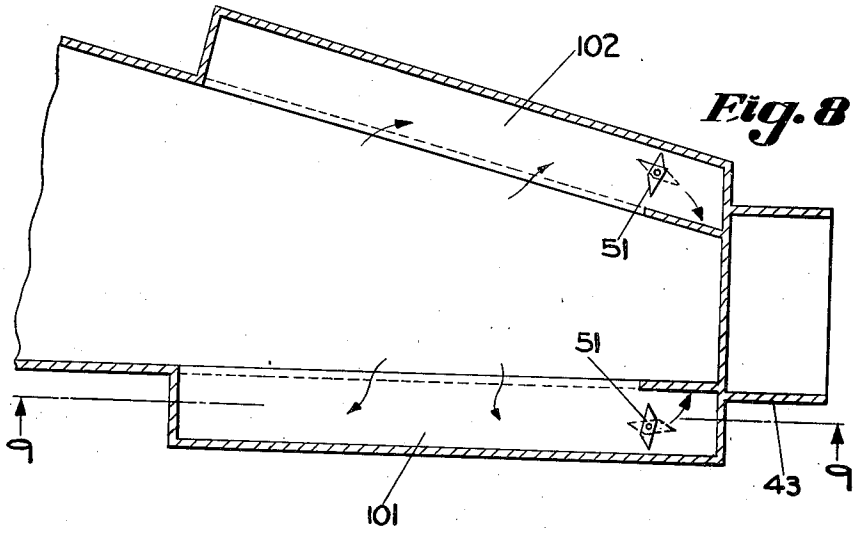


Fig. 8

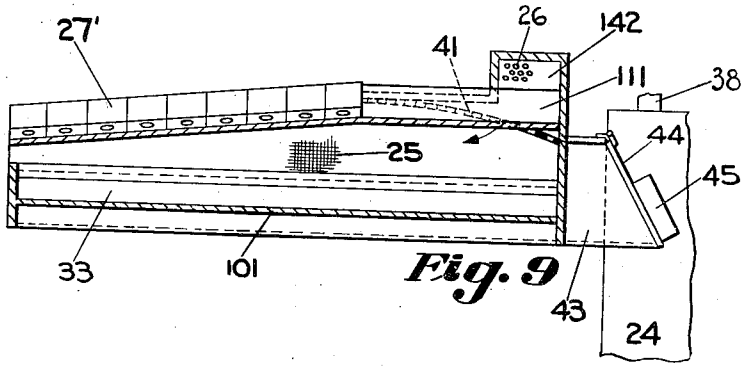


Fig. 9

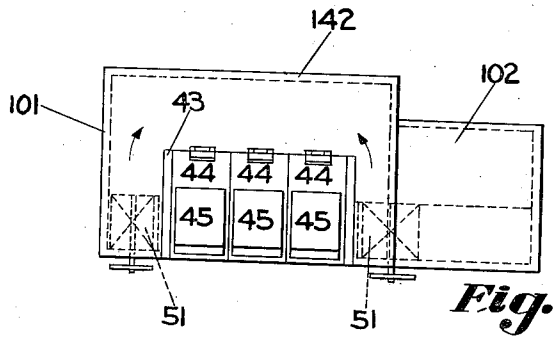


Fig. 10

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UNITED STATES PATENT OFFICE

2,139,823

APPARATUS FOR MINERAL SEPARATION

Mack E. Haworth, Columbus, Ohio, assignor to The Jeffrey Manufacturing Company, a corporation of Ohio

Application May 27, 1936, Serial No. 82,080

5 Claims. (Cl. 209—467)

This invention relates to the separation of a mixture of materials according to the relative specific gravities of the component parts, such as a mixture of coal and impurities, and has particular reference to apparatus for securing an efficient separation of the refuse from the coal while at the same time securing a refuse which is substantially free from coal.

One of the objects of the present invention is the provision of a new apparatus for producing unadulterated coal from a mixture, such as run-of-the-mine coal, containing coal and impurities.

