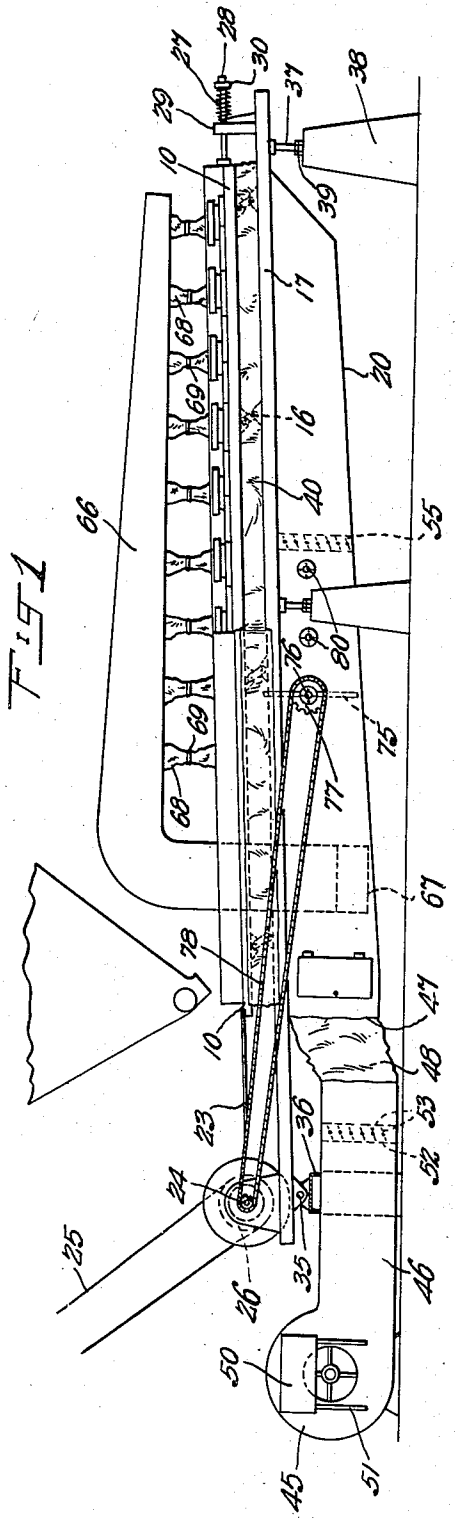
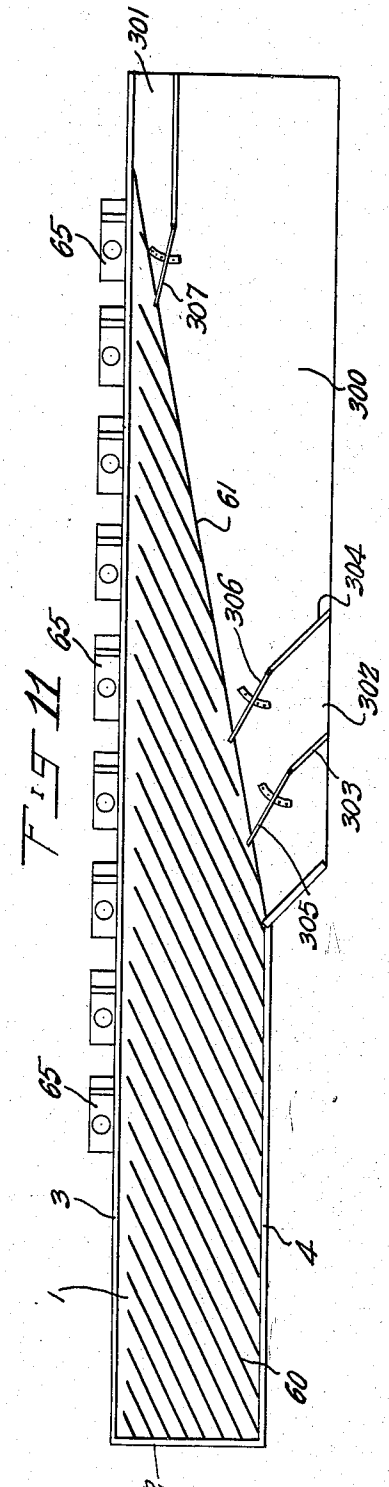
May 14, 1935. R. PEALE, JR 2,001,331

