United States Patent [19]

Hare

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[54] **PELLETIZER**

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[52] **U.S. Cl.** **425/222,** 264/117

[51] **Int. Cl.** **B29b 1/03**

[58] **Field of Search** 425/222; 264/310, 264/117

[56] **References Cited**

UNITED STATES PATENTS

2,306,698	12/1942	Heller	425/222 UX
2,861,294	11/1958	Gloxmer et al.	425/222
3,049,750	8/1962	Austin	425/222

FOREIGN PATENTS OR APPLICATIONS

2,826,647	10/1965	Australia	425/222

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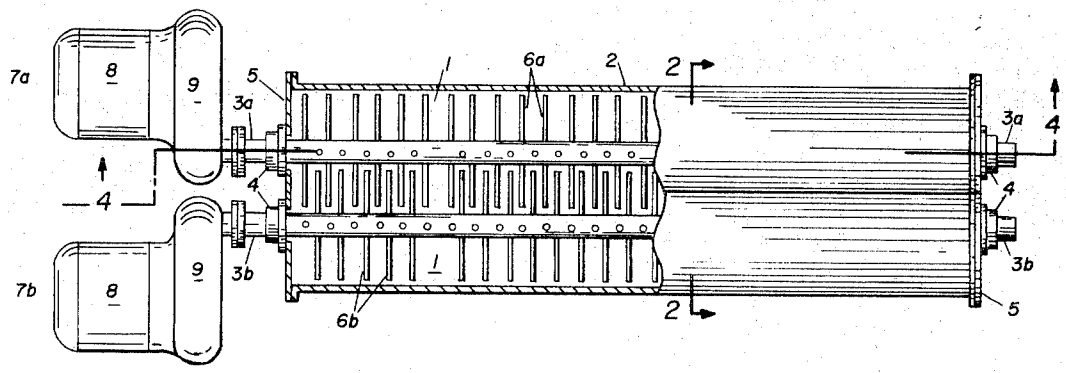
[57] **ABSTRACT**

A powder pelletizer having twin shafts which extend axially through an elongated conduit which bounds the pelletizing zone. Each of the shafts has a multiplicity of agitating members affixed thereto at spaced intervals along the length of the shaft and which extend radially outward therefrom. The agitating members of each shaft are arranged to move into and out interdigitating relationship with agitating members of the other shaft upon rotation of both shafts. The longitudinally extending peripheral wall of the conduit bounding the pelletizing zone is proximal to the tip-ends of the agitating members which are not interdigitating during rotation of the shafts.

10 Claims, 6 Drawing Figures



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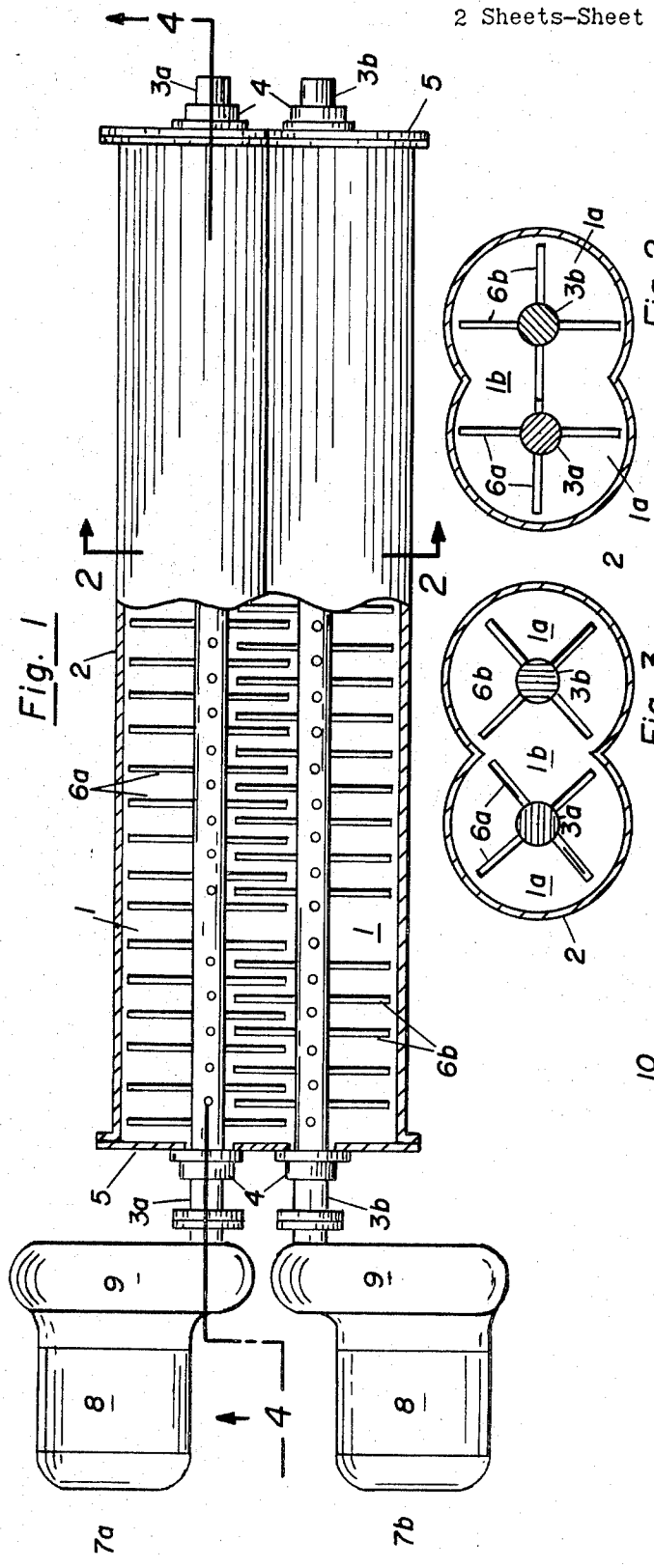

