Jan. 28, 1930. P. A. HIRSCH 1,744,895

PULVERIZING MACHINE

Filed Nov. 15, 1928 3 Sheets-Sheet 1

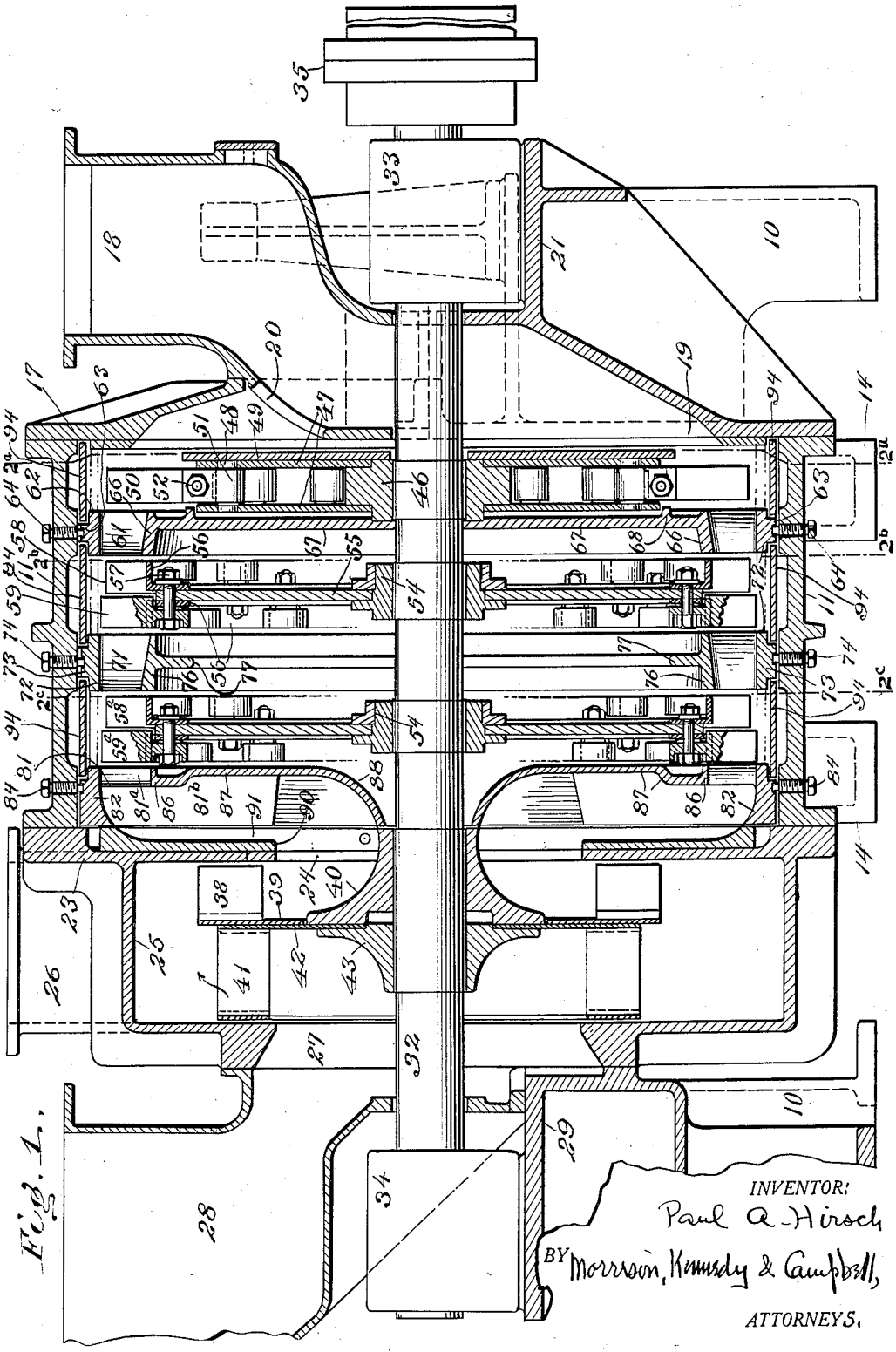


Fig. 1.