PROCESS AND MECHANISM FOR SEPARATING INTERMIXED DIVIDED MATERIALS

Original Filed Sept. 23, 1930 4 Sheets-Sheet 1



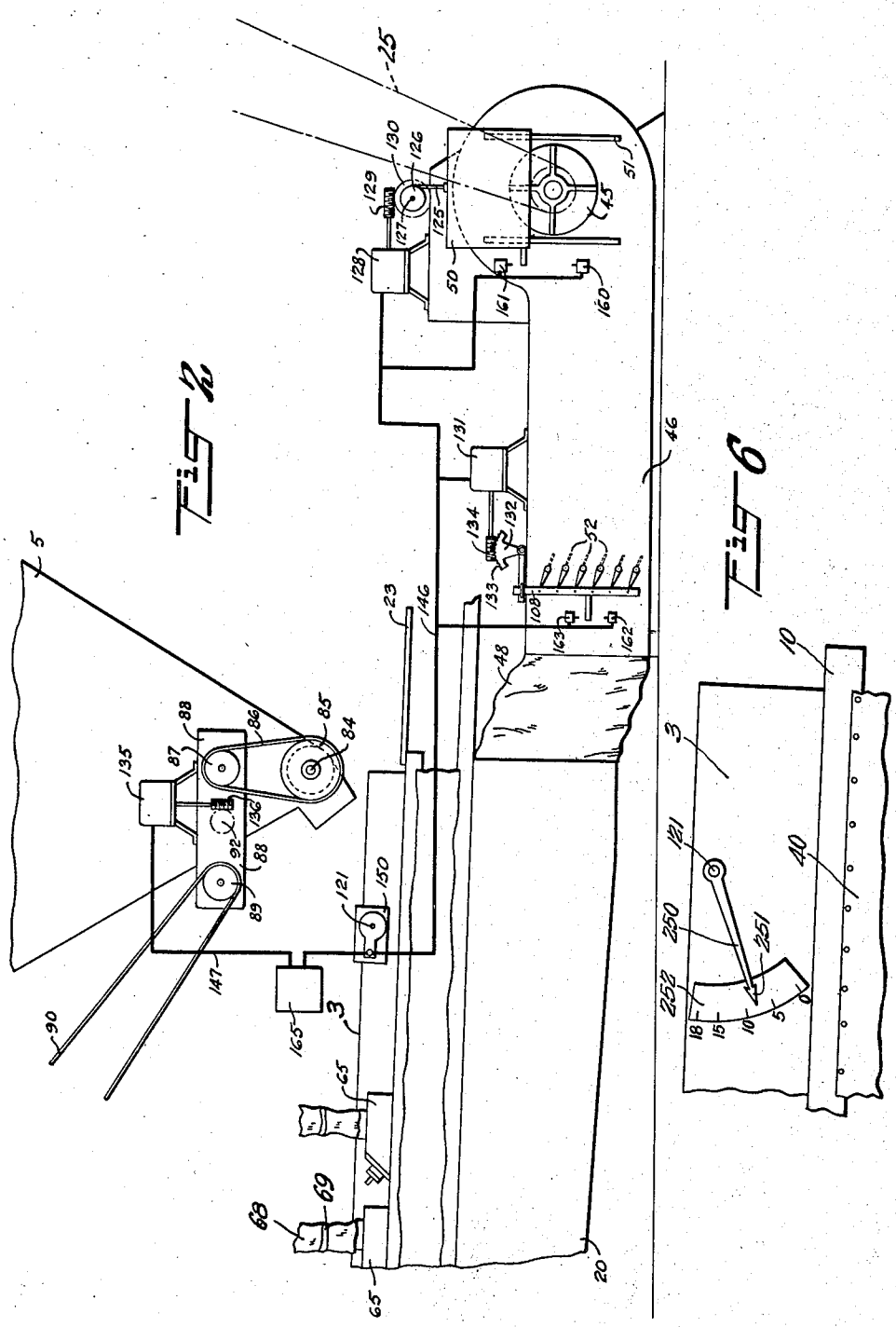


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PROCESS AND MECHANISM FOR SEPARATING INTERMIXED DIVIDED MATERIALS

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Fig 3

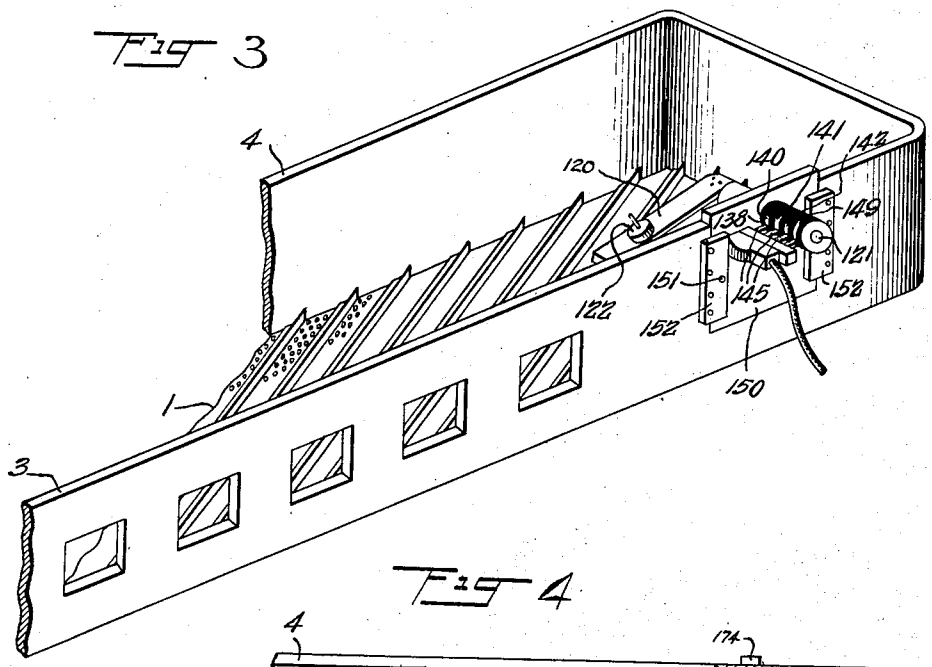


Fig 4

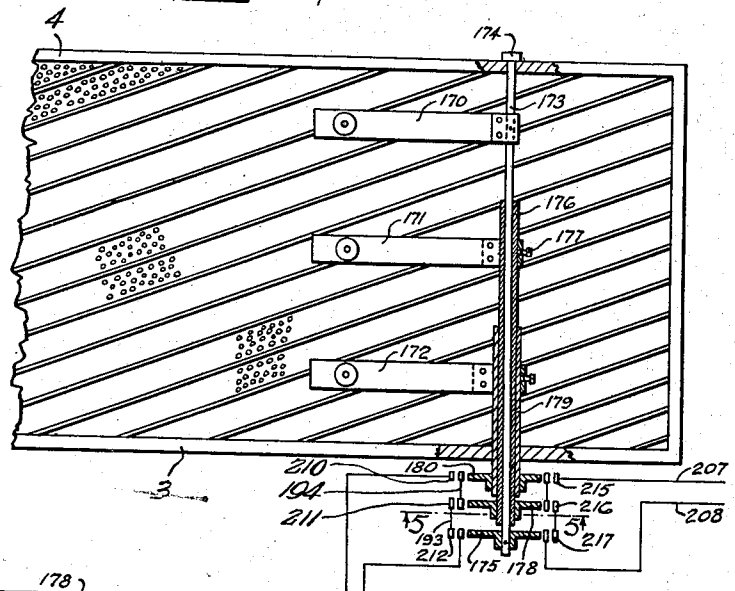
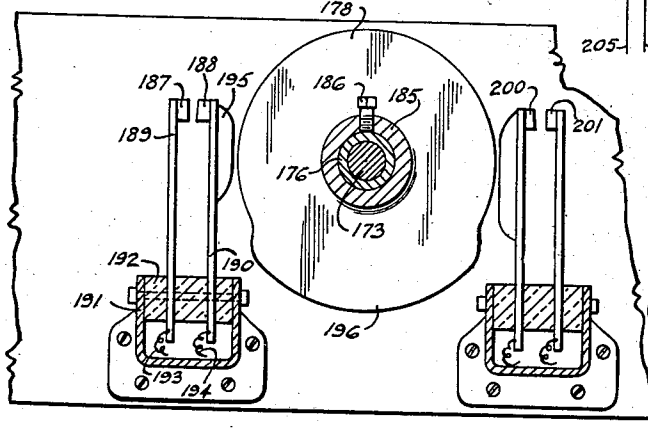


