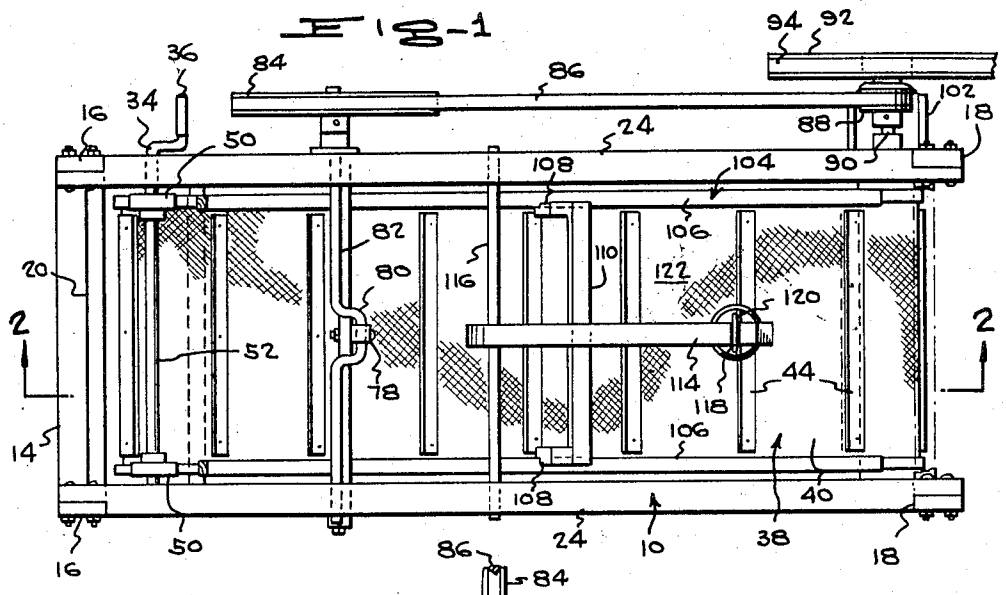
Dec. 16, 1958 G. T. BOLANDER 2,864,501

DRY CONCENTRATOR

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FIG-1



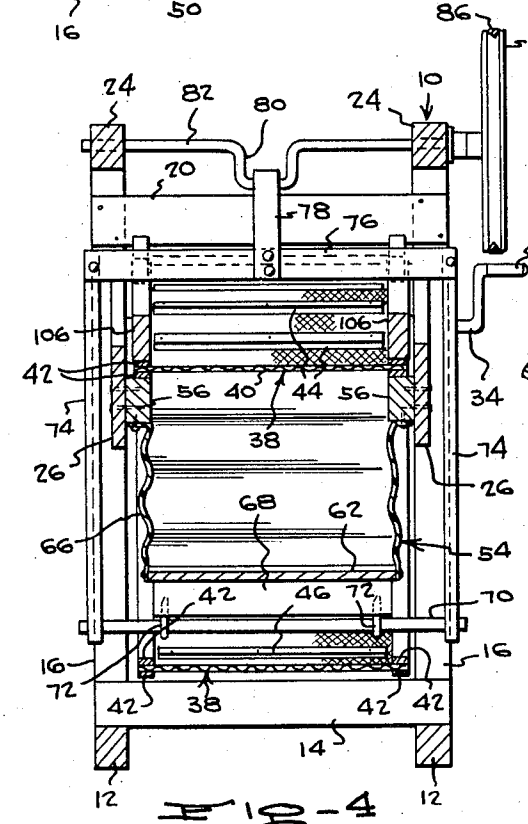


FIG-4

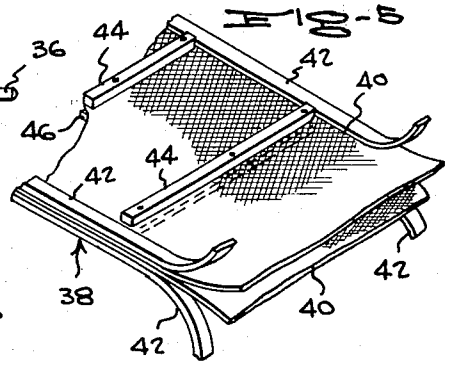


FIG-5

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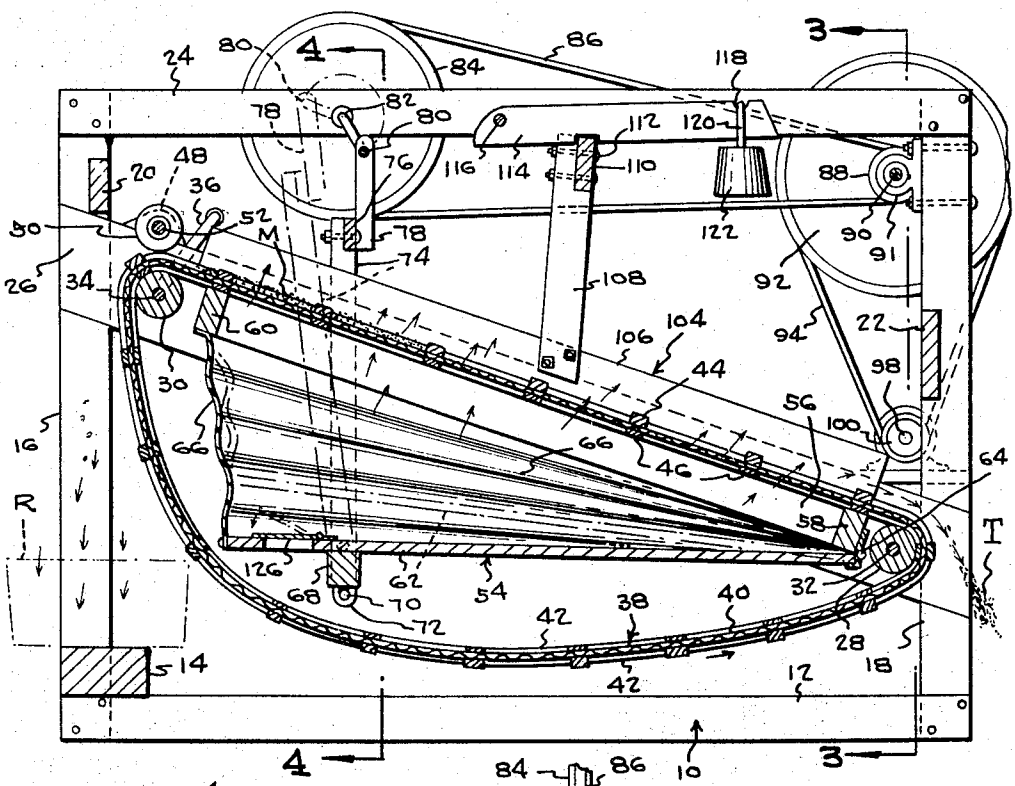


FIG-2

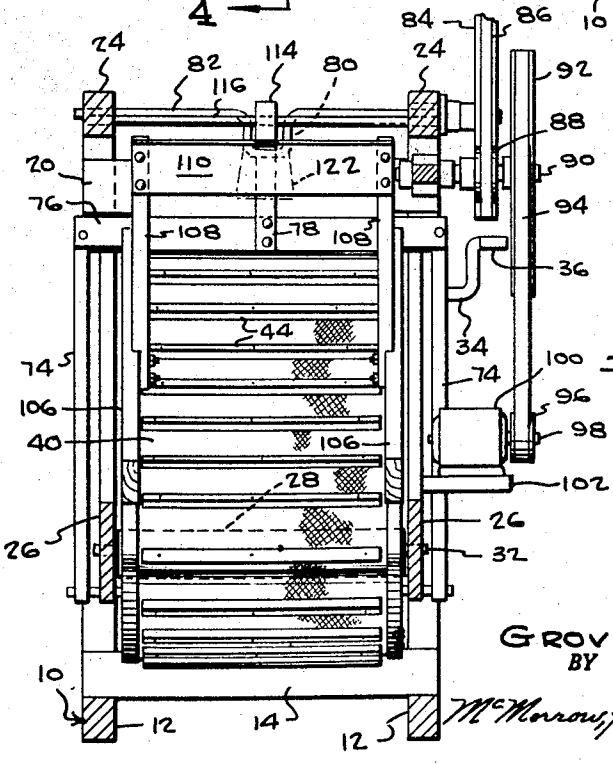


FIG-3

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2,864,501

DRY CONCENTRATOR

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Application November 29, 1957, Serial No. 699,540

7 Claims. (Cl. 209—470)

This invention relates to apparatus used in gold mining operations. More particularly, the invention has reference to a device which is used in placer mining activities for the purpose of separating the ore or similar materials from which the gold is to be extracted, into materials of different specific gravities.