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Jan. 28, 1930. P. A. HIRSCH 1,744,895

PULVERIZING MACHINE

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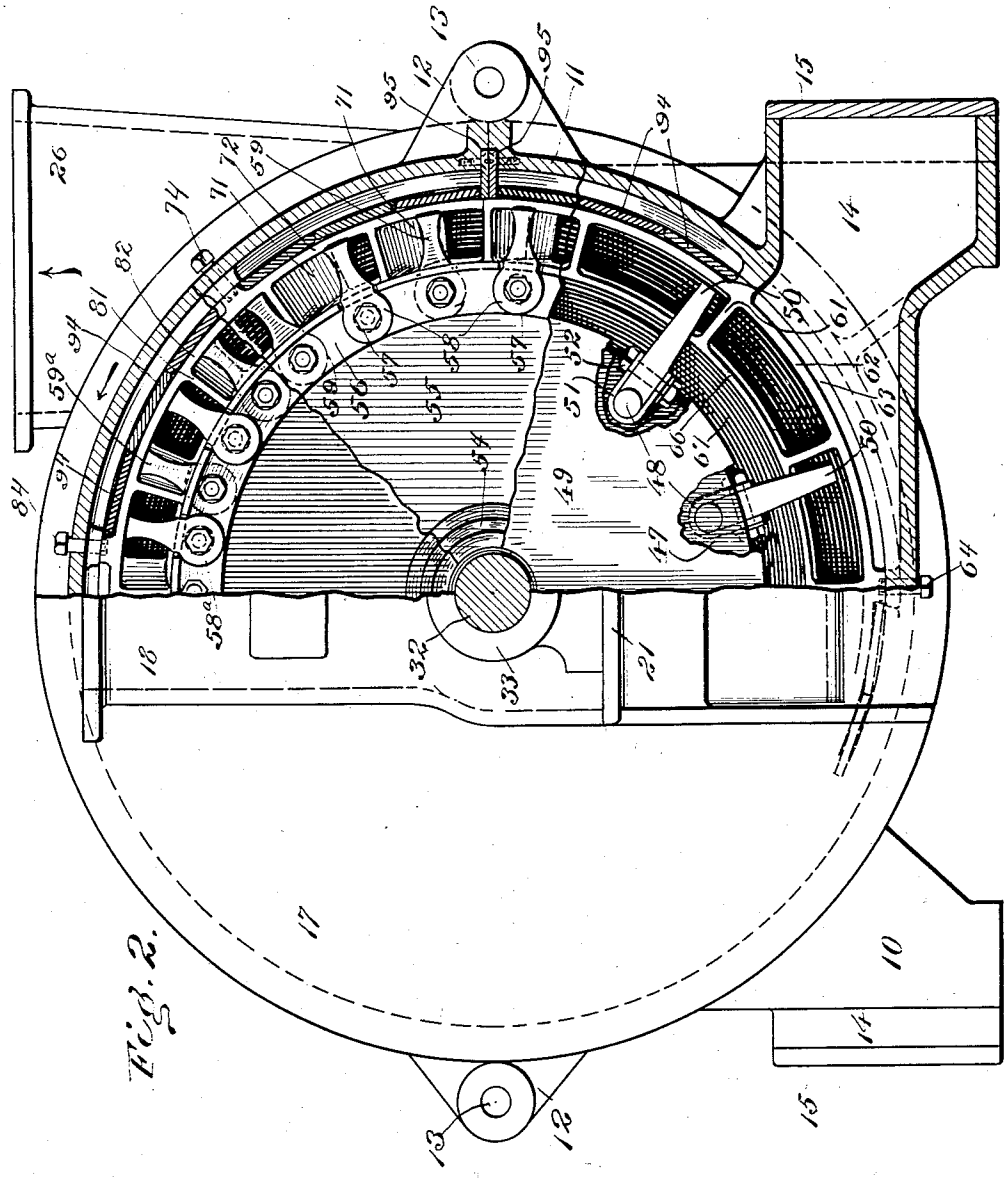


Fig. 2.

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Jan. 28, 1930. P. A. HIRSCH 1,744,895

PULVERIZING MACHINE

Filed Nov. 15, 1928 3 Sheets-Sheet 3

Fig. 3.

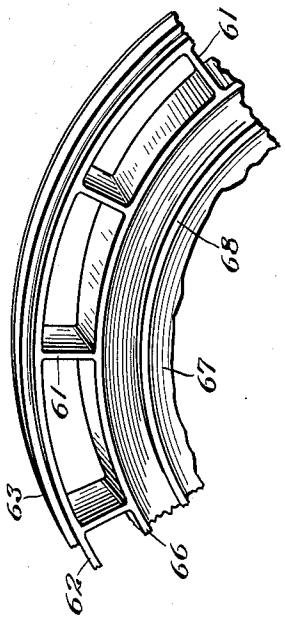


Fig. 4.