Fig 5



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PROCESS AND MECHANISM FOR SEPARATING INTERMIXED DIVIDED MATERIALS

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Fig 7

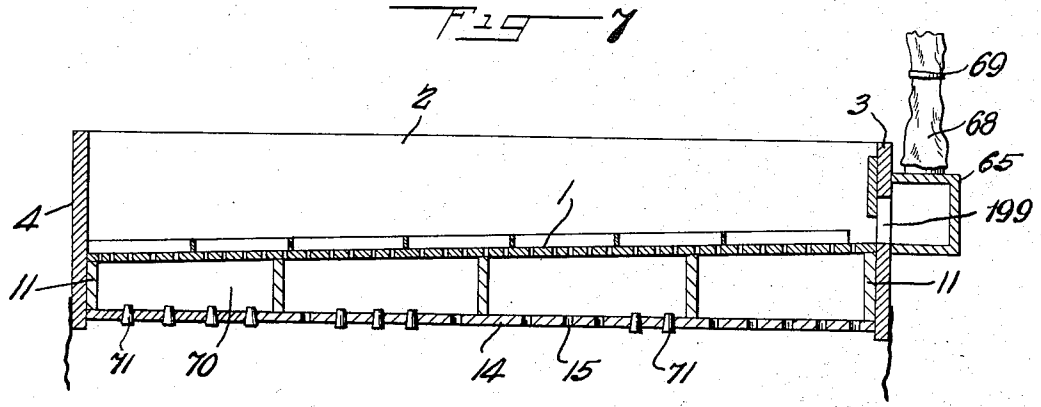


Fig 8

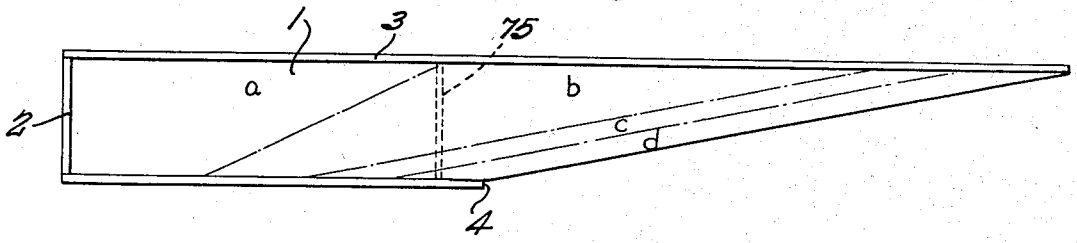
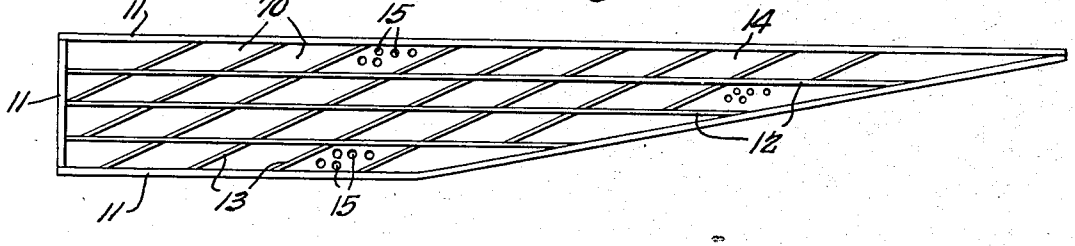


Fig 9



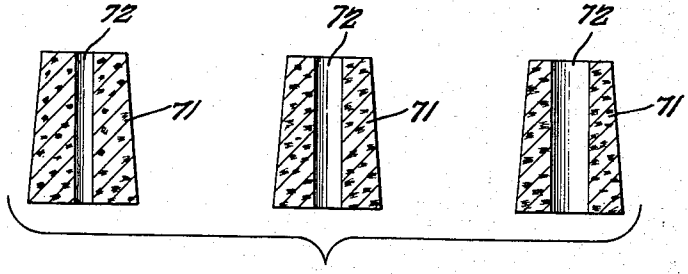


Fig 10

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PROCESS AND MECHANISM FOR SEPARATING INTERMIXED DIVIDED MATERIALS

Rembrandt Peale, Jr., St. Benedict, Pa., assignor, by mesne assignments, to Peale-Davis Company, Wilmington, Del., a corporation of Delaware

Application September 23, 1930, Serial No. 483,856. Renewed September 27, 1934. In Germany December 7, 1929

10 Claims. (Cl. 209—467)

The invention relates to a novel and useful process and mechanism for separating intermixed divided materials and especially to such a process for purifying unsized coal or the like wherein the pieces and particles vary relatively greatly in size but relatively little in their specific gravities.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the instrumentalities and combinations pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations and improvements herein shown and described.

The accompanying drawings, referred to herein and constituting a part hereof, illustrate one embodiment of the invention, and together with the description, serve to explain the principles of the invention.

Of the drawings:—

Fig. 1 is a partly diagrammatic side elevation of a coal-cleaning table embodying the invention;

Fig. 2 is an enlarged, fragmentary, and partially diagrammatic elevation of the rear portion of such a table showing an automatic control system;

Fig. 3 is a fragmentary perspective of the rear end of a cleaning table equipped with automatic control devices;

Fig. 4 is a fragmentary top plan showing a modified form of the mechanism of Fig. 3;

Fig. 5 is a fragmentary detail, in elevation, of the mechanism shown in Fig. 4;

Fig. 6 is a view similar to Fig. 5, showing a bed-depth indicating device;

Fig. 7 is a transverse, vertical section of a separating deck showing sub-areal chambers;

Fig. 8 is a plan of a deck showing one air-zoning layout;

Fig. 9 is a view similar to Fig. 8 with the pervious deck surface removed;

Fig. 10 is a detail showing vertical sections of a plurality of air-control stoppers; and

Fig. 11 is a top plan of a separating deck.

The invention pertains broadly to the separation of intermixed, divided materials, the term "divid d" being used to designate broken, fragmentary, granular, pulverulent or other materials comprising separated parts or pieces of different kinds of material. The invention in its novel features is more particularly directed, however, to effecting automatic separation, to practically the ultimate degree of possible efficiency of such mixtures of materials wherein the various pieces of the different kinds of materials vary relatively very greatly in size, while varying relatively little in their specific gravities.

One kind of intermixed divided materials which the invention is especially capacitated to successfully separate, is a mixture of coal, "bony" and rock, with the other impurities usually present in the coal, as it comes from the mine, that is, "run-of-mine" coal, except that the large lumps, say from seven inches up are crushed, although this crushing is not necessary even up to pieces ten inches in size. Usually, however, it is simpler to remove a few large chunks of coal and rock than to run them over separating tables. The rock and other impurities are separated from the "run-of-mine" coal by the present invention entirely automatically, on a single cleaning table, and without previous sizing of the materials, except as to said crushing or removing the very largest lumps, the practically perfect separation being effected down through the finest dust of the intermixed materials.

In common with other known separating processes, such as those disclosed in prior copending applications of Kenneth Davis, Richard Peale and myself (for example the application of Richard Peale, Ser. No. 389,722, filed August 31, 1929), in the preferred embodiment and practice of the invention a relatively deep bed of the intermixed materials is maintained in substantially continuous progression along a transversely inclined, air-pervious table, which is reciprocated, preferably in the direction of its length. Lifting and loosening air currents are passed upwardly through the bed to loosen the particles apart and to effect their stratification by fluidizing the bed, whereby the heavier and lighter materials stratify substantially according to their specific gravities, the heavy impurities gradually and progressively sinking through the unsized, fluidized bed, while the coal is floated and forms a progressively purifying superior stratum. The settled heavy impurities are directed and impelled to the upper side edge of the bed and to discharge therefrom in direct, short and non-cumulative paths, substantially as soon as they settle, by a series of transversely-disposed, separating partitions, while the flotant stratum of coal progresses freely forwardly along the table to discharge at the front end thereof.

In many cases the bed of materials so treated upon the separating table undergoes a concurrent or simultaneous sizing action, whereby the

flotant stratum of coal is classified according to size transversely of its direction of progression, whereby the larger coal pieces gradually work toward the upper and outer side of the bed, while the fines congregate along the inner and lower side thereof. One feature of my invention relates to a method and means for effecting complete ultimate purification of all sizes of the coal stratum when the described sizing action occurs.