Fig. 1

Fig. 2

Fig. 3

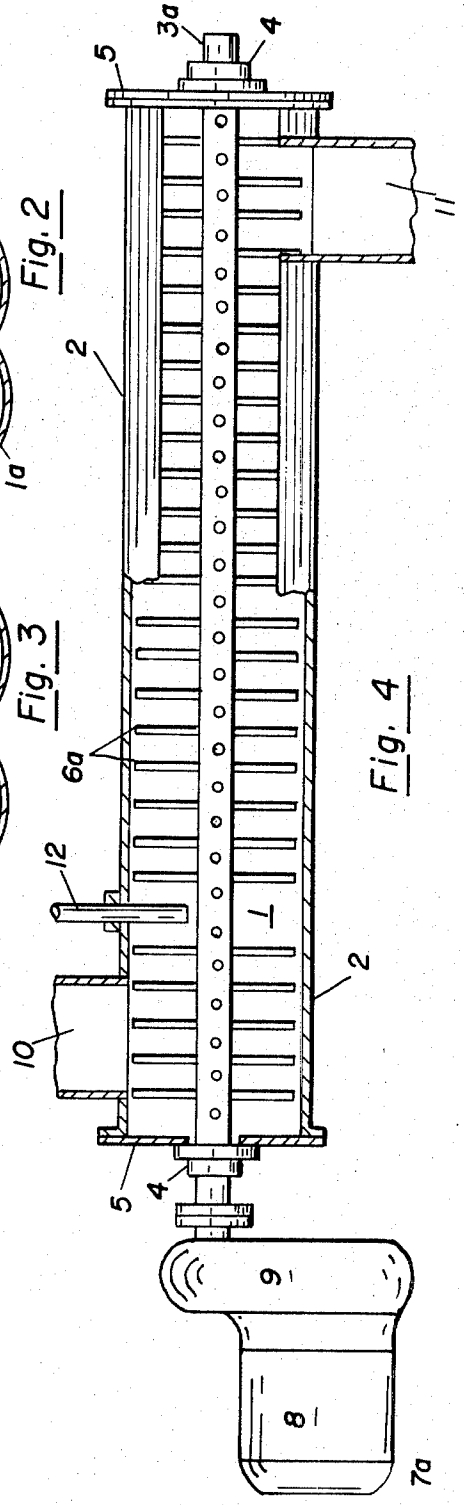

Fig. 4

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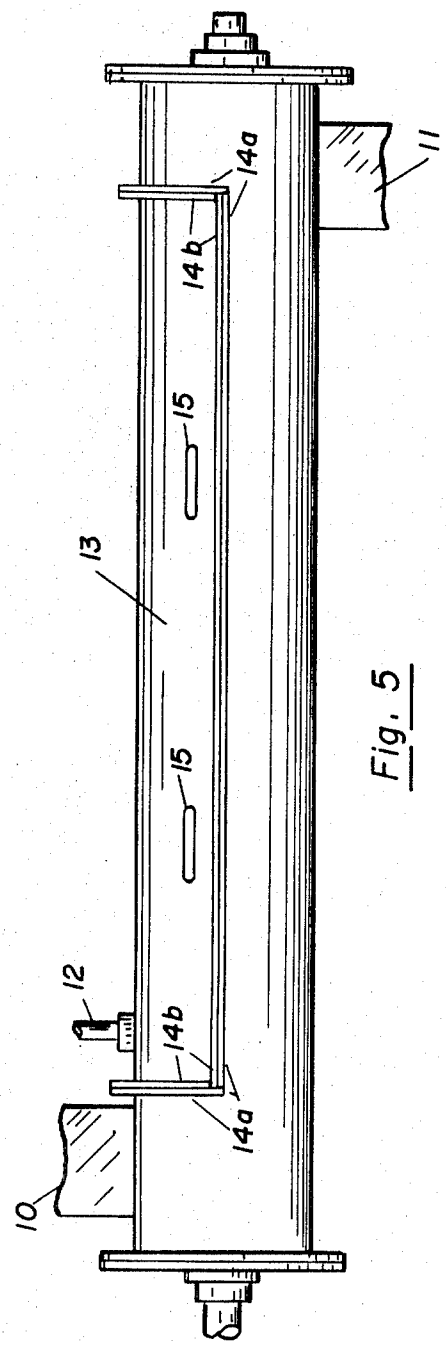

Fig. 5

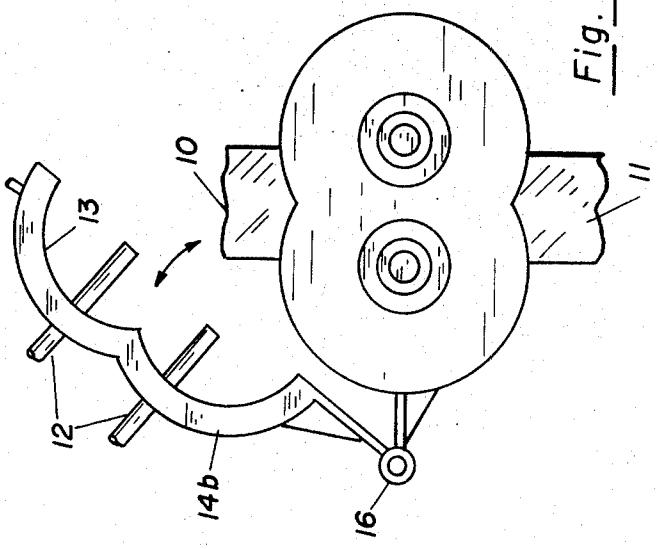

Fig. 6

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PELLETIZER

BACKGROUND OF THE INVENTION

The present invention pertains to improved apparatus for the pelletizing of powders. This invention resides in the general area of powder pelletizers having an elongated pelletizing zone, a rotatable shaft which extends through the zone, and a multiplicity of agitating members fixed at spaced intervals along the length of the shaft and which extend radially outward therefrom. By rotation of the shaft, the powder, usually wetted with a pelletizing amount of liquid pelletizing medium, is thus agitated and pelletized while also being advanced from the powder inlet of the pelletizing zone to the pellet outlet thereof.

In prior pelletizers usually only one shaft having agitating members affixed thereto extends through the pelletizing zone. By rapid rotation of the shaft, the powder is not only moved axially through the pelletizing conduit but is also slung outward against the wall thereof where it forms an annular mass. The tips of the agitating members move through this annular mass, thus cutting through it and thereby agitating and forming pellets of the powder particles in the mass, while also imparting same degree of rotary motion thereto, i.e., there is a tendency for the annular mass to spin in conjunction with the agitating members, and were it not for the friction provided by the pelletizer wall, the mass would spin at the same speed as the shaft and thus eliminate any agitation of the mass caused by transversal movement of the agitators through the same. Therefore, although effective for the formation of pellets, there is nonetheless a limit to the amount of pelletizing work which can be transferred into the powder mass by means of the method just described.