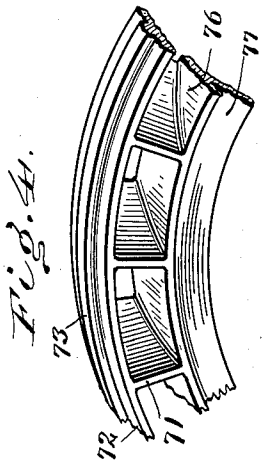


Fig. 5.

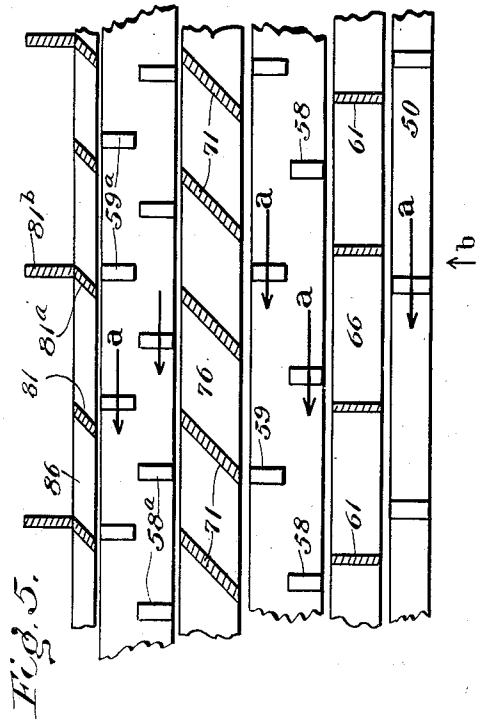


Fig. 6.

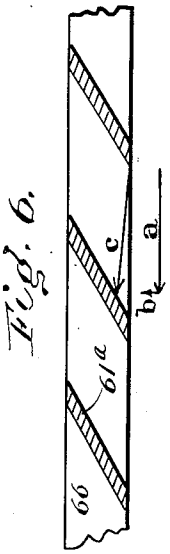
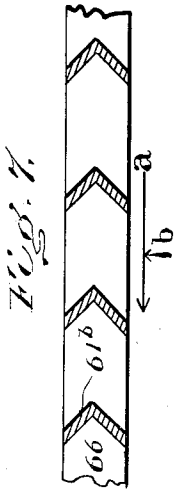


Fig. 7.



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Patented Jan. 28, 1930 1,744,895

UNITED STATES PATENT OFFICE

PAUL ARTHUR HIRSCH, OF NEW YORK, N. Y.

PULVERIZING MACHINE

Application filed November 15, 1928. Serial No. 319,620.

This invention is a novel pulverizing machine, and relates particularly to a pulverizer of the so-called impact type and designed for pulverizing coal or any other fuels or materials to an extremely fine degree of reduction; the impact type referring to a principle of reduction wherein the particles are acted upon by the reducing members or beaters while carried along in a flow of air, as distinguished from a crushing between two machine parts.

The present invention is herein shown embodied in a pulverizing machine having a chambered casing with an operating shaft therein and beaters or paddles revolved by the shaft, while axial air flow causes progressive advance of the material being reduced; although certain features hereof might be otherwise embodied. The illustrated construction of pulverizing machine is adaptable for the very fine reduction of coal, for example for the purpose of direct feed to a fire or furnace in suspension in air, thus dispensing with the need of storage bins for the pulverized fuel. Prior pulverizers of the class and for the purpose referred to are illustrated in certain patents heretofore issued to me, including Patents No. 1,479,540 of January 1, 1924 and No. 1,636,693 of July 26, 1927; the present invention being in some aspects an improvement on said prior patents and in other aspects being directed to independently useful features of invention.

The general objects of the present invention are to afford increased efficiency of pulverization, with an enlarged rate of output, and a high degree of fineness of pulverization, and uniformity thereof. Further objects are to minimize power consumption and to reduce wear, thus prolonging the life of the machine, while rendering the wear parts readily replaceable. Other and further objects and advantages will be explained in the hereinafter following description of one or more embodiments thereof or will be understood to those skilled in the subject.

To the attainment of the objects and advantages referred to the present invention consists in the novel pulverizing machine and the novel features of operation, combination, arrangement and construction herein illustrated or described.

In the accompanying drawings Fig. 1 is a substantially central vertical section of a pulverizing machine illustrating the present invention.

