Oct. 16, 1962 P. C. FIRING 3,058,673

APPARATUS FOR PULVERIZING MATERIAL

Filed April 4, 1961 3 Sheets-Sheet 1

Fig. 6.

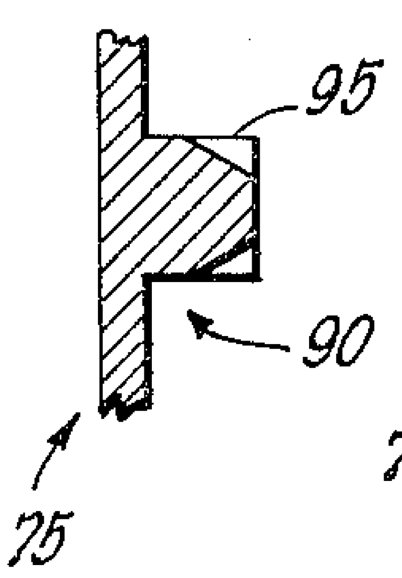


Fig. 7.

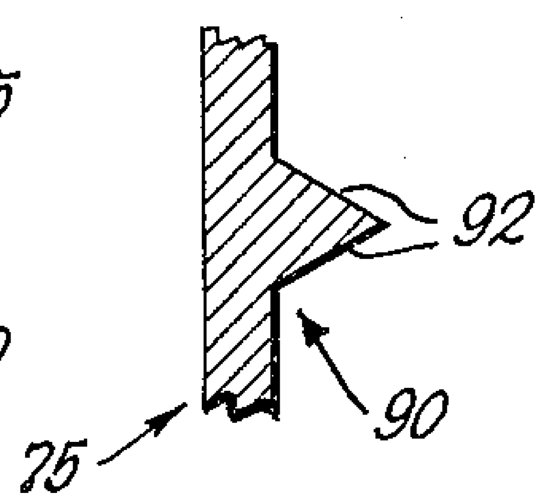
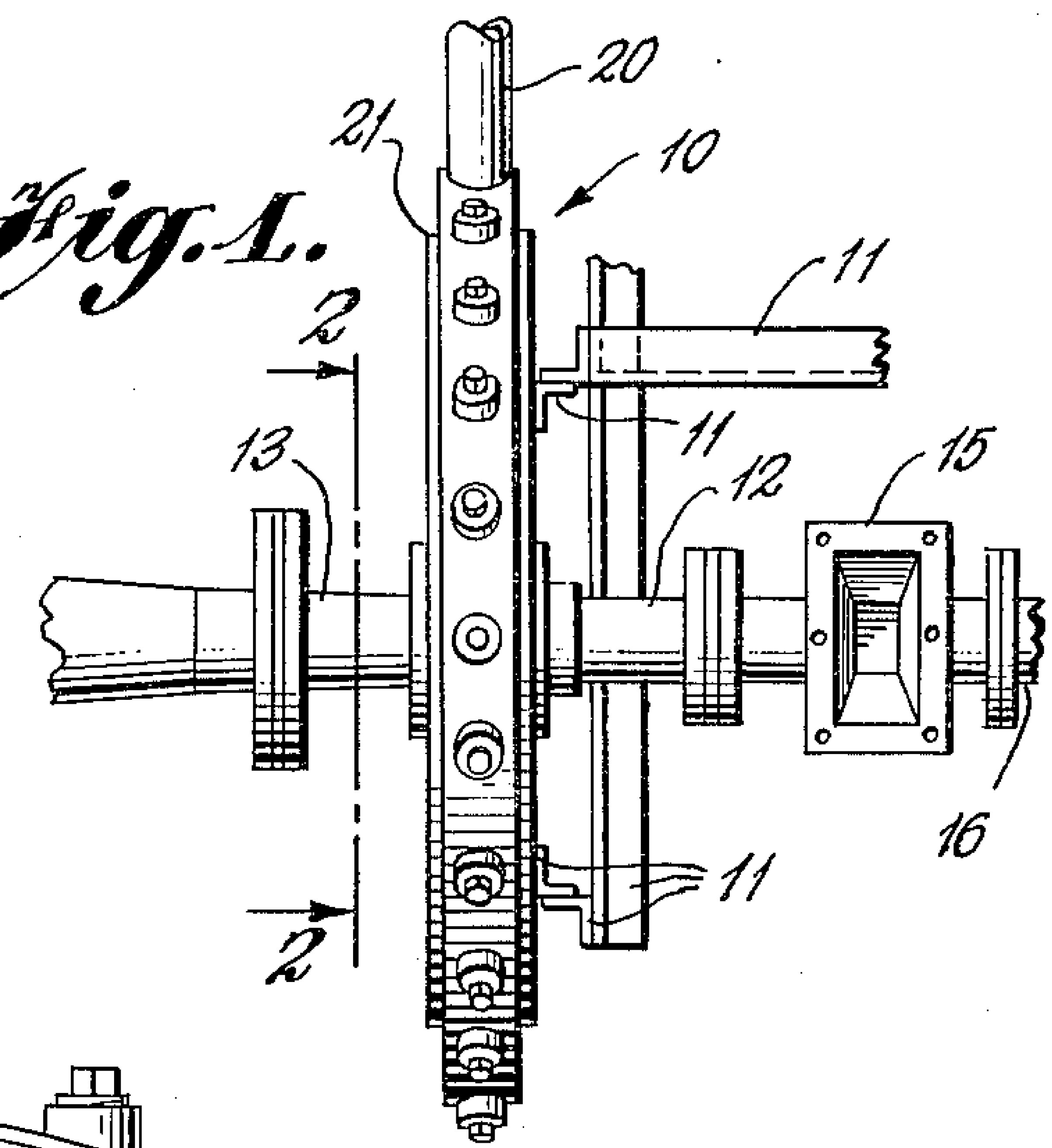