In order to increase the amount of work which can be effectively utilized to advantage in pelletizing powders, Glaxner and Kilpatrick provided a method and an apparatus as described in U.S. Pat. Nos. 2,828,191 and 2,861,294. As shown therein, the second pelletizing chamber 9 is provided with three parallel shafts 10 having agitating members 9*a*. The agitating members of each shaft are arranged to move into and out of interdigitating relationship with agitating members of an adjacent shaft upon rotation of the shafts. Agitation of the powder is thus accomplished by interdigitation of the members; i.e., the powder mass is very forcefully cut by closely spaced members which move in opposite directions upon counterwise rotation of the shafts.

However, in the method disclosed by Glaxner and Kilpatrick in the aforementioned patents, the movement of the powder mass from inlet to outlet of chamber 9 is transverse, rather than axial, with respect to extension of the shafts 10. In addition, the wall of chamber 10 does not conform to the circular path followed by the agitating members 9*a* of each of the shafts and is thus not proximal to the tip-ends of the members which are not in an interdigitating relationship. As a consequence of such an arrangement, there is little or no drag of the wetted powder against the wall of chamber 9, and this aspect of developing pelletizing work is, therefore essentially nonexistant within the system. It will also be noted that there is no provision for coextensive mixing of powder and liquid and the formation of wet pellets in chamber 9, i.e., these steps are accomplished beforehand in a first chamber 1.

This particular method of Glaxner and Kilpatrick is therefore somewhat elaborate and not altogether satisfactory for developing maximum pelletizing work. It will be appreciated that pelletization rate, density, and any amount of pelletizing liquid which may be required are a function of the amount of work delivered to the powder mass during agitation, i.e., as the work is increased the pellet formation rate and density increase and the required amount of a pelletizing liquid decreases.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an improved pelletizer for the pelletizing of powders.

Another object of this invention is to provide a pelletizer whereby the amount of work expended into a mass of powder during the pelletizing thereof can be greatly increased.

Still another object is to provide a pelletizer whereby mixing of a liquid with a powder and pelletization of the powder are carried out coextensively.

Yet another object is to provide a pelletizer having ready access to the pelletizing zone.

Other objects and advantages of the present invention will become apparent from the following description and the appended claims.

The pelletizer of the present invention comprises an elongated pelletizing conduit which bounds a zone for the pelletizing of powder, and having an inlet for powder toward one end thereof and an outlet for pellets toward the other end thereof. Two rotatable shafts extend axially through the conduit, and each shaft has a multiplicity of agitating members affixed thereto at spaced intervals along the length of the shaft and which extend radially outward therefrom. The agitating members of each shaft are adapted for movement into and out of interdigitating relationship with the agitating members of the other shaft upon rotation of both shafts. The pelletizing conduit has a curved, longitudinally extending wall which bounds the periphery of the pelletizing zone and is proximal to the tip-ends of the agitating members which are out of interdigitating relationship during rotation of the shafts. Means are also provided for rapidly rotating the shafts.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view, partly in section, of a pelletizing apparatus for forming pellets in accordance with the present invention.

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1 and show agitating members of each shaft in full interdigitating relationship with members of the other shaft.

FIG. 3 is the same as FIG. 2 except for showing the agitating members of each shaft just after they have moved out of interdigitating relationship, this being caused by rotating each shaft through 45° from the positions shown in FIG. 2.

FIG. 4 is a side view, taken along line 4—4 of FIG. 1.

FIG. 5 is a side view of the pelletizer of FIG. 1, but equipped with an access panel, or door, in the wall of the pelletizer conduit, the door being shown in the closed position.

FIG. 6 in an end view from the left of the pelletizer of FIG. 5 showing the access door in an open position.

DETAILED DESCRIPTION OF THE INVENTION

The pelletizer comprises an elongated pelletizing zone, generally represented at **1**, which is bounded by a pelletizing conduit **2** having the cross-sectional configuration of two overlapping circles having the overextending segment of each circle removed, e.g., as in FIGS. **2** and **3**, and thus providing communication between the two partially cylindrical bilateral halves of the pelletizing zone over its full length. Each side of the pelletizing conduit, i.e., each partial cylinder, is fitted with a rotatable shaft, **3***a* and **3***b*. Each shaft extends axially through the pelletizing zone along the axis of the partial cylinders. The shafts are supported by bearings **4** mounted on end-closure plates **5** for the pelletizer conduit. Each shaft is provided with a multiplicity of elongated agitating members **6***a* and **6***b*, hereinafter referred to as "pins," which are fixed at spaced intervals along the length of the shaft and which extend radially outward therefrom. The lateral spacing of the parallel shafts and the length of the pins is such that the pins overlap each other upon rotation of the shafts. However, the longitudinal spacing of the pins along one shaft is staggered with respect to the spacing on the other, so that the pins do not collide upon rotation of the shafts but rather clear each other and thus effect interdigitation of the pins of one shaft with the pins of the other.