Fig. 2 is a combined right elevation and section, the section being shown taken at three different planes indicated by the lines 2^a, 2^b and 2^c of Fig. 1.

Figs. 3 and 4 are detail perspective views of certain interior parts.

Fig. 5 is a diagrammatic view or development of the successive series of rotary pulverizing elements or beaters and the non-rotating elements between them.

Figs. 6 and 7 are developments similar to Fig. 5, but showing modifications as to certain of the elements.

Referring in detail to the illustrated structure the pulverizing machine is shown of the horizontal type, although it may in some cases be arranged vertically. The machine is supported by legs or hollow base portions 10 at the corners and other similar supporting extensions. The cylindrical casing or drum 11 is supported on such base parts and is preferably fixed against rotation. It is shown constructed in upper and lower halves, these being connected to each other at both the front and rear sides of the machine by hinge extensions 12 engaged by bolts 13, by which arrangement either bolt may be removed to unlock the casing, permitting the latter to be swung open at either front or rear. The lower casing half is shown as formed with four drop extensions 14, each of which is hollow and is adapted to receive pieces of metal and other foreign matter and is closed by a removable cover 15.

The drum or casing at its right end is shown closed by a circular end wall or head 17. This may be cast integral with two of the supporting legs 10 and may have an upward feed extension 18 by which fuel is fed to the pulverizer. The mode of feed and regulation of fuel may be as explained in said prior patents or otherwise. The inlet head has a passage extending downwardly from the feed extension and delivering through aperture

19 into the casing, while above the center is shown a second aperture 20 which may permit foreign matter to return through the head passage and permit admission of air into the upper part of the casing, it being understood that a certain amount of air is customarily admitted to the pulverizer along with the crushed coal or similar material, the air feed however as well as the feed of coal being suitably regulated. The inlet head 17 is shown as formed with a shelf 21 for a shaft bearing as will be described.

At the other end of the drum or casing is a discharge head 23 secured to the drum and having a central or axial, and preferably concentric, outlet or discharge opening 24. The head 23 may be extended integrally at 25 to form a fan casing, this being of usual shape with tangential outlet or delivery 26. The fan chamber at its outer wall may have a central air inlet 27 fed from an air box or duct 28 supplied either with atmospheric air or preheated air preferably under control of a damper. Adjacent the fan casing is shown a pedestal or shelf 29 for supporting a shaft bearing.

The machine is preferably operated through a central shaft 32 supported at the inlet end by a bearing 33 and at the outlet end by a bearing 34 resting respectively on the shelves 21 and 29. The shaft may be power rotated in any usual way and a clutch 35 is conventionally illustrated as a means of coupling and uncoupling the shaft.

Within the fan chamber 25 is shown a fan which may be of known form, for example substantially like that illustrated in my prior application 112,956. The fan is divided into separate portions. The coal unit 38 consists of blades supported on a web 39 extending outwardly from a hub 40 which is of a concavely curved shape to facilitate the smooth flow of the outgoing stream of fuel-laden air. The air unit 41 comprises blades mounted on a web 42 turning with a hub 43 concavely curved to facilitate the flow of air from the inlet 27 through the fan casing. The two hubs are secured to the shaft 32 and cause a whirling delivery of the fuel and air streams which combine and pass outwardly at 26.

Preferably a plurality of beating or reduction units are employed, and three are shown. The first beating unit comprises a hub 46 secured on the shaft, this having opposed webs 47 which are cross connected near their peripheries by a series of studs 48 serving as supporting pins for the beating elements. A wear plate 49 is shown attached in position to protect the elements 46, 47 and 48 from the wear of the incoming fuel. The beating elements may be in the form of swinging hammers 50, each contacting against a stud 48 and there held by a U-shape piece or stirrup 51 secured to the hammer by bolt 52. During the high speed rotation of the described reduction unit the hammers are capable of swingingly yielding, thus avoiding breakage in case of unduly large particles or obstructions.

The second beating unit is spaced from the first and the third is spaced from the second, and between each two of the successive beating units are arranged certain stationary parts to be described, so that in a sense each beating unit may be said to rotate within a definite space or reduction chamber. The second unit is shown as comprising a hub 54 secured on the shaft with a web 55 in the form of a closed disk and having near its periphery a transversely extending wall or ring which may conveniently be built up by the provision of two flanged rings 56 attached by bolts 57 at the opposite sides of the disk or web, with their flanges in substantial axial alinement. The rings 56 or the flanges thereof are shown as interrupted or recessed to receive the shanks of the beating elements or hammers. In this case as indicated in Figs. 1 and 5 there are two series of hammers 58 and 59, the former occupying the first half of the chamber and the latter the second half thereof, in staggered relation. This construction and arrangement of beating hammers is found to afford a more effective degree of impact and attrition of the floating particles.