A further object of the invention is to provide means for continuing the stratification and separation of a portion of the mixture on a specified deck portion after the principal separation has been effected and to utilize combined crowding action and air currents of predetermined directional force to aid in the final separation of the coal and refuse thereby to produce a refuse substantially free of all coal particles.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings,

Fig. 1 is a plan view of the air table or concentrator comprising my invention;

Fig. 2 is a transverse sectional and elevational view showing only the deck in section and taken on the line 2—2 of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a longitudinal sectional view taken on line 3—3 of Fig. 1 looking in the direction of the arrows;

Fig. 4 is a longitudinal sectional view of a modified form of my invention;

Fig. 5 is a longitudinal sectional view of another modified form of my invention;

Fig. 6 is a sectional and elevational view with only the deck shown in section and taken on the line 6—6 of Fig. 1 looking in the direction of the arrows;

Fig. 7 is a side elevational view of the apparatus with a refuse discharge chute shown in section;

Fig. 8 is a fragmentary sectional plan view taken on the line 8—8 of Fig. 2 looking in the direction of the arrows;

Fig. 9 is a side elevational view of a fragmentary section, with parts shown in section taken on the line 9—9 of Fig. 8 looking in the direction of the arrows; and

Fig. 10 is an end elevational view of the fragmentary section of Fig. 9.

This application is a continuation in part of my application for Apparatus for mineral separation, Serial No. 554,254, filed July 31, 1931.

Referring to the drawings, a suitable deck 10 is provided having the irregular shape shown and having parallel side walls 110 and 111, the former of which connects with an angularly disposed side wall 112, said deck 10 having a material supporting surface provided with perforations 11 substantially over the entire area thereof and having longitudinally extending riffles 12 extending upwardly therefrom. The perforations 11 may be of any desired size and spacing, and either varied or uniform in size, over the entire deck area. The riffles 12 are preferably parallel, forming troughs between them. They rise from the deck surface to a sufficient height to permit the largest particles of the mixture to be confined therein and terminate at one end short of the wall 112. The height of the riffles is limited by the maximum depth of bed desired, or the depth of bed which produces the best results, which depth is dependent upon the size and character of the material fed onto the table. These riffles are preferably of uniform height though they may be made of varying height or tapered to produce the desired results. The direction of the riffles may be such as to cause either the coal or refuse to flow laterally, the other one of the two flowing longitudinally of the deck.

As is best shown in Figs. 2, 6 and 7 of the drawings, the deck may be varied as to lateral inclination as provided by the hinges 13. That is, the deck 10 is mounted upon a suitable frame 115 carried by base 15 which base 15 is preferably also adjustable as to longitudinal inclination. Thus the deck 10 may be inclined both longitudinally and laterally in variable amounts.

A pressure duct system 16 is provided below the deck and a suction duct system 17 is provided above the deck. Flexible inclosing elements 18 and 118 connect the pressure duct system 16 and the suction duct system 17, respectively, to the deck 10, thus preventing dust from flying about and suitably confining the material being treated while directing the air currents to their proper paths.

The deck 10 is divided into a number of sections, for instance, twenty, as indicated by the dotted arrows on Fig. 1 of the drawings, and over each section is a suction hood 19, each having a constriction 20 before merging into the main suction duct 21 (Fig. 7). The constrictions 20 increase the velocity of the air passing therethrough, thus preventing an accumulation of dust therein. Suction or negative pressure

may be suitably created in the suction system 17 by any suitable means (not shown) such as a suction fan or blower attached to the duct 21. In a similar manner pressure may be created in the pressure system 16 by a suitable pressure fan or blower 22. In addition, suitable vibrating means may be provided to impart vibratory motion to the deck 10. It is therefore apparent that the air or fluid stream passes upwardly through the deck perforations 11 and the upward air currents in combination with the vibrating means cause stratification of the mixture of materials passing over the deck, which materials are fed thereto by suitable means, such as a feed chute 100 in the upper lefthand corner of the deck, as seen in Fig. 1 of the drawings.

Under each of the deck sections, previously mentioned, there is individual valve means for regulating the air current passing upward through that section and said regulating means, which are hereinafter described more completely, are entirely independent so that each may be independently adjustable. The precise regulation, of course, depends on the thickness and characteristics of the bed of material on each section. One advantage of such an arrangement is that the air currents can be so regulated that the effects thereof can be controlled. That is, a thin bed needs a low air velocity, and small particles, due to the low weight to be lifted, also require a low air velocity.

As best seen in Fig. 3 of the drawings, a refuse discharge opening 23 is provided adjacent the lower end of the deck, which opening leads to a refuse discharge chute 24 into which is discharged the highest gravity particles which form in the lower strata of the stratified bed.

