

June 23, 1925.

1,543,556

E. DENIS ET AL

COMBINED CRUSHING, PULVERIZING, AND SEPARATING MACHINE

Filed Jan. 16, 1924

2 Sheets-Sheet 2

Fig. 7

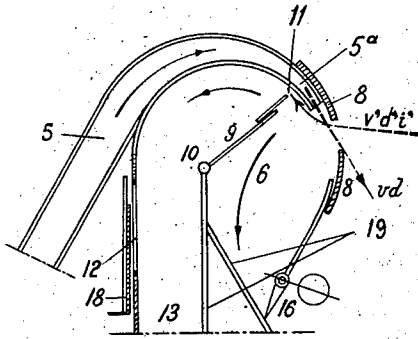


Fig. 9

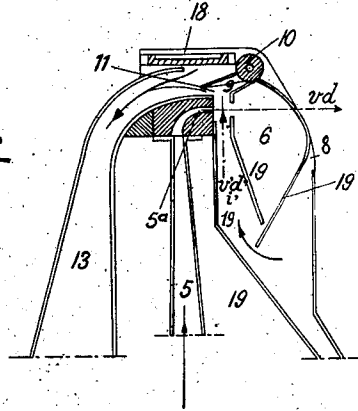


Fig. 8

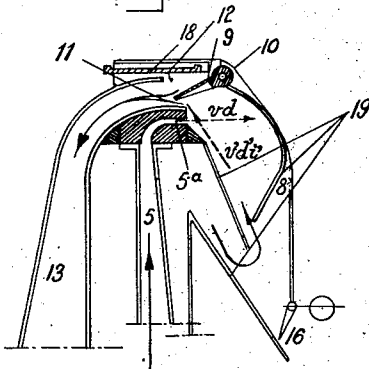


Fig. 10

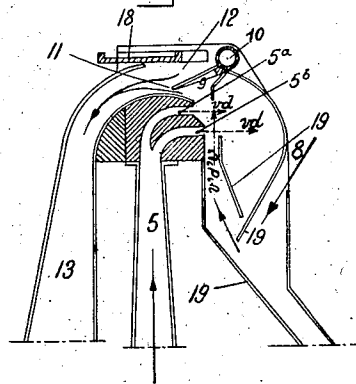
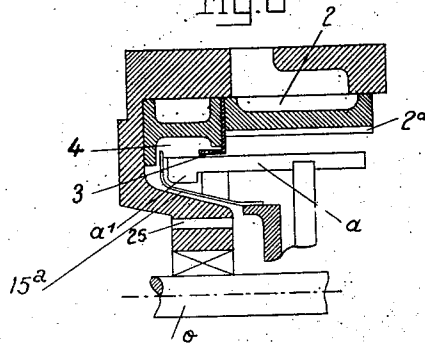


Fig. 6



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Patented June 23, 1925.

1,543,556

UNITED STATES PATENT OFFICE.

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COMBINED CRUSHING, PULVERIZING, AND SEPARATING MACHINE.

Application filed January 16, 1924. Serial No. 686,642.

To all whom it may concern:

Be it known that we, EMILE DENIS and FREDERICK HIPPERT, citizens of the Republic of France, and residents of Billancourt, France, and Paris, France, respectively, have invented certain new and useful Improvements in Combined Crushing, Pulverizing, and Separating Machines, of which the following is a specification.

The present invention has reference to a combined crushing, pulverizing and separating machine, that is to say to a machine comprising in combination a crushing mill of any approved type adapted for finely pulverizing the materials submitted to treatment and a separating device making it possible to automatically separate the sufficiently fine particles of the still insufficiently crushed portions of the materials undergoing the treatment above referred to, the said separation being operated by the meeting of two draughts having different directions and variable speeds, the said directions and speeds being regulatable at will.