The third beating unit is substantially identical with the second but, as indicated in Fig. 5, the beaters or hammers 58^a and 59^a are preferably more numerous and more closely spaced than in the case of the hammers 58 and 59.

Certain features of construction and operation herein are similar to said prior patents of 1924 and 1927. Thus it will be observed that the drum or casing 11 has no peripheral egress at any point. The outlet is of contracted diameter and the inlet does not reach to the periphery. It is therefore possible by high speeds to develop a high centrifugal pressure along the peripheral travel of the materials. Following each beating unit or set of hammers is shown a whirl obstructing element in the form of a series of blade-like vanes, relatively stationary, and so arranged as to afford additional impacts on the advancing particles and to retard the advance of the heavier particles. Following the final beating unit are whirl obstructing elements which are continued inwardly or toward the axis in a manner to cause the flowing materials to spread over the surfaces thereof, being thus carried inwardly against centrifugal force to the contracted outlet. By this action, coupled with the suction from the fan, it is practical to maintain the axial progress or flow through the pulverizing machine in spite of high speed and centrifugal pressure. In the drawings the shaft 32 is shown horizontal, but the entire machine might be turned at right angles so that the axial prog-

ress of the material will be either upwardly or downwardly as may be rendered desirable by any particular conditions.

The first whirl obstructing unit or vane unit is shown immediately succeeding the first reduction unit. It comprises a set of vanes 61 which may extend axially, by which is meant that the planes of these vanes either extend through the general axis of the machine or parallel thereto, although they might be somewhat slanted as and for the purposes to be described in connection with the second vane unit herein. The several vanes 61 are shown supported by an outer rim 62 having a bead 63 which is fixedly secured by screws 64 to the casing or drum 11. The complete vane unit may be split in upper and lower halves so as to permit opening and closing of the casing without detachment of the screws 64. The vanes 61 may be relatively short in a radial direction, terminating at approximately the inner limit of the second reducing zone, and the inner ends of the vanes are shown as interconnected by an inside rim 66 which is integrally extended as a web or disk 67 reaching substantially to the shaft 32 and having a side flange 68 overlying one of the webs 47 of the first beating unit. The vanes 61 and the outer and inner rims connecting them may be cast in a single casting with the web 67, as indicated in Fig. 3. The unit or set of vanes 61 may be considered as relatively stationary, meaning that they do not rotate with the shaft and beating units. In their function of diverting heavier particles and throwing them back from the advancing flow the vanes constitute a selective or separating device.

It will be noted that the inner rim 66 is substantially in alinement with the flange or rim portions of the rings 56 of the succeeding reducing element so that these parts, arranged in a generally axial or cylindrical manner, constitute a means or barrier for confining the advancing fuel near to the lining of the casing, these rims and the lining enclosing what may be termed the reduction zone or that portion of the periphery which is subject to the action of the beaters or hammers. The material therefore is forced to advance through the machine without escaping, but subject to, the action of the successive beating units and successive vane units.

The second vane unit comprises a system of vanes 71 which as indicated in Figs. 1, 2, 4 and 5 have a slant, or a greater slant than the vanes 61, and the vanes 71 are preferably more numerous. The slant or inclination of the vanes 71 is in relation to an axial direction or plane and the slant is a reversing slant so as to produce an action tending effectively to reject and throw back into the preceding chamber any heavy particles and in fact all solid material except the finest particles which have no substantial inertia and are drawn forwardly with the air into the next chamber.

As in the case of the first set of vanes the second set is interconnected by an outer rim 72 having a bead 73 attached to the casing by screws 74 and an inner rim 76 with an inwardly extending web 77 which is shown as of short extent, but might be carried clear inwardly as in the case of webs 67 so as to exclude the possibility of flow inside the rim.

Following the third reduction chamber is similarly shown a third set of vanes 81. This however, being the final set, is of special structure and arrangement. The vanes 81 are substantially slanted and may be as numerous or more numerous than the vanes 71. Alternate vanes 81^a of the third set however are shown as continued as axial extensions 81^b which, as seen in Fig. 1, are extended inwardly at least to the edge of the outlet opening 24, so as to facilitate the spread of the flowing materials inwardly to the outlet. The several vanes 81, 81^a and 81^b are shown formed with and supported by an outer rim 82 which is of special shape to fit the corner of the casing and is held by screws 84. There is also shown an inside rim 86 in substantial alinement with the rims 66 and 76 already mentioned and having an inwardly extending web 87, the inner portion of which is curved around at 88 into substantial circular alinement with the curved hub 40 of the fan.