As best seen in Figs. 2 and 9 of the drawings, the lower portion of each of the sides 111 and 112 of the deck is perforated at 25 and 26 respectively, near said refuse discharge opening 23. The longitudinal extent of these perforations is coextensive with the pressure chambers 101 and 102 associated therewith. Said perforations 25 and 26 may be provided by perforating the lower portion of the deck side plates or by forming this portion of wire cloth. These perforations 25 and 26 provide for the passage of a portion of the air current laterally into the bed of material on the said one end of the deck to effect a final and complete separation of the coal and refuse. An air regulator 27 is provided for adjusting the amount of air which passes through the perforations 25 and similar air regulators 37 are provided for adjusting the amount of air which passes through the perforations 26.

Attached to the side board 111 and above the perforations 25 is a plurality of adjustable plates 27' which may be bent over to any variable amount, for example, as illustrated in Fig. 2, whereby the effective height of the side board 111 above the perforations 25, which controls the discharge of the middlings, may be adjusted; thereby adjustably determining the depth of the bed on this portion of the table.

As shown in Figs. 1 and 3 of the drawings, refuse or high gravity material passes off the deck 10 through the opening 23 travelling over said deck 10 in a straight line direction and falling into chute 24, while the middlings pass over the adjustable plates 27' and down chute 29 being properly guided thereto by inclined guide 30 (Fig. 2).

As the coal or other mixture of material passes over the deck surface under the influence of air streams and mechanical agitation, the higher gravity materials are submerged in the lower strata of the bed, confined between the riffles 12 and directed toward the refuse discharge end of the table. The coal or lower gravity materials form in the upper strata of the bed and are directed laterally by the combined action of the air stream and gravity and flow over the riffles, being discharged in the clean coal chute 32. The middlings will accumulate adjacent the adjustable plates 27' and will be discharged thereover and guided by the guide 30 to the middlings chute 29.

The refuse tends to accumulate within the area outlined by the letters K—L—M—N—P (Fig. 1) and form a thick bed. Further separation of any coal or middlings which may be entrapped in the thick refuse bed is effected by air streams passing up through the deck and bed, by air streams passing laterally through the bed which enter by way of perforations 25 and 26, and by air which is forced downwardly through the top of the refuse bed, as hereinafter described in more detail. The air passing through perforations 25 and 26 is directed thereto by housings 101 and 102 respectively, to which air is admitted through ports 33 disposed as indicated in Fig. 2 of the drawings, or through air ducts 34 and 35 having flexible portions 34a and 35a respectively, which are flexible to provide for the aforementioned adjustment of the frame 115.

Under the deck, as illustrated in Fig. 2 of the drawings, are positioned the fixed and sliding perforated plates 39 and 40, respectively. There will be a single fixed plate 39 for the entire deck 10 and an individual plate 40 for each of the previously mentioned twenty sections thereof. Individual adjusting means 139 is provided for the adjustment of each of the plates 40. These, as previously pointed out, permit the desired regulation of air through the deck sections.

Attention is now directed particularly to Figs. 3, 8, 9 and 10 of the drawings and to a structural feature of particular importance in my invention. As was previously mentioned, adjacent the refuse discharge opening 23, the side walls 111 and 112 are provided with perforations 25 and 26, respectively. In addition, an arched hood 41, provided with perforations 141, is provided and extends laterally between the side plates 111 and 112. The pressure chamber 142 which communicates directly with pressure chambers 101 and 102 (see Figs. 1, 8 and 10) is provided for directing air under pressure to the hood 41, which air will be forced through the perforations 141 and into the accumulated refuse bed. The forward edge of the hood 41 and the chamber 142 are attached at 142'. To control the flow of the air into the chamber 142 from the chambers 101 and 102 I provide control valves 51 (see Fig. 8).

It is to be noted that the refuse accumulates in a progressively constricted chamber formed by the arched hood 41, the side walls 111 and 112 and the deck bottom leading to the refuse discharge opening 23. All of the walls forming this constricted chamber are preferably perforated and air is forced into the refuse bed from all sides. (Fig. 2.) As a consequence, the refuse is subjected to a distinct crowding action simultaneous with the forcing therethrough of air under pressure which will be effective to insure a clean refuse by virtue of the fact that any entrained particle of lower gravity material will be effectively removed therefrom.