Fig. 1.



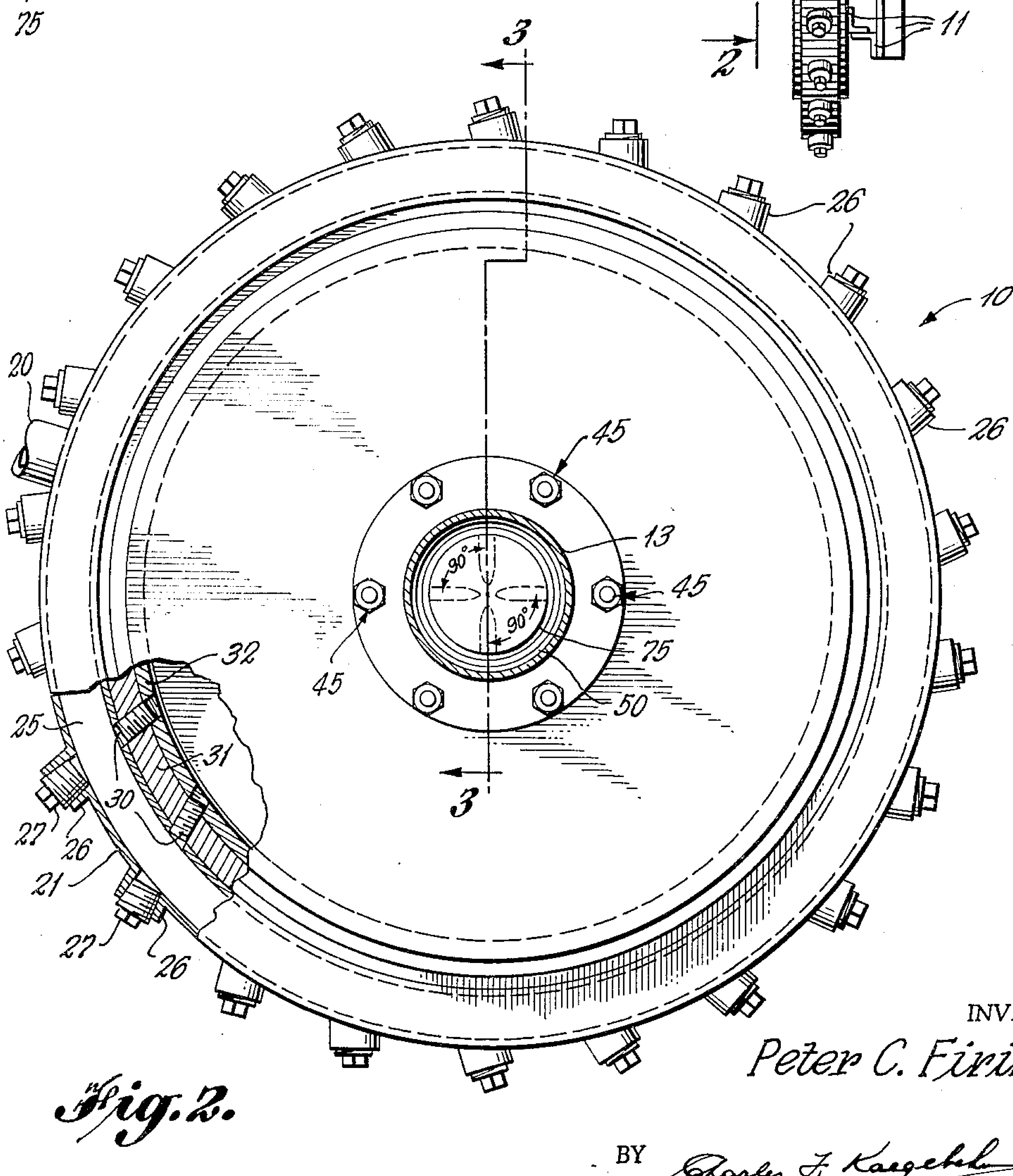


Fig. 2.

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Oct. 16, 1962 P. C. FIRING 3,058,673

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Filed April 4, 1961 3 Sheets-Sheet 2

Fig. 4.