Various lining or wear pieces are provided. The wear plate 49 near the inlet end has already been referred to. A readily replaceable lining piece 90 is shown fitted in an interior recess in the outlet head 23, and this lining piece may have radial ribs 91 in alinement with the vanes 81^b. The casing 11 is protected from direct wear by a system of lining pieces 94. These may be square flat pieces of cast iron, each confined endwise between the several outer rims 62, 72 and 82 and the casing. Each half circle of these lining plates may be confined within the half casing by the confining bars 95 as shown in Fig. 2.

The operation has been partly indicated. The crushed fuel enters by the passage 18 and thence enters the first reduction chamber within the casing 11. The swinging hammers 50 effectively reduce all substantial particles to a finely divided condition. Any foreign matters, scraps of iron etc., are rejected through the peripheral opening at the bottom of this chamber into the hollow receptacle 14. It will be noticed in Fig. 2 that the lining plates 94 are omitted to the extent necessary to admit the foreign matter into the receptacle. From the first chamber the pulverized fuel is compelled to pass through the passages between the vanes 61 into the second reduction chamber. The axial progress is maintained by suction at the fan end which may be supplemented by

air injection at the inlet end. The materials are whirled at high angular and linear speed and therefore under high centrifugal force. The vanes 61 however obstruct the whirling motion. The forward component carries a part of the whirling flow into the spaces between the vanes and any heavy particles entering such spaces are caused to impact against the vanes, with a rejecting action tending to throw such particles back into the first chamber. The result is that a certain percentage of the whirling air is carried forward and with it only of the finer particles of fuel, these being delivered into the second reduction chamber.

The system of alined rims or walls provided in connection with the non-rotating and rotating elements constitute a substantially continuous wall or barrier which serves to confine the whirling and advancing materials to the peripheral portions or beating zone of the interior of the casing. This feature is believed to be novel irrespective of the use of the described vanes 61, 71 or 81, so long as some selecting or separating device is introduced between the successive reduction units. The use of the closed webs or disks 55, 67 or 87 for either or both the vanes and the beaters cooperate in confining the materials to the peripheral zone, because preventing the materials being shunted inward toward the axis and thus forward to escape the beating or separating actions.

Referring to the first separating unit, comprising the vanes 61, the reduction of material is not merely by impact but also by attrition as the particles roll or slide along the surfaces of the vanes or enclosing rims. In Fig. 5 the whirling motion is diagrammatically illustrated by the long arrows *a* and the forward progress by the short arrow *b*. The proportions are not intended to represent actual conditions as the whirling or peripheral component may be many times as great as the progressing or axial component. The resultant of the two components is an inclined or helical motion or travel, and this tends to carry the particles slightly into the separation spaces, with the results as stated. As shown in Fig. 1, in each separating unit the forward passages between the vanes are preferably tapered by reason of the flared shape of the inner walls or rims.

The action at each separating device is a selective separation by passing the finer and rejecting the coarser particles. The combined walls 66, 56, 76, 56 and 86 form a barrier compelling all particles to undergo the selective separation, and in this action the closed webs or disks 67, 55 and 87 cooperate, especially the webs of the barrier walls at each set of vanes.

Between the casing and the combined barrier walls, the enclosed peripheral space may be considered as an annular zone in which the beating and separating actions occur, and the purpose of the barrier is to confine the whirling materials to this annular reduction zone.

In the second reduction zone the beaters are shown in two series and in staggered relation, owing to which any substantial particle passing forwardly through this zone is subjected to reduction not only at the first series or hammers 58, but again at the second series 59, thus multiplying the reduction action.

At the second separating point the vanes 71 are shown substantially inclined at what may be termed a reverse slant or backward incline. This gives a far more effective separating or excluding action since particles of appreciable momentum are positively thrown back by the camming action of the back-slanted surfaces. In this way any particles that stubbornly resist reduction are repeatedly thrown back into the reduction chamber and undergo repeated attrition before advancing.