The improved combined crusher, pulverizer and separator according to the invention is especially designed for pulverizing solid materials either for producing impalpable powders such as are required in numerous industries or else for producing pulverized coal or other carbonaceous substances.

A primary object of the invention is the provision of a combined crushing, pulverizing and separating machine wherein the whole of the pulverized materials are expelled by centrifugal power through an outlet positioned in the neighbourhood of the circumference described by the crushing members arranged at the periphery of the machine.

A further object of the invention is the provision of a combined crushing, pulverizing and separating machine wherein the separation of the pulverized materials is performed outside the crusher proper by the meeting of two independent draughts of regulatable directions and speeds.

A still further object of the invention is the provision of a combined crushing, pulverizing and separating machine wherein the regulation of the fineness of the pulverized materials is performed during the operation of the crusher.

According to one important feature of

the invention, the whole of the pulverized materials are carried away and expelled out of the crusher by means of a draught. This draught may be produced in a plurality of ways. Thus for instance it may be produced by the rotation of the movable crusher members. It may also be produced by a series of blades forming a turbine or fan, such blades being fixedly secured to the rotor of the crusher or to a shaft independent of the crusher shaft. It might also be produced by any approved ventilating device. The draught thus obtained and which, for the sake of clearness, will throughout this description be referred to as the "primary draught" carries in suspension a mixture of crushed materials containing particles of different sizes. This mixture is led through a specially-shaped nozzle into a separator which is so constructed as to discharge on the one side the sufficiently finely divided materials whilst expelling back to the crusher the insufficiently pulverized portions of the materials under treatment.

According to another important feature of the invention, the separation of the pulverized materials, according to their size, is performed by the meeting of the said primary draught with a secondary draught whose speed, intensity and direction are adjustable and which is produced by the drawing-in or driving-out action of a fan or other ventilating device adapted for producing such draught which, for the sake of clearness, will hereinafter be referred to as the "secondary draught." This secondary draught is adapted for deflecting the solid particles carried away by the primary draught so much the more as they are lighter and consequently to make it possible to take advantage of such differences of deflection for separating the said particles by means of an appropriate device constituted for example by a movable shutter.

With the above objects in view and such others as will incidentally appear hereinafter, the invention comprises the novel construction, combination and arrangement of parts that will now be described more in detail with reference to the accompanying drawings and will be specifically emphasized in the appended claims.

In these drawings is shown a preferred embodiment of the invention, the crusher

utilized in this machine being of the well-known percussion type.

Figure 1 is a vertical section on the line $y-y$, Fig. 2 of the whole machine comprising the combined crusher, pulverizer and separator.

Figure 2 is a vertical section on the line $x-x$, Fig. 1 showing the cavity for receiving the pulverized materials.

Figures 3, 4, 5 and 6 are vertical sections on a larger scale of a peripheral portion of the crusher showing several embodiments of the device for discharging the pulverized materials in the neighbourhood of the circumference described by the ends of the hammers.

Figures 7, 8, 9 and 10 are vertical sections on a larger scale showing several embodiments of the separator wherein two draughts are used, thereby enhancing its efficiency and lessening its volume.

Similar reference numerals designate similar parts throughout the said figures.

The sifting crown of the percussion crusher 1 selected by way of example in this machine is replaced by a non-perforated crown 2 fluted longitudinally at 2^a on its inner surface and/or provided with asperities intended for increasing the strength of the percussions. This crown 2 has arranged rearwardly thereof an annular concentric opening 3 whose inner diameter is slightly less than the inner diameter of the flutings 2^a. Behind the said opening 3 is formed a cavity 4 adapted for collecting and directing the mixture of air and pulverized materials which has just been expelled from the crusher whilst either maintaining the speed of said mixture or modifying same.

The cavity 4 may, as in the embodiment illustrated, afford the shape of a fan shell (see Fig. 2) or else it may also be constituted merely by a tube.

Several embodiments of the opening 3 through which the cavity 4 communicates with the crusher are represented in Figures 3 to 6 inclusive.