In gold mining activities, one method of mining involves processing of the raw material including sand, gold ore, etc., through washers or so-called ore concentrators or separators. In locations at which there is no water, the operation of recovering the gold is carried on by the use of machines known as dry washers or dry placer machines. Of course, there being no water used, the process is not a true washing process, but nevertheless the term is commonly employed and is referred to herein for the purpose of permitting a better understanding of the present invention.

The desirability of a machine that will effect the ready and quick separation of light from heavy substances, in the recovery of gold, will be readily appreciated among those skilled in the art, since the light substances are entirely waste materials and must be removed from the heavier substances which contain the gold. Heretofore, when water is not available, the separation process has involved considerable difficulties, and in accordance with the present invention, an improved machine is provided, that will effect the separation of the raw material into materials having different gravities, with maximum speed and ease.

Another object is to provide apparatus as stated wherein a substantial quantity of the material can be handled in a comparatively short time, considering the relative simplicity of the size of the machine.

Another object of importance is to effect the separation of the materials by the action of a bellows, operating in association with a belt having a predetermined porosity, in a manner such that material deposited upon the belt will de disposed in the path of air forced out of the bellows, whereby the material will be forced upwardly from the belt if said material is relatively light, that is, above a predertermined specific gravity. In this way, it is proposed that the lighter materials so forced upwardly will eventually find their way to the lower end of an inclined surface on which the materials are deposited, to be discharged as tailings or waste. The heavier materials are retained upon the belt and are periodically discharged from the upper end of the belt responsive to rotation of the endless belt about supporting rollers provided therefor.

A further object of importance is to provide apparatus of the character described which will be especially designed for operation by means of the expenditure of a relatively small amount of power, considering the overall capacity and rate of separation of the machine.

A further object of importance is to form a machine of the character described, which, despite its relatively low cost and its substantial capacity for handling materials of the character stated, will nevertheless be

rugged, fully efficient in use, and adapted for operation over substantial periods of time with a minimum of attention and with a minimum requirement of maintenance and repair.

Other objects will appear from the following description, the claims appended thereto, and from the annexed drawings, in which like reference characters designate like parts throughout the several views, and wherein:

Figure 1 is top plan view of apparatus according to the present invention;

Figure 2 is a longitudinal sectional view therethrough substantially on line 2—2 of Figure 1;

Figure 3 is a transverse sectional view substantially on line 3—3 of Figure 2;

Figure 4 is a transverse sectional view substantially on line 4—4 of Figure 2; and

Figure 5 is an enlarged, fragmentary perspective view, partially exploded, of the riffle belt.

Referring to the drawings in detail, designated generally at **10** is an upstanding, rectangular, open-center support frame including at its bottom parallel, horizontal, elongated side rails **12** adapted to rest directly upon a supporting surface and adapted, if desired, to be bolted or otherwise fixedly secured to said supporting surface in the event the device is used upon a concrete base or the like.

In any event, at one end of the frame there is provided a transversely extending support ledge **14** supported at its opposite ends upon side rails **12** (Figure 3) and designed to hold a receptacle R shown in dotted lines in Figure 2, said receptacle being in position to receive the heavier material or concentrate, in a manner to be described in greater detail hereafter.

Fixedly secured at their low ends to the ends of the rails **12** and extending vertically upwardly therefrom are front corner posts **16** and rear corner posts **18** of the support frame. Fixedly connected between the upper end portions of posts **16** is a cross brace **20**. Fixedly connected between the intermediate portions of posts **18** (Figure 2) is a cross brace **22**.

Fixedly connected between the upper ends of the posts **16**, **18**, are top rails **24**, vertically aligned with and extending parallel to the bottom rails **12** as shown in Figure 4.