As shown in Fig. 3 of the drawings, an adjust-

able retaining plate 42' is provided adjacent the opening 23 which may be raised or lowered to provide an opening 23 of desired size. A plurality of hinged and weighted gates 44 carrying counter-weights 45 are associated with a discharge chute box 43 and control the discharge of the refuse into chute 24.

In order to prevent the discharge of dust into the surrounding atmosphere which would present a fire or explosion hazard, as well as presenting an objectionable condition to persons present, I provide a pair of pipes 38, each of which has one end connected to the suction system 17, as best seen in Fig. 2, with the other end extending into the refuse discharge chute 24, as shown in Fig. 7.

In Fig. 4 of the drawings I have shown a modified form of refuse discharge mechanism including a retaining plate 42 and positive rotating ejector 46 within the box 43 which may be rotated at a variable speed, thereby to control the discharge of the refuse at any desired variable rate. In Fig. 5 of the drawings I have illustrated another modified form of refuse discharge mechanism including vertically adjustable retaining plate 42'' and an adjustable stroke, variable speed slide plate 48 which may be reciprocated by a roller 49 at a variable rate or through a variable distance.

In the operation of the device comprising my invention, raw coal will be fed to the deck 10 over the feed chute 100. The deck 10, will be vibrated longitudinally of the riffles 12 and air will be forced through the perforations 11 thereof in amounts controlled by the individual valves 40. As a consequence, a stratification of the material according to specific gravities will take place, with the refuse or high gravity material accumulating between the riffles 12 and by said riffles directed to the lower or right hand end of the table, as viewed in Fig. 1. Due to the longitudinal and lateral slope of the deck the low gravity material or coal will move laterally over the deck and be directed by the guide 30 into the clean coal chute 32. The middlings or intermediate gravity material will accumulate adjacent the lower right hand end of the deck in the upper strata of the bed and be discharged over the adjustable plates 27' being guided by the guide 30 into the middlings chute 29. The riffles 12 will guide the refuse or high gravity material to the constricted compartment leading to the refuse discharge opening 23, which compartment is formed by the arched hood 41, the side plates 111 and 112 where they are perforated by perforations 25 and 26, and by the deck bottom which is also perforated. The extent of the hood 41 as viewed in plan can readily be determined from Fig. 1 where the lateral edges are shown located at 111, 112 and the front edge at 142'. In some instances, the perforated hood 41 may be replaced by an imperforate hood of the same dimensions, and the compartment 142 omitted.

In this progressively constricted compartment or chamber, the accumulated refuse will be subjected to a progressive crowding action all the while air is forced therethrough from the lateral sides, the top and the bottom, or at least through the bottom. As a consequence, there will be a final and complete separation of coal from the refuse and a complete stratification of the material according to specific gravity. As a result refuse only, free from coal, will pass through the refuse discharge opening 23 from which it will be discharged into a box 43 and into a discharge chute 24 by controlled means of one of the types illustrated in Figs. 3, 4 or 5. As a consequence, the upper stratum of low gravity material which may contain some coal, is crowded upwardly and laterally as illustrated in Figs. 3, 4 and 5, so that a complete separation of the high gravity material or impurities, from the low gravity material is effected, refuse only being discharged into the chute 24.

It is also to be noted that in the apparatus comprising my invention, the air is forced through the deck by both negative pressure above the deck and positive pressure below it. Furthermore, the deck is sectionalized and individual arrangements are provided with individual control valves, thereby to control the rate of air flow through each deck area. It is furthermore to be noted that there is a complete elimination of dust in the surrounding atmosphere, both by the provision of the suction hood above the deck and by the provision of suction pipes 38 which lead to the refuse discharge chute 24.

As clearly shown in Figs. 3, 4 and 5, the discharge opening 23 is provided at the discharge end of the deck, for the heavy gravity materials or refuse. The discharge opening 23 in turn leads to a refuse discharge chute 24. Adjacent the discharge end of the deck are also located the mentioned upright perforated plates 25 and 26. The perforated plate 25 is parallel to the guides or riffles on the deck, and the perforated plate 26 converges toward the discharge end of the deck as shown in Fig. 1. If desired wire cloth may be substituted for the perforated plates 25 and 26. By means of the arrangement shown in Figs. 1 and 2 air currents are directed laterally and inwardly into the bed of materials on the deck to assist in effecting a separation of the light gravity materials from the heavy gravity materials as illustrated in Figs. 3, 4 and 5. Air regulators 27 and 37 are provided for adjusting the amount of air which passes through the upright perforated plates 25 and 26.