In the embodiment shown in Figure 3, the inner diameter of this opening 3 is slightly less than the inner diameter of the crown of hammers a .

In the embodiment shown in Figure 4, the inner diameter of the opening 3 is comprised between the inner diameter and the outer diameter of the crown of hammers a .

In the embodiment shown in Figures 5 and 6, the inner diameter of the opening 3 is comprised between the outer diameter of the crown of hammers a and the inner diameter of the flutings 2^a.

Referring to Figures 3, 4 and 5 the circulation of the mixture through the cavity 4 (having the shape of a fan shell as shown in Figure 2) is accelerated by a fan turbine having blades 15.

Referring now to Figure 6, the hammers a are extended to the rear part of the cavity 4. The rear end of the said hammers a carries tongues a' which constitutes the blades of the turbine.

From cavity 4 the mixture formed by pulverized materials contained in suspension in the air travels through a horn-shaped duct 5 (see Figs. 1 and 2) whose open end or nozzle 5^a is greatly reduced in thickness, i. e. throttled thereby to produce one or several layers of the said mixture. The said nozzle 5^a opens in the upper part of a chamber 6 positioned in the path of travel of the whole or part of the primary draught produced by a fan V. In the embodiment illustrated the shaft p on which this fan revolves is mounted upon the shaft o of the rotor of the crusher. However it must be understood that the said two shafts might equally well be relatively positioned in any other suitable way and might rotate at different speeds.

The inner arrangement of the chamber 6 may afford the various configurations as illustrated in Figures 7 to 10 inclusive, wherein the chain-lined arrows d d' indicate the direction followed by the draughts, their speed v v' and their intensity i i' .

Reference being now had to Figure 7, the throttled duct 5 is positioned externally of the chamber 6. Such duct is closed by a door having one or two leaves 8 for regulating the flow of the drawn-in air. This chamber 6 is provided with a regulating shutter 9 plane or curved shaped and pivotally mounted upon a spindle 10 so as to allow of the necessary adjustment of the size and position of the opening 11 establishing communication between the said chamber 6 and the duct 13 leading to the fan V which draws the sufficiently finely divided materials, the residual materials being discharged along a suitable chute furnished with a shutter 16 or by any other means permitting to collect such residual materials or to send them back automatically to the hopper A feeding the crusher.

A sliding shutter 18 positioned opposite to an opening 12 formed in the wall of the duct 13 also allows of the required variations in the speed of the mixture through the opening 11.

Reference being now had to Figure 8, the open end or nozzle 5^a of the duct 5 opens horizontally in the inside of the chamber 6 whereby the materials are imparted a direction d , a speed v and an intensity i as indicated by the arrows. In this embodiment, the spindle 10 about which pivots the shutter 9 is positioned at the top part of the chamber 6. The opening 12 is positioned at the top part of the machine such opening occupies the whole width of the chamber 6 and is masked either by a sliding shutter 18

or by a shutter pivotally mounted upon a spindle. Within the chamber 6 are positioned partitions 19 which direct the air and the materials.

5 In the embodiment shown in Figure 9, the position of the partitions 19 has been somewhat modified so as to cause the materials to be separated by the secondary draught to meet several times.

10 In the embodiment shown in Figure 5, the duct 5 is divided into two flattened sections 5^a and 5^b positioned horizontally in superimposed relation. The arrangement of the partitions 19 is the same as in Figure 9.

15 It will be understood that, by the arrangements shown in Figures 7 to 10 inclusive or by like arrangements, it is possible by modifying the openings through properly adjusting the controlling shutter 9 and the shutters 18 to readily regulate the speed, the direction and the intensity of the two draughts and consequently the fineness of the materials drawn in by the fan V. The relative position of the several members of the separator permits to send back the residual materials directly to the chute A leading to the crusher (see Fig. 1).