One of the principal objects of my invention is to provide a novel and useful process and mechanism whereby the separating forces may be automatically controlled and varied substantially in accordance with the nature and changing characteristics of the materials being treated. As disclosed in the copending application of Richard Peale, Ser. No. 389,722, filed August 31, 1929, the material fed to the bed undergoing separation may change in its characteristics from time to time and these changes require corresponding variations in the separating forces. For example, one of the most frequent and disturbing variations in run-of-mine coal from a given mine or source is that which occurs in the moisture content of the coal. In some mines the seam of coal is alternately dry and wet due to subterranean springs, so that the moisture-content of the coal may vary greatly almost momentarily. Another factor which varies frequently and has a great effect upon the separating action, is the relative quantity of fine material in the raw coal. For example, the coal loaded during the morning hours frequently contains a relatively high proportion of fines from the machine cuttings of the previous night, while the afternoon run of coal consists more largely of shot-down coal wherein the proportion of large lumps is greater.

Both the moisture content and the fines content are important factors in determining the separating forces required. For example, the air force necessary to adequately stratify a given quantity of coal which is relatively high in moisture and/or fines content, is relatively much greater than the air force for performing the same amount of work in a bed where the coal is dry and/or the fines content is relatively less. Especially when the moisture content is relatively high, the bed will tend to pack and form a cohesive and non-fluidized mass which slides along the table without properly stratifying. Accordingly, the amount of moisture and/or fines is quite accurately reflected by the relative depth of the bed because when the moisture content or the fines content increases even slightly, the bed will tend to compact and become thicker unless more air force is supplied to stratify it. In some cases, where the moisture content in the raw coal becomes excessive, the bed has been known to pile up beneath the feed hopper in an immobile heap several feet deep.

As disclosed in the said application of Richard Peale, Ser. No. 389,722, it is desirable to control the amount and distribution of air supplied to the bed of materials on the table in accordance with changes in the depth of the bed, and to also alternatively or conjunctively control the amount of material which is fed to the bed so as to vary the bed depth and thereby effectively control the air action. In said application of Richard Peale, manually operated means are shown for conjunctively or independently controlling the air supply and the feed of the material in accordance with observed changes in the depth of the bed due to variations in the characteristics of the material.

My present invention provides an improved method and mechanism for automatically controlling the separating forces in accordance with changes in the characteristics of the material, particularly as such changes affect the bed depth. More specifically, my invention provides means for automatically determining changes in the bed depth and means for automatically controlling the air supply and distribution and the feed of the materials to automatically vary the separating forces to counteract and take care of such changes. In the present preferred embodiment, I provide a pivoted arm or float which lies on the bed and is responsive to variations in the depth thereof, said float being operatively connected with control mechanisms for the air supply devices and material feeding means, whereby the movements of the float are transmitted to and control the operation of said air supply and feeding means.

It will be understood that the foregoing general description and the following detailed description as well are exemplary and explanatory of the invention but are not restricted thereon.

Referring now in detail to the embodiment of the invention illustrated by way of example in the accompanying drawings, an air-pervious table or deck 1 is provided, which is rendered air-pervious in any suitable way, and may consist of perforated metal sheets, the relative areas of the perforations and the solid portions determining the degree of air-perviosity, and variations made in these relative areas affording means for zoning or varying the degree of air-perviosity in different parts of the table. As shown in Fig. 8, the perviosity of the deck may decrease forwardly in zones *a*, *b*, *c* and *d*, although this arrangement may be varied as desired.

The table is mounted for longitudinal reciprocation through a relatively short path, over a stationary air chamber from which are supplied the air currents which are forced upwardly through the bed. As embodied, the walls, 2, 3 and 4 extend downwardly below the table surface and are attached on their outer sides to a supporting frame 10, which preferably consists of angle beams fastened together at the corners of the table structure. The air-pervious deck 1 is supported by means of an inner box-like frame 11 fixed on the inner sides of the retaining walls 2, 3 and 4. A series of longitudinally extending supporting beams 12 divide the frame 11 longitudinally and serve to support the intermediate portions of the deck. The deck is also supported by a series of cross-beams 13, extending transversely of the beams 11 and serving to divide the space beneath the deck into a plurality of relatively small, mutually isolated sub-chambers 70. The beams 11 and 12 rest upon a sub-deck or partition 14 which is fixed to the bottom edges of the inner frame 11. The sub-deck 14 is apertured with a plurality of spaced-apart perforations 15, and this sub-deck, together with the chambers formed by the beams 11 and 12, comprises a part of the air current control system which will be later described.

The means for reciprocably mounting the table upon the stationary air chamber, as embodied, comprises a plurality of supporting arms or links 16, arranged at intervals along either side of the supporting frame 10 of the reciprocable table, these arms 16 being pivotally connected to the frame 10 at their upper ends, and at their lower ends are pivotally mounted in the longitudinally-disposed, stationary side members 17 of the top

frame of the air chamber proper. The air chamber 20 is non-reciprocable, but may be longitudinally variably inclinable together with the table itself, as will be later described. The pivotally-connected supporting arms 16 are upwardly and backwardly inclined, whereby the short reciprocating movement of the table is upward and forward and downward and rearward. In addition, the movement of the table is relatively slow upwardly and forwardly and relatively quick backwardly and downwardly.

The means for effecting a reciprocatory movement of the table may be of any known or suitable form. As embodied, a connecting rod or pitman 23 is connected to the rear end of the table frame 10. This rod may be driven by any suitable reciprocating mechanism, such as an eccentric on the drive shaft 24. The shaft 24 may be connected to any suitable driving means, as by the belt 25 running on drive pulley 26. The table drive may embody a regenerative feature, such as the springs 27, which are slidable on rods 28 attached to the forward end of the table. The rods are adapted to reciprocate through apertures in the stationary member 29, upstanding from the forward end of the frame 17 of the air chamber, and have nuts 30 screw-threaded on their forward ends for compressing the springs against the member 29. This mechanism serves to pull the table forwardly and upwardly, at the end of the rearward and downward strokes effected by the reciprocating drive. The springs 27 also serve as buffers to take up the shock of the table movement.

The reciprocable table, and the non-reciprocable air chamber, are longitudinally tiltable to vary the longitudinal inclination of the table. As embodied, the rear end of the upper frame-work 17 of the air chamber is pivotally mounted at 35 on the fixed support 36, while the intermediate and forward portions of the frame are pivotally supported on downwardly extending screw rods 37, which are in turn pivotally mounted on fixed supporting pillars 38. Nuts 39 are screw-threaded on rods 37 and bear against the upper side of the pillars 38. By turning these nuts at the various points along both sides of the structure, the longitudinal inclinations of the table may be varied as desired. Suitable mechanism (not shown) may be provided for varying the transverse inclination of the table, which normally is higher on the outer side 3 adjacent the refuse discharge devices (Fig. 7). The devices for varying the transverse inclination of the table may be of any known or suitable form, as for instance the mechanism shown in the copending application of Richard Peale and Kenneth Davis, S. N. 283,600, filed June 7, 1928.

The embodied means for providing the lifting air currents and for forcing them through the bed of materials comprises a stationary air chamber 20, which is suspended from a frame of I-beams 17. The stationary air chamber and the reciprocable table are connected together by a flexible air-impervious member such as a canvas juncture 40.