By reason of the construction illustrated and described so far, it will be seen that there is provided a rectangular support frame wholly open at its center, the movable parts of the apparatus being mounted almost wholly in the open center of the frame in a manner to be described hereinafter.

A pair of transversely aligned, inclined riffle belt support members **26** is provided in the apparatus. Said members are inclined upwardly from the rear end of the machine toward the end as shown in Figure 2 and may be formed from lengths of stout board stock. Members **26** are inclined correspondingly to the inclination of the upper flight of the belt, the belt being disposed between the members **26**.

Members **26** constitute part of the support frame 10. Extending between the lower, rear ends of said members is an idler roller **28**, while similarly carried by and between the upper or forward ends of members **26** is a drive roller **30**, said rollers being carried by shafts **32**, **34**, respectively, shaft **34** being connected to and rotatable by a hand crank **36**.

A riffle belt generally designated **38** is in the form of an endless, wide, conveyor type belt cleated both externally and internally to provide riffles or corrugations on the belt in which the material M that is to be separated will be disposed during operation of the machine. Belt **38** includes a pair of flexible, wide sheets or belt laminations **40**, and in accordance with the invention one of

these is formed of a screen mesh cloth, and constitutes the inner layer or lamination. The outer layer, that is, the layer facing to the outside when the belt is trained about the rollers **28**, **30**, is of a porous cloth, the mesh of which would be substantially smaller than that of the screen mesh inner lamination.

The registered side edges of the laminations are bound by lengths of tape **42**, adhesively secured to the laminations and formed to a width of approximately one inch, more or less, to provide a surface on the belt that will be adapted to rest upon the sides of the bellows, which will be described in detail hereinafter. Cleats **44**, **46** are secured to the outer and inner surfaces, respectively, of the belt, with the cleats **44** being registered with corresponding cleats **46** and being substantially thicker than the cleats **46**. Cleats **46**, in fact, constitute reinforcing means, but the cleats **44** form corrugations or equivalent means upon the outer surface of the belt, defining between each pair of adjacent corrugations spaces in which the material M will be deposited, and will be retained until discharged from the belt in a manner to be described in full detail hereafter.

Idler roller means is provided at the head or discharge end of the belt, adapted to hold the sides of the belt in firm engagement with the drive roller **30**. Referring to Figure 2, said means includes bearings **48** mounted upon the forward ends of the members **26**, with idler rollers or wheels **50** being mounted upon a shaft **52** journaled in the bearings, the rollers **50** being held in firm engagement with the tape-covered side edges of the riffle belt to engage the belt against roller **30** frictionally, so that the belt will be driven by roller **30** without slippage.

A bellows has been generally designated **54**, and includes a frame of rectangular formation, said frame being disposed in an inclined plane corresponding to the inclination of the members **26**. The frame of the bellows includes transversely extending end members **58**, **60** and elongated longitudinal side members **56**. The frame of the bellows is disposed between and is fixedly secured to the members **26** of the support frame. This is shown clearly in Figure 4, and as will be noted from this figure of the drawing, the side edge portions of the belt are slidably supported upon the top surfaces of the members **56** in full contact therewith.

The bellows includes a back plate **62**, hingedly connected at one end **64** to end member **58**, with the axis of swinging movement of the plate **62** extending horizontally, in parallel relation to the shafts **32**, **34**. Plate **62** swings between the full and dotted line positions of Figure 2, and secured to the free end and to the sides of the plate **62** is a collapsible wall **66**, having accordion pleats and so connected to the plate **62** as to prevent leakage between the wall **66** and the edges of the plate **62**. The top edges of the wall **66** are secured to the side members **56** and to the end member **60** of the bellows frame.

It will thus be seen from the description so far provided that when the bellows is contracted, air previously accumulating therein will be forced upwardly through the bellows frame and through the porous material of the belt, in a direction shown by the arrows in Figure 2.

Means is provided for operating the bellows automatically, and to this end there is provided a cross member **68** secured to the underside of plate **62** and carrying spaced, depending eyes **72** through which extends a transversely disposed rod **70** the ends of which are rotatably engaged in the lower end portions of elongated, straight, upwardly extending yoke arms **74** secured at their upper ends to a bight portion **76**, the arms **74** and bight portion **76** forming a yoke of inverted U-shape straddling the belt and bellows.