The vanes 71 are shown in Fig. 5 at an angle of about 45°, but they may be at a lesser or greater angle. For example, they may be at the greater angle of 60° as shown at 61^a in Fig. 6, giving a more thorough separating action. Diagrammatically are shown in Fig. 6 the arrows *a* and *b* with the resultant arrow *c* indicating in a general way the motion of the particles and making clear the action of the vanes 61^a in throwing back any particles too heavy to be floated forwardly with the air stream diverted by the vanes. Only impalpably fine coal is carried forwardly between the vanes into the next reduction chamber.

A modified arrangement is that shown in Fig. 7 wherein the vanes 61^b are of double incline shape, like arrow heads, directed toward the whirling motion. The first part of each vane gives the described separating and rejecting action, while the second part tends to expedite the forward progress of the air and finest particles, thus preventing back pressure in the succeeding chamber and facilitating progress through the pulverizer. In each case the first or entrance part of the vane is back slanted to afford positive separating action.

The final beaters 58^a and 59^a are similar to 58 and 59, but are more numerous so as to give a greater number of impacts at this final stage. The final vanes 81 and 81^a afford a separating action, while the extensions 81^b or some of them facilitate the drawing inwardly, toward the axis, against centrifugal force, of the fuel-laden air to the contracted outlet 24 delivering into the fan chamber. The web 87 cooperates in this, and together with its outer portion, formed as the barrier 86, compels the whirling materials to advance only through the separating vane unit 81, 81^a.

There has thus been described a pulveriz-

ing machine embodying the principles and attaining the objects of the present invention. Since various features of operation, combination, arrangement and construction may be modified without departing from the principles involved it is not intended to limit the invention to such features except to the extent set forth in the appended claims.

What is claimed is:

1. A pulverizing machine having a substantially cylindrical casing, a rotary reducing device operating in a peripheral annular zone in the casing, a set of separating vanes located beyond the beating device in said annular zone, and a barrier wall confining the whirling materials to such zone and compelling them to undergo the reducing and separating actions.

2. A pulverizing machine having a casing, and means for maintaining progressive advance of air therethrough, rotary beating means operating in an annular zone within the casing and adapted to cause whirling of the air and material to be pulverized, a relatively stationary device succeeding the beating means comprising whirl obstructing vanes in such annular zone, and walls confining the whirling materials to the annular zone.

3. A pulverizing machine having a casing, and means for maintaining progressive advance of air therethrough, a rotary beating device adapted to cause whirling of the air and material to be pulverized, a second such beating device spaced from the first, a relatively stationary device between the beating devices comprising means for selectively separating and throwing back heavier particles, and a barrier wall confining the whirling materials to the peripheral space within the casing.

4. A machine as in claim 1 and wherein is a transverse wall extending across and closing the space inside the annular zone and vanes.

5. A machine as in claim 3 and wherein is a closing disk extending across the space from one side to the other inside the barrier wall.

6. A machine as in claim 3 and wherein each rotary beating device comprises beaters carried on a closed web compelling the materials to progress in the annular space outside the barrier wall.

7. A pulverizing machine having a casing, and means for maintaining progressive advance of air therethrough, a central shaft, a rotary beating device adapted to cause whirling of the air and material to be pulverized, comprising a disk on the shaft, a barrier wall at the disk periphery, and beaters exterior to the barrier wall, a selectively separating device succeeding the beating unit and having a closed wall extending substantially to the shaft and a barrier wall at the periphery thereof, in alinement with the first barrier wall, whereby the whirling materials are confined to the peripheral space within the casing, and thereby compelled to undergo beating and separating actions.

8. A pulverizer comprising a power shaft, a concentric casing, a circular series of separating elements or vanes extending partially inwards from the casing and enclosing flow spaces, a barrier wall closing the inner sides of such flow spaces, a closed disk extending from the shaft to the barrier wall, and a reducing device on the shaft immediately in advance of the barrier wall and disk.

9. A pulverizing machine having a casing, and means for maintaining progressive advance of air therethrough, a rotary beating unit adapted to cause whirling of the air and material to be pulverized, and a relatively stationary unit succeeding the beating unit comprising vanes arranged at a slanting angle to cause whirling particles of excessive size to be selectively separated and diverted back towards the beating unit.

10. A pulverizing machine having a casing, and means for maintaining progressive advance of air therethrough, a rotary beating unit adapted to cause whirling of the air and material to be pulverized, and a relatively stationary unit succeeding the beating unit comprising vanes arranged at a slanting angle to cause whirling particles of excessive size to be selectively separated and diverted back towards the beating unit while the finer particles are carried forward with the air stream between the separating vanes.