The air currents may be supplied by any suitable means, such as a rotary fan 45 which supplies the air current through a duct 46 into the rear end 47 of the stationary air chamber. The duct 46 and the air chamber may be connected by flexible air-tight means 48, to permit of the angular movement of the air chamber in regulating the inclinations of the table as already described.

Means for primarily regulating the general supply of air to the table may be utilized in carrying out the invention and, as embodied, comprise shrouds or veils 50 slidably mounted on tracks 51 at the fan inlet, and variably positionable to regulate the amount of air supplied to the fan and thence to the air chamber 20. Another form of means for varying the entire air supply to the table, and which may be used either together with the fan veils 50 or as a separate and alternative means, comprises an air-regulating valve or shutter device 52, preferably mounted in the air duct 46 adjacent the flexible connection 48. The valve member 52 preferably comprises a plurality of small, pivotally-mounted shutters 53, similar to the ordinary window shutters, positioned in superposed relation across the duct 46, so that the air blast passing through the duct can be minutely controlled in amount. The individual shutters 53 are preferably mounted for simultaneous opening and closing movement and are operable from the outside of the air duct 46. Although other forms of air valves may be used for this purpose, the type shown is preferred because the individual spaced-apart shutters interfere as little as possible with the straight forward passage of the air current, and introduce practically no eddy currents or cross blasts.

A third optional form of means for controlling the general air supply comprises a multiple-shutter valve mechanism 55, which is positioned in the air chamber 20 intermediate the ends of the air-pervious deck 1. The structure and operation of the valve 55 may be substantially identical with that of the valve 52 already described. The position of the valve 55 is variable longitudinally of the air chamber as desired and according to the conditions and requirements of the process.

In the present preferred arrangement of separating partitions upon the surface of the air-pervious deck 1, all of the separating partitions 60 are inclined forwardly and outwardly, that is, toward the longer or outer and upper side of the table as shown in Fig. 11, terminating at or near the bed-retaining wall 3. These separating partitions are parallel to each other and preferably extend at an angle to the oblique or diagonal front coal spillage edge 61 of the table, so as to direct the settled heavier material away therefrom.

The discharge boxes 65 for the rock and other impurities may be of any known or suitable form such as is shown in copending application Ser. No. 283,600, above-referred to, and they are here shown more or less conventionally. These boxes will be located at proper points along the table, will be connected through variably-sized openings 199 in the bed-retaining wall 3, and have the operations and functions described in said application. Likewise as shown in said application, a header 66 is provided above and alongside the deck, being supplied with air by opening 67 in the side wall of the air chamber, having individual flexible air connections 68 with the various refuse discharge boxes 65 and being provided with air current regulating devices 69.

The regulation of the air-lifting forces in the different parts of the bed may be facilitated and rendered more effective by other forms of air-regulating means capacitated to cooperate with the deck zoning mechanism already described. With certain types of coals, it will be found most effective to control the general supply of air to the entire air chamber, so that the lifting force of the air currents can be made very much lower

than that formerly used in separating tables such, for instance, as that shown and described in copending application of Richard Peale, Ser. No. 387,397, filed August 21, 1929.

The embodied means for effecting the desired general reduction and control of the air supply, preferably comprises the veils **50**, mounted at the air supply inlet for the fan **45**. By raising or lowering these veils as required, the total supply of air to the chamber **20** can be closely regulated. Another way of accomplishing the same function is to provide the fan drive with change speed mechanism, and changing the speed of the fan as required. This method has the added advantage of saving power when a low air force is desired.

Another mechanism for effecting substantially the same result comprises the multiple shutter valve **52**, positioned in the air duct **46**. By simultaneously actuating the individual shutters **53**, the total air supply to the chamber **20** may be accurately controlled, independently of or in conjunction with the fan control.

The multiple shutter valve **55**, located medianly of the table may be optionally employed to cut down the air supply to the forward portion of the table and to correspondingly augment the air pressure in the rear portion of the table. It will be understood that the longitudinal position of the valve **55** is not fixed, but may be varied as desired by sliding it along the air chamber on suitable trackways. By virtue of the air valve **55**, the relative change of pressure between the rear and forward portions of the table may be made very abrupt or pronounced and may be flexibly regulated as desired. It will be understood that the air valve **55** may be employed independently of or in conjunction with the hereinbefore described means for regulating the general supply of air to the table. With some types of coal, the rear portion of the bed will be best treated by receiving the full blast of air from the fan, reductions in the general supply of air to the forward portion of the table being accomplished solely by the shutter **55**, cooperating with the zoning of the deck. Under other conditions, the shutter **55** may be used in conjunction with the hereinbefore-described fan supply control and/or the shutter **52**, so as to further influence the reduction of air pressure in the forward portion of the chamber **20**.

Still another means for controlling the air currents in the different parts of the bed and also generally throughout the table, comprises means for creating pulsations in the air currents. As embodied, the rotatable shutter **75**, which is variably positionable longitudinally of the air chamber **20**, serves to create pulsations in the air current supplied to the bed, and when located longitudinally medianly of the table, causes the air pressure in the rear portion of the air chamber to vary between maximum and intermediate pressure limits, while the air currents in the forward portion of the bed beyond the rotatable shutter vary between the intermediate and minimum pressure limits. The rotatable shutter **75** for creating pulsations in the air currents is optionally employed with any or all of the hereinbefore described means for controlling the air currents.

Means are provided for variably positioning the shutter shaft, comprising spaced apart hub bearings **80** in either side wall of the air chamber **20**. The embodied means for rotatably driving the shutter **75** comprises a sprocket wheel **77** keyed to the shaft **76** and driven by a chain **78** from the main table drive shaft **24**.

Referring now to the means for flexibly and independently controlling the air action in relatively small and localized sub-areas of the bed, a preferred embodiment thereof is shown in Figs. 7, 9 and 10. As described, the space between the sub-deck **14** and the upper pervious deck **1** is subdivided into a plurality of relatively small and mutually isolated sub-chambers **70** through which the air passes from the main air chamber. As shown, the apertures **15** in the sub-deck are adapted to receive stoppers **71** which plug up the apertures and thereby control the amount of air supplied to the individual chambers **70**.

In accordance with my invention, the supply of air to the sub-chamber **70** is even more nicely and accurately regulated than heretofore, the invention providing for varying the amounts of air supplied to different parts of the sub-chambers and for very finely and accurately controlling the supply of air to any localized area of the deck. As embodied some of the stoppers **71** are themselves apertured, as shown in Fig. 10, being provided with central longitudinal conduits **72** through which air may pass and these conduits may be of different diameters in different stoppers.

By virtue of this construction, it is possible to reduce the amount of air supplied to a sub-chamber **70** to as small amount as desired, without totally blanking or obstructing passage of air therethrough. In many cases, it is desirable to admit a relatively very little amount of air to portions of the bed, although a total dead space must be avoided. For example, when a transverse classifying action takes place and the fines congregate along the lower and inner side of the bed, it is desirable to subject these fines to a relatively very low air pressure so as to enhance the settlement of the fine heavy particles. In prior structures it was difficult to obtain the proper air action among the fine particles because a blanking off of all of the apertures **15** along the lower side of the deck produced a dead area in which no separating action or coal flotation could take place. However, if one or two of the apertures **15** were left open in each sub-chamber **70**, the air would pass therethrough in a relatively very strong and localized jet, so that a succession of areas of too great air action would be interspersed with dead spaces. By use of the apertured stoppers **71**, the amount of air admitted to the sub-chambers along the inner and lower side of the deck may be reduced to as small an amount as required while the distribution thereof may be maintained substantially uniform within any given area.