Further, according to another feature of the invention, the structure of the crusher is so designed as to insulate the bearings of the operating shaft from the cavities through which circulate the dust-like thinner particles of the pulverized materials. To this effect, the central bearings are provided with channels 25 (see Figs. 1 and 3) through which the air passes on to the cavity 4 of the crusher so as to preclude every return movement of the pulverized materials towards the shaft and therefore any interference thereof with the bearing and ball bearings. Baffle-plates 26, 27, 28 also assist in this protective action of the channels 25. The end bearing 29 is also provided with six channels 30 and baffles.

45 When the materials to be treated, for instance carbonaceous materials, are already in a finely divided form including a substantial proportion of powdered particles having a fineness equal to the one which it is desired to obtain by pulverizing, it is useless to treat these materials in a crusher, it being sufficient to drive them through the duct 5 by means of any approved refluxing appliance.

55 The operation of the machine is as follows:—The material to be pulverized having been distributed by an oscillating or other device drops, after having passed over a magnetic separator S of known type, in front of the shaft of the disc 1 which carries one or several series of short concentric hammers *c* and a series of long peripheral hammers *a*. The material is thus crushed between the said hammers *c* and the stationary crown *b*, and then pulverized between

the hammers *a* and the outer crown 2. The disc 1 carrying the hammers by rotating produces a ventilation thereby drawing in together with the material to be pulverized a certain amount of air which, only being 70 permitted to pass out at the rear part of the machine, flows through the latter while carrying away the crushed material.

The speed of such draught is increased by the shape of the rear cavity 4 and, if desired, by the blades 15 which drive it through the duct 5 to the chamber 6. The shape of the said cavity 4 is so designed as to direct the said draught to the duct 5.

When reaching the throttled end 5^a of the said duct, the material in suspension in the said primary draught has a speed *v* and a direction *d* which is imparted thereto by the flattened shape of the said end or nozzle 5^a. The material then receives the impact of the secondary draught from the sucking fan V which draught has a speed *v'*, a direction *d'* and an intensity *i'* which have been regulated by properly adjusting the shutters 9 and 18. It will be understood that, by properly adjusting the respective values of *v*, *d* and *v'*, *d'* and *i'* the resulting draught will be made to follow such a direction as will accurately pass by the corresponding edge of the shutter 9, whereby all the thinner particles of the material will be entrained by the secondary draught without contacting with the said shutter 9 whereas all the thicker and heavier portions of same will strike such shutter and be deflected thereby so as to drop into the chamber 6. Thus it is seen that provision is made for causing the said resulting draught to correspond to the required predetermined fineness of the resulting material.

It must be understood that the forms of this invention hereinbefore described with reference to the accompanying drawings are to be taken as the preferred embodiments of the same and that various changes in the shape, size, construction and more generally in the arrangement of the various parts might be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

What we claim and desire to secure by Letters Patent is:—

1. A device of the character described, including in combination, a crusher shaft, crusher means associated with said shaft, a hopper adapted to axially feed material to be crushed to said crusher means, a discharge passageway adapted to receive crushed material, a fan concentric with said crusher shaft, an air duct supplying air to said fan, said duct intercepting the discharge passageway for the crushed material.

2. A device of the character described, including in combination a crusher shaft, crusher means associated with said shaft, a

hopper adapted to feed material to be crushed to said crusher means, a discharge passageway arranged at right angles to said crusher shaft and adapted to receive crushed material, said passageway leading from the periphery of said crusher means and having a throttled upper end, a sucking fan concentric with said crusher shaft, a vertical and terminally curved air duct leading down to said fan, regulatable shutters adapted to suitably mask air inlet openings formed in the curved portion of said duct, the latter intercepting the discharge of the crushed material through the throttled end of said passageway and causing the thinner particles of said material to be sucked by said fan and thereby separated out.

In testimony whereof we have signed our names to this specification.

EMILE DENIS.

FREDERICK HIPPERT.