The refuse or heavy gravity material passes off the extreme right-hand end of the deck shown in Fig. 1. This movement is in a straight line direction parallel to the guides or riffles on the deck adjacent to the perforated plate 25 but is in a converging direction along the upright perforated plate 26, as shown in Fig. 1. The middlings or light gravity material passes laterally over the top of the perforated plate 25 and is directed by the sectional apron composed of the chute plates 27' onto the guide plate 30, and thence into the middlings chute 29, as shown in Fig. 2. A suitable chute 32 is provided for receiving the clean coal which forms the lightest gravity material or the uppermost strata of the stratified mixture before the bed of materials reaches the space between the perforated plates 25 and 26.

As shown in Figs. 3, 4 and 5 the lower side of the hood 41 is semi-arch-shaped so as to provide a discharge receiving passageway between the lower ends of the guides or riffles on the deck and the discharge opening beneath the vertical plate 42, 42' or 42''. The hood 41 extends laterally between the vertical perforated plates 25 and 26, as shown in Fig. 1. It will be seen that the underside or roof of the hood 41 slopes gradually upwardly from the plate 42, 42' or 42'' to the free space approximately where the deck riffles end. The space beneath the hood 41 therefore diverges from the plate 42 to such free space in a vertical plane, whereas by reason of the inclined position of the perforated plate 26 the

space beneath the hood 41 in a horizontal plane converges from the discharge end of the deck rearwardly.

By restricting the discharge openings at the extreme right-hand end of the apparatus in accordance with the rate of vibrations of the table, the heavy gravity material may be caused to back up or become crowded as permitted by the arching on the underside of the hood 41 and as illustrated in Figs. 3, 4 and 5. The lighter or low gravity materials will thus be caused to reach the higher elevation for more efficient discharge of the same by gravity over the upper edge of the perforated plate 25 and along the laterally extending sectional apron formed by plates 27' shown in Figs. 1 and 2.

The pocket formed under the hood 41 therefore serves to compel the light or low gravity material to be separated from the heavy or high gravity material and to be discharged laterally. Furthermore, the crowding of the heavy or high gravity material into such pocket having greater depth at its entrance, assures the delivery of only the heaviest gravity materials through the discharge opening under the vertical gate 42. As shown in Figs. 1 and 7, the pipes 38 are connected to the chamber beneath the hood 41 to produce such a negative pressure in such chamber as to prevent dust escaping from the front of the hood.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. Apparatus for concentrating material comprising in combination, a deck, of means for stratifying material on said deck according to specific gravities and discharging low gravity material laterally thereof, a high gravity discharge opening, a perforate arched port leading to said discharge opening, and means for forcing fluid through said perforate port.

2. Apparatus for concentrating material comprising in combination, a sloping deck having a refuse pocket, of means for causing stratification of material on said deck with an accumulation of high gravity material in said pocket, said pocket having a perforate arched top and perforate side walls, and means for forcing air through said side walls and top.

3. Apparatus for concentrating material comprising the combination with a deck having side plates over one of which material discharges and which are perforated adjacent the lower refuse accumulating area and a perforate bottom plate at said area, individually controlled means for independently adjusting the flow of air through said bottom plate and said side plates at said area independently of the other deck area, and means for supplying air to be controlled as aforesaid.

4. Apparatus for cleaning coal comprising a deck having a generally open top and a horizontal refuse accumulating passageway formed by top, bottom and side walls, means for stratifying coal on said deck and effecting a lateral discharge of clean coal with an accumulation of refuse in said passageway, the top of said passageway being perforated and positioned to form a progressively decreasing passageway area leading to the refuse discharge end thereof, and means for forcing air through said perforate top to aid the crowding action afforded thereby to remove any entrapped small particles of coal in said refuse passageway.

5. Coal cleaning apparatus comprising a deck, of means constructed and arranged to cooperate with said deck to effect stratification of coal thereon with a lateral discharge of clean coal therefrom and an accumulation of refuse at one end, a horizontally disposed refuse accumulating passageway at one end of said deck leading to a refuse discharge opening, said passageway being constructed to provide a continuous smoothly progressing restriction in area from one end thereof to the other terminating in said refuse discharge opening, the top of said passageway being perforate, and means for forcing air through said perforate top.

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