Furthermore, the action of the air throughout any desired portion of the table may be gradated as nicely as desired to supplement or correct the effect of the major zones *a*, *b*, *c*, and *d* in the pervicus deck **1**. For example, it is frequently desirable to rather radically reduce the air action in the forward portion of the bed, particularly forwardly of the end of the inner wall **4**. As disclosed in application Ser. No. 389,722, of Richard Peale, filed August 31, 1929 and in our joint application Ser. No. 498,016, filed November 25, 1930 such a drastic lowering of the air action is desirable to bring the air pressure into the "low pressure range", whereby the established size classification of the bed may be partially or completely reversed. The reversal of the sizing is desirable in many cases in order to automatically cause

the fines to work towards the outer side of the deck whereby the fine impurities may be more easily discharged.

I have found that it is very difficult to effectively reduce the air action sufficiently to give the desired size reversal by the use of zones of low perviosity in the upper deck 1 alone. The perforated brass sheets of which the deck surface 1 is customarily constructed are not obtainable below a certain perviosity, and the use of any finer mesh would be disadvantageous because of the tendency of the fine particles to clog up and blind the fine perforations. However, by reducing the air supply to the forward portion of the deck by use of the apertured stoppers 71, it is possible to use the standard low-perviosity brass sheeting and still effect the desired reduction in air pressure in the front portion of the bed.

It will be understood that the apertures 72 in the stoppers 71 may be of as many different diameters as desired and that solid stoppers may be used in conjunction therewith when desired.

Referring now to those features of the invention which relate to automatically regulating the air and material supplies according to changes in the depth of the bed of materials on the deck, in the present exemplary embodiment (Figs. 2 to 5) means responsive to variations in the depth of the bed of materials are provided for automatically controlling the actuation of the fan veils or the air-supply valves, and/or the speed-change mechanism on the feed hopper. As embodied, an arm or detector-finger 120 is mounted over the air pervious table near the rear end thereof and extends preferably substantially parallel to the side walls, so as to register variations in the depth of the bed above and below a selectively predetermined normal depth and to automatically transmit said variations to the air and feed-control actuating means. As shown in Fig. 3, the upper or rear end of the arm 120 is mounted to rotate with a horizontally-disposed shaft 121 which projects through the side wall 3 of the table and is rotatively trunnioned therein. The lower and free end of arm 120 is adapted to rest freely on top of the bed of materials and to rise and fall with variations in depth of the bed. A variable weighting device 122 may be mounted near the free end of the arm 120 to cause said arm to closely follow the top of the bed.

For automatically transmitting the changes in the depth of the bed to the air and feed control actuating devices, an electrical transmission system is preferably provided, although such transmission could be effected by mechanical, pneumatic or any other suitable means if desired. In the present preferred form, each of the air-supply controls and the feed control may be operated by a small individual, reversible-drive electric motor and each motor is responsive to the movements of the arm 120. As embodied, the fan veils 50 are suspended by cables 125 from a hoisting drum 126 mounted on a shaft extending across the top of the fan housing. A reversible motor 128 is mounted adjacent shaft 127 and drives the same to raise and lower the fan veils 50 by the worm 129 on the motor shaft which engages with a ring gear 130 fixed to shaft 127.

A similar motor 131 is provided for setting the shutter valve 52. The actuator rod 108 is pivotally connected at its upper end to one end of a bell crank 132. The other end vertically disposed arm of said bell crank comprises a geared segment 133 which engages with worm 134 on the shaft of motor 131.

The feed hopper is provided with variable-speed drive for the feed comprising a rotatable hopper valve mounted on a rotatable shaft 84 near the mouth of the hopper. The shaft 84 is driven from a pulley 85 which is connected by belt 86 to the drive pulley 87 of a Reeves variable speed transmission 88, or other known or suitable variable speed mechanism. The driven pulley 89 of the speed transmission may be connected by a belt 90 to any suitable power mechanism. For operating the speed change mechanism for the feed hopper 5, a reversible motor 135 is mounted on the casing 88. Worm 136 on the motor shaft engages with a pinion gear on shaft 92.

Referring now to the embodied means for controlling the operation of the actuating motors 128, 131 and 135 from the movements of the arm 120, a drum 138 is mounted on shaft 121 to turn therewith. Said drum is provided with three arcuate electric contact surfaces 140, 141 and 142 which correspond to the three motors. Said contacts extend only partly around the drum, which has three similar contact members (not shown) at another part of its periphery for connecting the motors to drive in reverse direction. Separating the two sets or reverse-drive contacts is a neutral insulated zone on the drum. A set of contact brushes 145 are mounted adjacent the drum to contact with the periphery thereof and to transmit current therefrom to the motors 128, 131 and 135 by suitable cable connections 146 and 147. It will be understood that the drum is electrically connected to a suitable source of electric power (not shown) and is wired to effect the desired reversal of the motors. Return or ground contacts 146 for all the motors are also mounted on the drum.

Means are provided for varying the normal setting of the arm 120 so as to selectively predetermine the desired normal depth of the bed. As embodied, the shaft 121 and its attendant mechanism are mounted on a vertically-slidable panel 150 which may be set at desired levels by pins or set-screws 151 mounted in the panel guides 152.

The operation of the mechanism shown in Figs. 2 and 3 is as follows:—The arm 120 is set at the predetermined height desired and the free end thereof rests on the upper surface of the bed of material which travels forwardly along beneath the arm. So long as the depth of the bed remains within the limits desired, the insulated or neutral portion of the drum 138 will contact with the brushes 145 and the motors 128, 131 and 133 will remain inactive, leaving the air valves and feed drive at their original settings. However, as soon as the depth of the bed increases appreciably, due to increased moisture in the ran coal, or other causes, the arm 120 will rise and the contacts on the drum will energize the motors. The setting 5 of the drum contacts and motors is such that the air supply will be increased upon a rising of the bed, while the feed will be conjunctively decreased, if necesary. The increased air pressure will operate to loosen and stratify the particles and return the bed to normal depth, whereupon the arm 120 will drop to normal position and cut off the motors. If, on the other hand, the bed becomes too thin, the arm 120 will swing the reverse set of contacts into energizing position and the motors will act to lower the air supply and increase the feed.

Automatic stop switches 160 and 161 may be provided for cutting off the motor 131 near the upper and lower limits of travel of the veil 50 so

as to prevent breakage of the mechanism. Similar stop switches 162 and 163 may be provided for the valve actuator 108.

It will be understood that the control motors for the fan veils and the valve 52 are usually not used together, one mechanism usually being a substitute for the other. Also, similar control mechanism, manual or automatic, may optionally be provided for any other air valves pertaining to the table. Furthermore, the control for the feed mechanism 84 may frequently be dispensed with, as in many cases the changes in air supply will be sufficient to keep the bed at normal desired depth. On the other hand, in some cases it may be desirable to control only the feed mechanism automatically. For these various selective operations, a central switch box 165 may be provided at any suitable place in the electric cable circuit, wherein there may be switches for cutting out any of the motors 128, 131 or 135 as desired, thereby rendering their respective control mechanisms independent of the depth of the bed.