Each shaft is equipped with a variable speed drive unit, generally represented at **7***a* and **7***b* consisting of an electric motor **8** and a speed reducer **9**.

The pelletizing zone has an inlet **10** toward one end for the introduction of powder to be pelletized and an outlet **11** toward the other end for the removal of pellets.

A liquid supply conduit **12** extends through the conduit **2** for introducing a liquid pelletizing medium into the pelletizing zone. Two such conduits can be employed, as shown in FIG. **6**, for introducing liquid into each partial cylinder of the pelletizing conduit. The method and means described in U.S. Pat. No. 3,535,412 is preferred for injecting the liquid longitudinally into the pelletizing zone and mixing it with the powder therein.

Although not essential, the pelletizer can be provided with a panel, or door, which provides ready access to the pelletizing zone for inspection, cleaning, and replacement or repair of the pins. FIGS. **5** and **6** show the pelletizer equipped with a door **13**, which is in fact a removable section of the curved, longitudinally extending conduit wall **2**, but equipped with flanges **14***a* and **14***b* so that the door can be provided with a seal and fastened in place. For obtaining access to the pelletizing zone, the door is unfastened and is then removed using handles **15**. More conveniently, however, the door can be provided with a hinge **16** so that the pelletizer can be more easily opened and closed.

In operation, powder and a liquid pelletizing medium can be fed into the pelletizer simultaneously at predetermined rates through the powder inlet **10** and the liquid conduit **12**, respectively. The proportion of powder-to-liquid feed, i.e., an amount which results in the formation of pasty wet pellets rather than "dusting out" as occurs from use of insufficient liquid or "mudding out" which results from using an excess liquid. The exact proportions necessary for formation pellets are usually well known to those skilled in the art of pelletizing any particular powder with a given liquid, but can be easily determined in any case by means of a few simple experiments. Where preferred, the powder and pelletizing liquid can be combined prior to introduction into the pelletizer, but mixing of the two can usually be accomplished very quickly and efficiently in the pelletizer, thus obliviating a need for premixing.

Within the pelletizing zone, the wetted powder mass is vigorously agitated by rapid rotation of the shafts **3***a* and **3***b*, which causes the pins **6***a* and **6***b* to move through the mass. Rotary motion of the shafts gradually advances the wetted powder axially through the pelletizing zone toward the outlet **11**, and also rapidly swirls the powder so that it is slung out against, and is moved around, the curved wall of the conduit **2**. The other portion lies toward the center of the pelletization zone, section **1***b*.

It will be noted that the curved, longitudinally extending peripheral wall of the conduit **2** closely conforms to the circular path of rotation of the tip-ends of pins **6***a* and **6***b* which are not interdigitated. Any of members **6***a* and **6***b* which are out of interdigitating relationship during rotation of the shafts are thus moving through that portion of the mass against the wall of conduit **2**. As this portion leaves the wall and moves into the central section **1***b* of the pelletizing zone, it is subjected to the action of pins moving into and out of interdigitation and thereafter moves back to the wall. Accordingly, the mass of wetted powder being agitated and pelletized is repeatedly circulated from the wall of the pelletizing conduit to the interdigitating members and then back to the wall as the mass also advances axially toward the outlet of the pelletizing zone.

It will thus be appreciated that two different agitating actions are carried out concurrently on the same mass of powder, each of which is very intense and adjunctive to the other in the forming of pellets. By virtue of the fact that the conduit wall is proximal to the tip-ends of all pins in the pelletizing zone which are not in an interdigitating relationship, none of the work available from their motion is wasted, i.e., the non-interdigitating pins not only move the wetted powder over the pelletizer wall—which in itself causes considerable agitation and tumbling of the particles—but since the pins are moving relatively faster than the wetted powder, they also cut through it and cause additional agitation and tumbling of the powder. Further in addition to this, of course, there is the agitation and tumbling in the central portion of the pelletizing zone which results from interdigitation of the pins. Intense tumbling results from the close passage of the pins in their movement by each other while the powder is trapped between them. This action is most intense when the shafts are rotated in the same direction since the pins move in relatively opposite directions during interdigitation, but excellent results can also be obtained when the shafts are rotated in opposite directions and the pins move in the same relative direction.