Medially between its ends portion **76** is secured to the lower end of a short connecting bar **78**, the upper end of which has a transverse opening receiving a crank **80** formed on a shaft **82** medially between the ends of the shaft. Shaft **82** is journaled in the top rails **24**, and at one

end projects beyond one side of the support frame, being there connected to a large pulley **84**, about which is trained a belt **86** trained also about a smaller pulley **88** carried by a stub shaft **90** mounted in a bearing **91** secured to the support frame (see Figure 2).

Trained about a large pulley **92**, said pulley **92** being rotatable with pulley **88**, is a drive belt **94** extending downwardly from pulley **92** and trained about a small drive pulley **96** (see Figure 3) mounted upon the shaft **98** of a drive motor **100** secured to a motor support bracket **102**, that is rigidly attached to and projects laterally outwardly from the support frame.

Thus, drive means is provided for the bellows, which drive means includes a motion translating connection that converts rotary motion into a pivotal movement of the plate **62**, whereby to alternately contract and expand the bellows. A valve **126** is mounted over an air inlet in the back plate **62** and is gravity actuated to a closed position and openable upon creation of a partial vacuum in the bellows **54**.

The porosity of the riffle belt is selected of a value such that the material M deposited thereon will not be drawn through the interstices of the belt when the bellows is expanding. However, air of course can be drawn through said interstices, on expansion of the bellows and will subsequently be forced in a return direction upwardly through the belt so as to lift lighter substances provided in the material M that is being acted upon.

Generally designated at **104** is a hold-down or sealing assembly, which serves to firmly engage the riffle belt along the opposite sides thereof against the side members **56** of the bellows frame, thus to form a seal between the belt and the bellows frame whereby all air forced out of the bellows will be directed through the interstices of the belt.

Assembly **104** includes elongated hold-down bars **106** inclined correspondingly to the top flight of the belt and resting upon the taped side edge portions of the belt as shown in Figure **4**. Tapes **42**, of course, are of a flexible and a compressible material, so that in effect they form gaskets at the sides of the belt which compress slightly under the weight of the bars **106** to provide an effective seal.

Fixedly secured at their lower ends to the intermediate portions of hold-down bars **106** are upwardly extending arms **108** of a yoke that includes also a transversely extending bight portion **110** the intermediate portion of which seats in a downwardly opening notch **112** of an elongated weight support arm **114** pivoted at one end on a cross bar **116** that extends between the top rails **124**. An upwardly opening notch **118** formed in the other end of arm **114** receives a hook **120** of a weight **122**. Thus, arm **114** is continuously biased downwardly about its pivot axis, bearing firmly against the yoke, which in turn causes the hold-down bars **106** to be pressed firmly against the sides of the conveyor or riffle belt.

In use of the device, the material to be separated into concentrate and tailings is deposited upon the top flight of the belt, adjacent the head end thereof. The material should preferably be deposited upon the belt to a thickness, which is maintained uniformly throughout the operation of the machine, of approximately ¾ inch, with the material being heavily coated in this manner upon the belt over the full portion of the belt that overlies the bellows frame.

The machine is placed in operation and the bellows will alternately expand and contract, with the riffle belt remaining stationary at the time the bars **106** are pressed firmly thereagainst. In other words, the belt **38** is stationary while there is an air seal between said belt and the bellows frame. It may be noted that the belt **38** has a step-by-step advancement, and each time it comes to rest, inner cleats **46** thereof will be disposed in contact with the end members **58**, **60** of the bellows frame

as shown in Figure 2, forming a seal at the ends as well as at the sides of the bellows frame.

When the air is forced upwardly on contraction of the bellows, it will pass through the foraminous belt, and will lift the lighter materials and, for that matter, some of the heavier materials as well. The materials will be blown upwardly to a slight extent, and the lighter materials will of course be blown upwardly to a further degree and will attempt to travel downwardly along the inclined top flight of the belt to be discharged as tailings T (Figure 2) from the lower end of the belt. The heavier materials immediately settle back onto the belt, however, and periodically the machine operator lifts the weight or hold-down means slightly, and imparts a one-step advancement to the belt, so that the heavier substances are carried beyond the roller **30** and drop into the receiver R as concentrate. Quite possibly, the step-by-step advancement of the belt might be effected without elevating the hold-down bars, since the pressure of said bars against the belt ordinarily would not be so great as to prevent all movement whatsoever of the belt.