Instead of a single arm or detector finger, a number of arms, extending along the breadth of the table may be employed. The control connections from these arms may be such that all or a substantial number of the arms must be moved in order to change the rate of feed and/or the air supply. In this way, transitory actuation of a single arm by an isolated lump or local accumulation of material will not affect the control, provided the average depth of the bed remains unchanged.

As embodied, (Fig. 4) three detector arms 170, 171 and 172 are positioned at substantially equal intervals across the breadth of the bed near the rear end of the table. Arm 170 is fixed to shaft 173 to rotate therewith. The shaft is rotatably journalled at 174 in the side wall 4 of the table and extends clear across the width of the table, being rotatably supported with respect to the other side wall 4. Shaft 173 extends for some distance beyond side wall 3 of the table and has a cam plate 175 fastened to its outer end, the purpose of which will be hereinafter described.

Arm 171 is fixed to a rotatable sleeve 176 near the inner end thereof, as by a set screw 177, the sleeve surrounding shaft 173 and being freely rotatable with respect thereto. The outer end of sleeve 176 stops short of the outer end of shaft 173 and has keyed thereto a cam plate or disc 178 which is similar to disc 175. A third sleeve 179 surrounds both shaft 173 and sleeve 176 and supports the arm 172 in the manner already described with respect to arm 171. The outer end of sleeve 179 lies between the side wall 3 of the table and cam disc 178, and a similar cam disc 180 is keyed to said outer end. Sleeve 179 is journalled in the side wall 3 of the table for free rotation with respect thereto. It will be understood that shaft 173, sleeve 176 and sleeve 179 as well as their respective arms 170, 171 and 172 are freely rotatable independently of each other with respect to the table structure.

Cam discs 175, 178 and 180 are substantially identical in essential structure and operation. As shown in Fig. 5, disc 178 is roughly circular in outline, having an axially-extending collar 185 which surrounds sleeve 176 and permits the disc to be set in the desired angular position with respect thereto, as by a set screw 186. A pair of electric contacts 187 and 188 are mounted adjacent the periphery of disc 178, said contacts forming the terminals of a normally open switch in an electric circuit connected to the air-control mechanism of the table. Contacts 187 and 188 are mounted on uprights 189 and 190 respectively, the lower ends of which are secured in a suitable insulated bracket 191, which may be secured to the wall 3 of the table. The lower ends of the uprights 189 and 190 preferably extend through the insulated supporting member 192 and connect with circuit wires 193 and 194 respectively. Either or both of the uprights are preferably formed of resilient metal or the like so that the contacts 187 and 188 are normally held apart, but lateral pressure upon arm 190 will bring them together.

A cam shoulder 195 is provided on arm 190 for cooperating with a cam surface on the disc 178. The disc 178 is provided with a cam or projection 196 which normally is out of contact with shoulder 195. Clockwise movement of the disc will bring cam 196 against shoulder 195 and close the switch.

A pair of contacts 200 and 201 are positioned on the side of the disc opposite to contacts 187 and 188 and are mounted and connected in a similar manner, and are adapted to be closed by counter clockwise movement of the disc and the cam 196.

Reverting to Fig. 4, circuit wires 205 and 206 are provided for connection with the reversible motors on the fan veil control mechanism, the air control shutter 52 and the motor for the speed control on the material feed mechanism. When electrical contact is established between wires 205 and 206, the motors will operate in the proper direction to increase the air supply and/or decrease the feed. A similar pair of circuit wires 207 and 208 are provided for energizing the motors to turn in the reverse direction, to decrease the air current and/or increase the feed of material.

It will be understood that means are provided for energizing circuit 205—206 when the depth of the bed rises above the normal limit, while an undesirable decrease in bed depth will actuate mechanism to close circuit 207—208, and that such means, comprising the detector arms 170—171 and 172 and their associated mechanism, operate in essentially the same manner as the single arm 120 described in connection with Figs. 2 and 3.

By virtue of the mechanism described in connection with Figs. 4 and 5, circuit 205—206 and circuit 207—208 will not be energized unless the change in the bed depth is general throughout the width of the table. As embodied, three switches, 210, 211 and 212 are arranged in series in the circuit 205—206, said switches comprising normally open contacts constructed in accordance with the mechanism shown in Fig. 5. The switches 210, 211 and 212 are disposed adjacent the cam discs 180, 178 and 175 respectively and are adapted to be closed by clockwise movements of said respective discs.

It will be clear that closure of any one or any two of said switches will not energize the circuit 205—206 but such energization will be effected only when all three switches are closed by simultaneous clockwise movement of the three cam discs. Consequently it is necessary for all three arms 170, 171 and 172 to rise together before the air and/or feed control motors will be energized. This prevents energization of said motors by the chance or transitory lifting of a single detector arm, as by the passage beneath the arm of a large lump of material projecting above the average lever of the bed.

Similar mechanism, comprising switches 215, 216 and 217, may be provided for controlling the reverse movement of the motors for correcting a drop in the bed level. These switches will be closed in a similar manner by counter clockwise movement of the cam discs when the detector arms are lowered.

It will be understood that the mechanism described in connection with Figs. 4 and 5 is adapted for use in the control mechanism and circuits shown and described in connection with Figs. 2 and 3. Suitable switches may be provided in the circuits for cutting out any one of the control motors, as desired, so that either the feed control, the air control or both, may be rendered independent of the depth of the bed as desired.

In accordance with one feature of my invention, I provide means for automatically indicating the depth of the bed at all times, and said indicating mechanism may be utilized either in conjunction with the hereinbefore described means for automatically controlling the material feed and/or the air supply and distribution, or automatic bed depth indication may be provided alone for use without the automatic control devices. In many cases it will be found desirable to have some means for automatically indicating the depth of the bed and changes therein when the automatic control means are not provided. For example, when the air supply, including the setting of the veils on the fan, and the material feed are controlled manually, it is very advantageous for the operator to be able to ascertain the depth of the bed without going to the table and putting his hand in on the bed of the coal, as is necessary under the previous manual systems, as described in the copending application of Richard Peale, S. N. 389,722, filed August 31, 1929.

As embodied, an indicating pointer 250 is mounted for pivotal movement on the outer surface of the side wall 3 of the table, said pointer being fixed to and mounted to turn with the shaft 121 which is actuated by one or more of the detector arms 120. The pointer 250 is preferably about equal in length to the detector arm 120 whereby the free end 251 of the pointer indicates the actual rise and fall of the detector arm. An arcuate scale 252 may be provided at the end 251 of the pointer with divisions for indicating the depth of the bed in inches or otherwise. If desired, suitable gearing may be provided for amplifying the movement of the pointer arm so as to indicate the changes in bed depth on a greater scale.

If desired, means may be provided for transmitting the indications of bed depth to remote points. For example, flexible shafts may be provided for transmitting the movement of the pointer to indicators stationed near the feed control mechanism and the fan, whereby the operator can ascertain the depth of the bed without leaving his station at these mechanisms. Generally, however, it will be found that visual indicating means of the type shown in Fig. 6 will be sufficient for all practical purposes.