It will be appreciated that various combinations of shaft speed and rotational direction can be established for varying the conditions of agitation to obtain the most desired results. As previously indicated, the shaft rotation can be the same or opposite, and the shaft speeds can be the same or different to the extent desired. Where preferred, the shafts can be operated

using one motor and a gear system which establishes the sought direction of shaft rotation and speed. More convenient, however, is the arrangement described with reference to FIGS. 1–4 wherein independent, variable speed drive units are employed for each shaft. To additional advantage, one or both of these drive units can be reversible for changing the direction of shaft rotation.

The minimum speed at which the shafts should be turned is widely variable depending upon what particular results desired with respect to mean pellet size, pellet size distribution, production rate, and the like. Generally, speeds which provide a pin tip velocity of at least about 15 feet per second can be employed to advantage, and preferred speeds are generally within the range of about 20 to about 50 feet per second.

It will be understood that although the present invention is being described and claimed with reference to pelletizers having two shafts equipped with interdigitating pins, the invention is not thus limited, i.e., three or more shafts arranged to effect the inventive features described herein must also be regarded as embodiments of the present invention.

The described pelletizer herein has been utilized to great advantage in producing wet pellets of a powder at a greatly increased rate, which are denser after drying, and at a somewhat reduced requirement of a liquid pelletizing medium. It is felt that these benefits are provided by the ability to transfer substantially larger amount of pelletizing work into the wetted powder mass during the pelletizing process.

The invention has been described with reference to particular apparatus arrangements and process conditions, but it will be understood that even more embodiments will become apparent which are within the spirit and scope of the invention defined by the following claims.

Therefore, what is claimed is:

1. Pelletizer comprising:

a. an elongated pelletizing conduit which bounds a pelletizing zone, said conduit having partially cylindrical bilateral halves and a cross-sectional configuration of two overlapping circles with the overextending segment of each circle removed, thus providing communication between the two bilateral halves of the pelletizing conduit over the length of the pelletizing zone,

b. an inlet for powder toward one end of the pelletizing conduit and an outlet for pellets located toward the other end,

c. two rotatable shafts which extend through the elongated pelletizing conduits, one of said shafts extending axially through one of the partially cylindrical bilateral halves and the other shaft extending axially through the other half,

d. a multiplicity of agitating members affixed to each shaft, the members being affixed to their respective shafts at spaced intervals along the length of the shaft and aligned to extend radially outward therefrom, the agitating members of each shaft being adapted for movement into and out of an interdigitating relationship with agitating members of the other shaft upon rotation of both shafts, the interdigitation of the members being in the central portion of the pelletizing zone within the conduit, the tip-ends of agitating members of each shaft which are out of interdigitating relationship being proximal to the curved wall of one of the bilateral partially cylindrical halves of the pelletizing conduit, and

e. means for rotating said shafts.

2. The pelletizer of claim 1 and further including a means for introducing a liquid into said pelletizing conduit separately from powder which is fed into said conduit.

3. The pelletizer of claim 1 wherein the means for rotating said shafts is adapted to provide a rotational tip velocity to said agitating members of at least about 15 feet per second upon rotation of said shafts.

4. The pelletizer of claim 1 in which the shafts are adapted to turn in the same direction.

5. The pelletizer of claim 1 in which the shafts are adapted to turn in opposite directions.

6. The pelletizer of claim 1 provided with means to vary the speed of at least one of the shafts during operation of the pelletizer.

7. The pelletizer of claim 1 having an access opening in the curved, longitudinally extending wall of the conduit which bounds the periphery of said pelletizing zone, and a panel which normally seals the access opening.

8. The pelletizer of claim 7 in which said panel section is part of said wall of said conduit.

9. The pelletizer of claim 8 in which said panel is adapted for removal from said pelletizer for obtaining access through the opening therefor.

10. The pelletizer of claim 8 in which said panel is hinged for obtaining access through the opening therefor.

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