In any event, the operation continues, with the top flight of the belt having the material M of uniform depth thereon. The light materials are so acted upon as to tend to settle towards the lower end of the belt, while the heavier materials remain between the cleats or riffles at all times and will be carried off the higher or discharge end of the belt.

In this way, a substantial amount of concentrate may be accumulated, in a relatively short time, from materials in areas in which there is no water. A great amount of acreage falls in this category and heretofore it has not been commercially feasible to effect separation of the matter previously described herein in such instances, due to the lack of machines that would operate efficiently and at a cost sufficiently low to justify commercial activities. With the present machine these difficulties are obviated, and rapid and efficient processing of the ore is effected, at a very low cost, without the use of any water or equivalent substances.

It is believed apparent that the invention is not necessarily confined to the specific use or uses thereof described above, since it may be utilized for any purpose to which it may be suited. Nor is the invention to be necessarily limited to the specific construction illustrated and described, since such construction is only intended to be illustrative of the principles of operation and the means presently devised to carry out said principles, it being considered that the invention comprehends any minor change in construction that may be permitted within the scope of the appended claims.

What is claimed is:

1. Apparatus for separating comminuted materials according to the relative specific gravities of its components, comprising: a frame; an endless, air-previous belt movably mounted thereon in position for supporting on one flight of the belt the material to be separated; means on the frame arranged for directing air upwardly through said flight through the supported materials for dividing the same into a concentrate and tailings having a specific gravity substantially less than that of the components of the concentrate, comprising a bellows supported by the frame in juxtaposition to said flight and formed wholly open at its top, said one flight of the belt extending over the open top of the bellows as a closure therefor; and hold-down means movably mounted on the frame extending in overlying relation to opposite side edge portions of said one flight of the belt and exerting a pressure downwardly thereagainst sealably engaging said side edge portions with opposite sides of the bellows, comprising a pair of hold-down bars extending in contact with the opposite side edge portions of said one flight of the belt, a yoke extending upwardly from and connecting said hold-down bars, a pivoted arm carried by the frame and swingable downwardly into contact with the yoke, and weight means on the pivoted arm tending to urge the same in a downward direction, thus to exert a pressure downwardly against the yoke for frictionally binding the hold-down bars against said one flight of the belt.

2. Apparatus for separating comminuted materials according to the relative specific gravities of its components, comprising: a frame; an endless, air-pervious belt movably mounted thereon in position for supporting on one flight of the belt the material to be separated; means on the frame arranged for directing air upwardly through said flight through the supported materials for dividing the same into a concentrate and tailings having a specific gravity substantially less than that of the components of the concentrate, comprising a bellows supported by the frame in juxtaposition to said flight and formed wholly open at its top, said one flight of the belt extending over the open top of the bellows as a closure therefor; and hold-down means movably mounted on the frame extending in overlying relation to opposite side edge portions of said one flight of the belt and exerting a pressure downwardly thereagainst sealably engaging said side edge portions with opposite sides of the bellows, comprising a pair of hold-down bars extending in contact with the opposite side edge portions of said one flight of the belt, a yoke extending upwardly from and connecting said hold-down bars, a pivoted arm carried by the frame and swingable downwardly into contact with the yoke, and weight means on the pivoted arm tending to urge the same in a downward direction, thus to exert a pressure downwardly against the yoke for frictionally binding the hold-down bars against said one flight of the belt, the bellows including at its open top a frame contacted at the sides and ends thereof by said one flight of the belt, said hold-down bars overlying the opposite sides of the bellows frame for binding the side edge portions of said one flight of the belt against said sides of the bellows frame.