Referring now to Fig. 11, my invention provides a novel method and mechanism for enhancing the ultimate purification of all sizes of the coal in the bed, especially when a transverse size classification thereof takes place concurrently with the separating action. This feature of my invention relates to the extraction and retreatment of a middlings product, i. e. a portion of the bed which has not been completely separated and which contains coal and impure materials in partial intermixture. As embodied, the coal-discharge chute 300 is shown provided with a division forming a middlings chute 301 disposed adjacent the forward and outer tip of the table for receiving and separately discharging a selected middlings product delivered at said portion of the table. The middlings product delivered to the chute 301 usually consists of some few relatively very coarse coal pieces directed toward the outer side of the bed by the simultaneous action, intermixed with very fine heavy impurities which have escaped discharge through the refuse boxes 65 and a considerable amount of low-gravity refuse of different sizes, consisting principally of pieces of "bone" and agglomerated coal and rock.

By my invention, I provide for making a middlings "cut" at one or more other sections of the discharging coal stream, preferably adjacent that section of said stream where the fine particles congregate and are discharged. In some cases, particularly with coals containing a relatively large proportion of very dirty fines, the simultaneous sizing action in the bed causes much of the fine refuse to work toward the inner and lower side of the table with the fine coal. As the fine material congregates and travels along the lower side of the bed, the fine heavy particles will gradually and progressively settle to the bottom. However, after settling, these fine heavy particles must travel along the separating partitions substantially the full width of the deck to reach the refuse boxes at the outer side thereof. As a result it sometimes happens that a portion of the fine refuse has not been settled behind a separating partition before the portion of the flotant stratum in which it is traveling has reached the inclined coal spillage edge 61. Furthermore, some fine particles of refuse which do settle and travel along the separating partitions for some distance may be again floated into the upper strata by the air action as they travel toward the outer side of the deck. This re-floating and remixture of the fine refuse is attributable to the fact that the presence of the coarser coal particles in the outer portion of the deck provides voids in the bed into which the fine refuse is blown by the rising air currents. Consequently, with some coals an appreciable quantity of fine refuse may be discharged with the coal at an intermediate section of the coal spillage edge 61.

By my invention I provide means for extracting a relatively impure section of the coal stream, such as one containing intermixed, fine particles for the reasons described. As shown in Fig. 11, an auxiliary middlings chute 302 is provided intermediate the sides of the discharging coal stream and relatively near the lower side of the table, whereby a middlings cut may be made of the fine middlings, i. e., coal containing intermixed fine refuse. As shown, the chute 302 is formed by walls 303 and 304, disposed diagonally on the surface of coal chute 300. The middlings chute 302 is provided with means for selectively varying the amount of fine middlings extracted, and for also selectively varying the location of the extraction point so as to allocate the fine middlings cut according to the location in the coal stream of the entrained fine refuse particles. As embodied, the sides 303 and 304 are provided with independently angularly movable vanes 305 and 306, respectively, which may be swung laterally for the purposes described. Similarly, the regular middlings chute 301 is provided with a transversely positionable pivoted vane 307 for con-

trolling the amount of middlings cut from the coal stream at the outer tip of the table.

In accordance with the usual practice followed with respect to the middlings cut from chute **301**, the middlings or intermixed fine coal and refuse delivered by chute **302** may be returned to the feed hopper of the table and remixed with the bed to undergo a second separating action.

The invention in its broader aspects is not limited to the specific mechanisms shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

I claim:

1. In a mechanism for separating intermixed divided materials including in combination an air-pervious deck, an air chamber, a member in the chamber below the deck containing a plurality of aperaures for admitting air to the deck and means for controlling passage of air through said apertures comprising apertured stoppers.

2. In a mechanism for separating intermixed divided materials including in combination an air-pervious deck, an air chamber, a member in the chamber below the deck containing a plurality of apertures for admitting air to the deck and means for controlling passage of air through said apertures comprising a plurality of stoppers having apertures of different sizes.

3. In a mechanism for seperating intermixed divided materials including in combination an air-pervious deck, a member having a plurality of apertures for admitting air thereto, and means for controlling the passage of air through said apertures comprising a plurality of stoppers adapted to fit into and partially obstruct the apertures.

4. In a mechanism for separating intermixed divided materials including in combination an air chamber, a member having a plurality of apertures mounted in the chamber, and a plurality of stoppers adapted to fit into the apertures, said stoppers having openings therein for admitting a limited amount of air through the apertures, said openings being of different size in different stoppers.

5. The process of purifying coal which comprises subjecting a substantial bed of raw coal to vibration and lifting and loosening air currents to stratify and separate the coal and heavy impurities, progressing the flotant coal stratum to discharge and concurrently effecting a transverse size classification thereof, extracting middlings from the coarse coal and separately extracting middlings from the fine coal.

6. The process of purifying coal which comprises subjecting a substantial bed of raw coal to vibration and lifting and loosening air currents to stratify and separate the coal and heavy impurities, progressing the flotant coal stratum to discharge and concurrently effecting a transverse size classification thereof, extracting a selected portion of the coarser coal in the discharging coal stream as middlings and extracting finer middlings from another portion of said stream, and returning the middlings to the bed for additional separating action.

7. A mechanism for separating intermixed divided materials including in combination an air-pervious table, means for maintaining a continuous, traveling bed of raw coal thereon undergoing stratification and separation, means for discharging the coal as a flotant, transversely sized stratum, means for impelling settled heavier material transversely of the flotant stratum to discharge, means for removing a middlings product from the coarse coal and means for removing a middlings product from the fine coal.

8. Mechanism for separating intermixed divided materials including in combination an air-pervious deck, means for maintaining thereon a traveling bed of raw material undergoing pneumatic stratification and separation including a mechanically-actuated feeder for regulably supplying raw materials to the deck, a member contacting with the surface of the bed on the deck and movable in conformity to changes in the depth of the bed, and devices controlled by said member for regulating the feeder thereby to vary the supply of raw material to the bed in accordance with variations in depth thereof.

9. Mechanism for separating intermixed divided materials including in combination an air-pervious deck. means for maintaining thereon a traveling bed of raw material undergoing pneumatic stratification and separation including a mechanically-actuated feeder for regulably supplying raw materials to the deck, a member contacting with the surface of the bed on the deck and movable in conformity to changes in the depth of the bed, and devices controlled by said member for regulating the feeder thereby to vary the supply of raw material to the bed in accordance with variations in depth thereof, a motor-driven fan for supplying air under pressure to the bed, a regulating device for varying the amount of air supplied by the fan, and devices controlled by said member for actuating the fan-regulating device.

10. Mechanism for separating intermixed divided materials including in combination an air-pervious deck, means for maintaining thereon a traveling bed of raw material undergoing pneumatic stratification and separation including a mechanically-actuated feeder for regulably supplying raw materials to the deck, a member contacting with the surface of the bed on the deck and movable in conformity to changes in the depth of the bed, and electric circuit devices controlled by said member for regulating the feeder thereby to vary the supply of raw material to the bed in accordance with variations in depth thereof.

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