11. A pulverizing machine having a casing, and means for maintainng progressive advance of air therethrough, a shaft in the casing, a rotary beating unit on the shaft adapted to cause whirling of the air and material to be pulverized, a second such unit spaced from the first, and a relatively stationary unit between the beating units comprising vanes arranged at such a slanting angle that heavy whirling particles impacting the vanes are selectively separated and diverted back.

12. A pulverizing machine having a casing, and means for maintaining progressive advance of air therethrough, a rotary beating unit adapted to cause whirling of the air and material to be pulverized, and a relatively stationary vane unit succeeding the beating unit comprising whirl obstructing vanes, a second beating unit succeeding the vane unit, and a second vane unit succeeding the second beating unit, the vanes of the second unit having a greater back slant than those of the first unit to give a finer selective separation of heavier particles.

13. A pulverizing machine as in claim 12 and wherein the first vanes are axially arranged and the following vanes at a decided back slant.

14. A pulverizing machine as in claim 12 and wherein the final vanes, following the final beating unit are inclined, and continued

as axial walls extending to the casing outlet.

15. A pulverizing machine as in claim 9 and wherein the vanes are V-shape, the first portion slanted as stated, the second portion reversely slanted to assist progress of air and finer particles.

16. A pulverizing machine as in claim 10 and wherein is a barrier wall between which and the casing is an annular zone in which the vanes are located.

17. A pulverizing machine as in claim 12 and wherein is a barrier wall confining the whirling materials to the annular zone in which the vane units are located.

18. A pulverizing machine having a substantially cylindrical casing, and means for maintaining longitudinal advance of air therethrough, a central shaft for high speed rotation, a plurality of rotary beating units on said shaft adapted to operate in the peripheral annular zone in said casing to cause whirling of the air and material to be pulverized, a relatively stationary device in the annular zone between two beating units comprising a system of whirl obstructing vanes extending inwardly from the casing and arranged at a slanting angle to divert the heavier particles reversely, and a barrier wall spaced concentrically within the casing and enclosing said peripheral annular zone whereby the progressing materials are confined to said zone subject to the action of the beating units and the diverting vanes.

19. A pulverizing machine comprising a casing having a central discharge, a rotary reducing unit therein operating in a peripheral annular zone, a vane unit following the reducing unit comprising a set of vanes in such zone for separating and selectively throwing back heavier particles while permitting the advance of air and finer particles between the vanes, said vanes having a barrier preventing the materials passing inwardly from such zones, a second such reducing unit, and a final vane unit, comprising separating vanes extended axially and then inwardly to the central discharge and having a barrier confining the materials to the annular zone between the vanes and extended inwardly to prevent access to the discharge except through such zone and along the inward extensions of the vanes.

20. A pulverizing machine having a substantially cylindrical casing, and means for maintaining longitudinal advance of air therethrough, a central shaft for high speed rotation, a beating device on said shaft operating in an annular zone to cause whirling of the air and material to be pulverized, a set of separating vanes succeeding said beating device extending between the casing and a barrier wall in such annular zone, such barrier wall, and a disk closing the space between such barrier wall and the shaft, a second beating device on the shaft, having a barrier wall in alinement with the first barrier wall, a second set of separating vanes succeeding the second beating device arranged at a back slant to throw back heavier particles, and having a barrier wall in alinement with the second barrier wall.

21. A pulverizing machine having a cylindrical casing with central outlet to a suction fan, a central shaft, one or more rotary devices on said shaft with peripheral beaters adapted to cause whirling of the air and material to be pulverized, a stationary system of whirl obstructing peripheral vanes succeeding the final beating device, the same having continuations extended toward the shaft to carry the flow to the casing outlet, and a closed wall forming a barrier within the peripheral vanes and extended inwardly toward the shaft.

22. A machine as in claim 21 and wherein the closed wall is spaced from the casing end wall to afford passages between the vane continuations, and is curvedly extended toward the outlet to afford a smooth delivery to the fan.

In testimony whereof, this specification has been duly signed by:

PAUL ARTHUR HIRSCH.

CERTIFICATE OF CORRECTION.

Patent No. 1,744,895. Granted January 28, 1930, to

PAUL ARTHUR HIRSCH.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 6, line 44, claim 19, for the word "zones" read "zone"; same page and claim, strike out lines 45 to 47 inclusive, and insert instead "unit, and a final vane unit, comprising separating vanes extended axially and then inwardly to the central discharge and having"; and that the said Letters Patent should be read with these corrections there in that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of May, A. D. 1930.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)