3. Apparatus for separating comminuted materials according to the relative specific gravities of its components, comprising: a frame; an endless, air-pervious belt movably mounted thereon in position for supporting on one flight of the belt the material to be separated; means on the the frame arranged for directing air upwardly through said flight through the supported materials for dividing the same into a concentrate and tailings having a specific gravity substantially less than that of the components of the concentrate, comprising a bellows supported by the frame in juxtaposition to said flight and formed wholly open at its top, said one flight of the belt extending over the open top of the bellows as a closure therefor; and hold-down means movably mounted on the frame extending in overlying relation to opposite side edge portions of said one flight of the belt and exerting a pressure downwardly thereagainst sealably engaging said side edge portions with opposite sides of the bellows, comprising a pair of hold-down bars extending in contact with the opposite side edge portions of said one flight of the belt, a yoke extending upwardly from and connecting said hold-down bars, a pivoted arm carried by the frame and swingable downwardly into contact with the yoke, and weight means on the pivoted arm tending to urge the same in a downward direction, thus to exert a pressure downwardly against the yoke for frictionally binding the hold-down bars against said one flight of the belt, the bellows including at its open top a frame contacted at the sides and ends thereof by said one flight of the belt, said hold-down bars overlying the opposite sides of the bellows frame for binding the side edge portions of said one flight of the belt against said sides of the bellows frame, the belt including compressible strips along said side edge portions thereof interposed between the hold-down bars and the respective sides of the bellows frame, and compressible responsive to downward pressure of the hold-

down bars thereagainst, whereby to provide a seal at opposite sides of the belt between the same and the bellows frame.

4. Apparatus for separating comminuted materials according to the relative specific gravities of its components, comprising: a frame; an endless, air-pervious belt movably mounted thereon in position for supporting on one flight of the belt the material to be separated; means on the frame arranged for directing air upwardly through said flight through the supported materials for dividing the same into a concentrate and tailings having a specific gravity substantially less than that of the components of the concentrate, comprising a bellows supported by the frame in juxtaposition to said flight and formed wholly open at its top, said one flight of the belt extending over the open top of the bellows as a closure therefor; and hold-down means movably mounted on the frame extending in overlying relation to opposite side edge portions of said one flight of the belt and exerting a pressure downwardly thereagainst sealably engaging said side edge portions with opposite sides of the bellows, comprising a pair of hold-down bars extending in contact with the opposite side edge portions of said one flight of the belt, a yoke extending upwardly from and connecting said hold-down bars, a pivoted arm carried by the frame and swingable downwardly into contact with the yoke, and weight means on the pivoted arm tending to urge the same in a downward direction, thus to exert a pressure downwardly against the yoke for frictionally binding the hold-down bars against said one flight of the belt, the bellows including at its open top a frame contacted at the sides and ends thereof by said one flight of the belt, said hold-down bars overlying the opposite sides of the bellows frame for binding the side edge portions of said one flight of the belt against said sides of the bellows frame, the belt including compressible strips along said side edge portions thereof interposed between the hold-down bars and the respective sides of the bellows frame, and compressible responsive to downward pressure of the hold-down bars thereagainst, whereby to provide a seal at opposite sides of the belt between the same and the bellows frame, the belt including cleats uniformly spaced therealong and extending transversely of the belt, said cleats being on the inside surface of the belt and being so spaced as to dispose the same, in selected positions to which the belt is moved upon the support frame, in contact with opposite ends of the bellows frame, whereby to provide a seal between the belt and bellows frame at the ends of the bellows frame.

5. Apparatus for separating comminuted materials according to the relative specific gravities of its components, comprising: a frame; an endless, air-pervious belt movably mounted thereon in position for supporting on one flight of the belt the material to be separated; means on the frame arranged for directing air upwardly through said flight through the supported materials for dividing the same into a concentrate and tailings having a specific gravity substantially less than that of the components of the concentrate, comprising a bellows supported by the frame in juxtaposition to said flight and formed wholly open at its top, said one flight of the belt extending over the open top of the bellows as a closure therefor; and hold-down means movably mounted on the frame extending in overlying relation to opposite side edge portions of said one flight of the belt and exerting a pressure downwardly thereagainst sealably engaging said side edge portions with opposite sides of the bellows, comprising a pair of hold-down bars extending in contact with the opposite side edge portions of said one flight of the belt, a yoke extending upwardly from and connecting said hold-down bars, a pivoted arm carried by the frame and swingable downwardly into contact with the yoke, and weight means on the pivoted arm tending to urge the same in a downward direction, thus to exert a pressure downwardly against the yoke for frictionally binding the hold-down bars against said one flight of the belt, the bellows including at its open top a frame contacted at the sides and ends thereof by said one flight of the belt, said hold-down bars overlying the opposite sides of the bellows frame for binding the side edge portions of said one flight of the belt against said sides of the bellows frame, the belt including compressible strips along said side edge portions thereof interposed between the hold-down bars and the respective sides of the bellows frame, and compressible responsive to downward pressure of the hold-down bars thereagainst, whereby to provide a seal at opposite sides of the belt between the same and the bellows frame, the belt including cleats uniformly spaced therealong and extending transversely of the belt, said cleats being on the inside surface of the belt and being so spaced as to dispose the same, in selected positions to which the belt is moved upon the support frame, in contact with opposite ends of the bellows frame, whereby to provide a seal between the belt and bellows frame at the ends of the bellows frame, said one flight of the belt, the hold-down bars, and said bellows frame being inclined from the horizontal for gravitation of the tailings along said one flight toward the lower end thereof for discharge from the belt at the lower end of the belt.

6. Apparatus for separating comminuted materials according to the relative specific gravities of its components, comprising: a frame; an endless, air-pervious belt movably mounted thereon in position for supporting on one flight of the belt the material to be separated; means on the frame arranged for directing air upwardly through said flight through the supported materials for dividing the same into a concentrate and tailings having a specific gravity substantially less than that of the components of the concentrate, comprising a bellows supported by the frame in juxtaposition to said flight and formed wholly open at its top, said one flight of the belt extending over the open top of the bellows as a closure therefor; and hold-down means movably mounted on the frame extending in overlying relation to opposite side edge portions of said one flight of the belt and exerting a pressure downwardly thereagainst sealably engaging said side edge portions with opposite sides of the bellows, comprising a pair of hold-down bars extending in contact with the opposite side edge portions of said one flight of the belt, a yoke extending upwardly from and connecting said hold-down bars, a pivoted arm carried by the frame and swingable downwardly into contact with the yoke, and weight means on the pivoted arm tending to urge the same in a downward direction, thus to exert a pressure downwardly against the yoke for frictionally binding the hold-down bars against said one flight of the belt, the bellows including at its open top a frame contacted at the sides and ends thereof by said one flight of the belt, said hold-down bars overlying the opposite sides of the bellows frame for binding the side edge portions of said one flight of the belt against said sides of the bellows frame, the belt including compressible strips along said side edge portions thereof interposed between the hold-down bars and the respective sides of the bellows frame, and compressible responsive to downward pressure of the hold-down bars thereagainst, whereby to provide a seal at opposite sides of the belt between the same and the bellows frame, the belt including cleats uniformly spaced therealong and extending transversely of the belt, said cleats being on the inside surface of the belt and being so spaced as to dispose the same, in selected positions to which the belt is moved upon the support frame, in contact with opposite ends of the bellows frame, whereby to provide a seal between the belt and bellows frame at the ends of the bellows frame, said one flight of the belt, the hold-down bars, and said bellows frame being inclined from the horizontal for gravitation of the tailings along said one flight toward the lower end thereof for

discharge from the belt at the lower end of the belt, the belt being mounted upon the support frame for movement of said one flight in a direction toward the higher end thereof, whereby to effect discharge from said concentrate from the higher end of the said one flight responsive to advancement of the belt at selected intervals.

7. Apparatus for separating comminuted materials according to the relative specific gravities of its components, comprising: a frame; an endless, air-pervious belt movably mounted thereon in position for supporting on one flight of the belt the material to be separated; means on the frame arranged for directing air upwardly through said flight through the supported materials for dividing the same into a concentrate and tailings having a specific gravity substantially less than that of the components of the concentrate, comprising a bellows supported by the

frame in juxtaposition to said flight and formed wholly open at its top, said one flight of the belt extending over the open top of the bellows as a closure therefor; and means for effecting expansion and contraction of the bellows comprising a crank shaft journaled on the frame, means mounted upon the frame for rotating said crank shaft, and a yoke connected to the crank shaft and to said bellows, whereby to be given back and forth movement responsive to rotation of the crank shaft tending to alternately expand and contract the bellows.

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