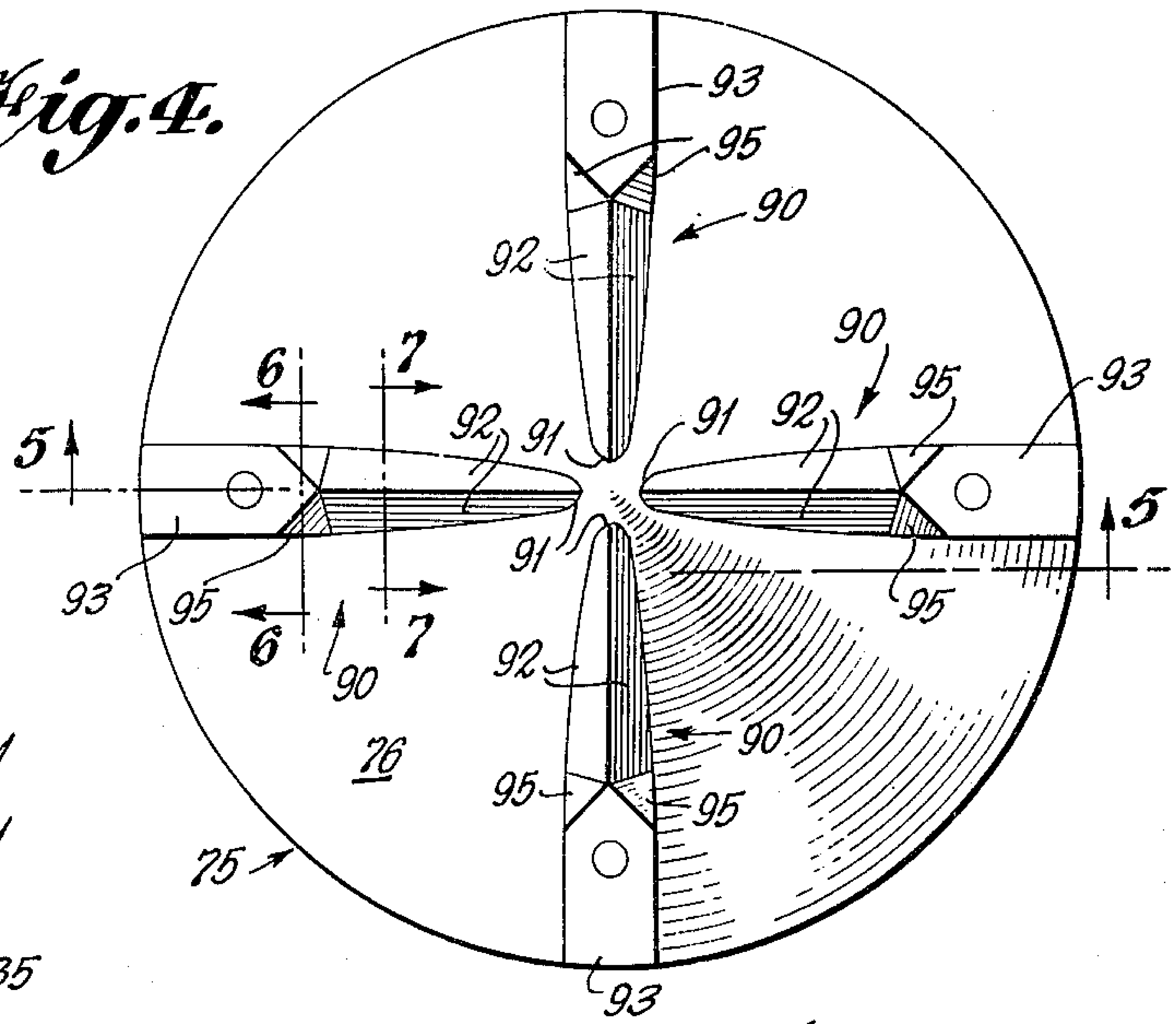
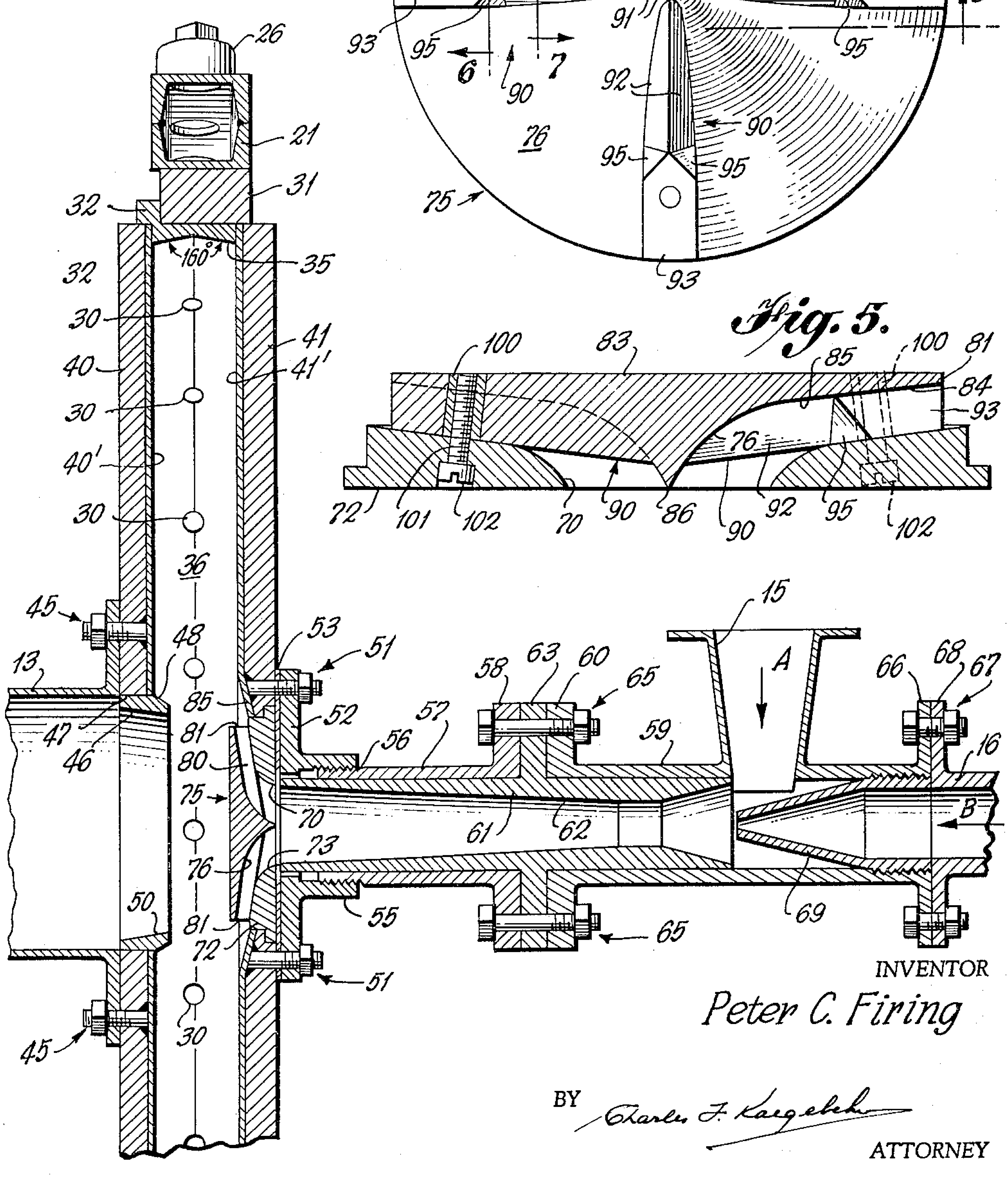


Fig. 3.

Fig. 5.



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Filed April 4, 1961 3 Sheets-Sheet 3

Fig. 8.

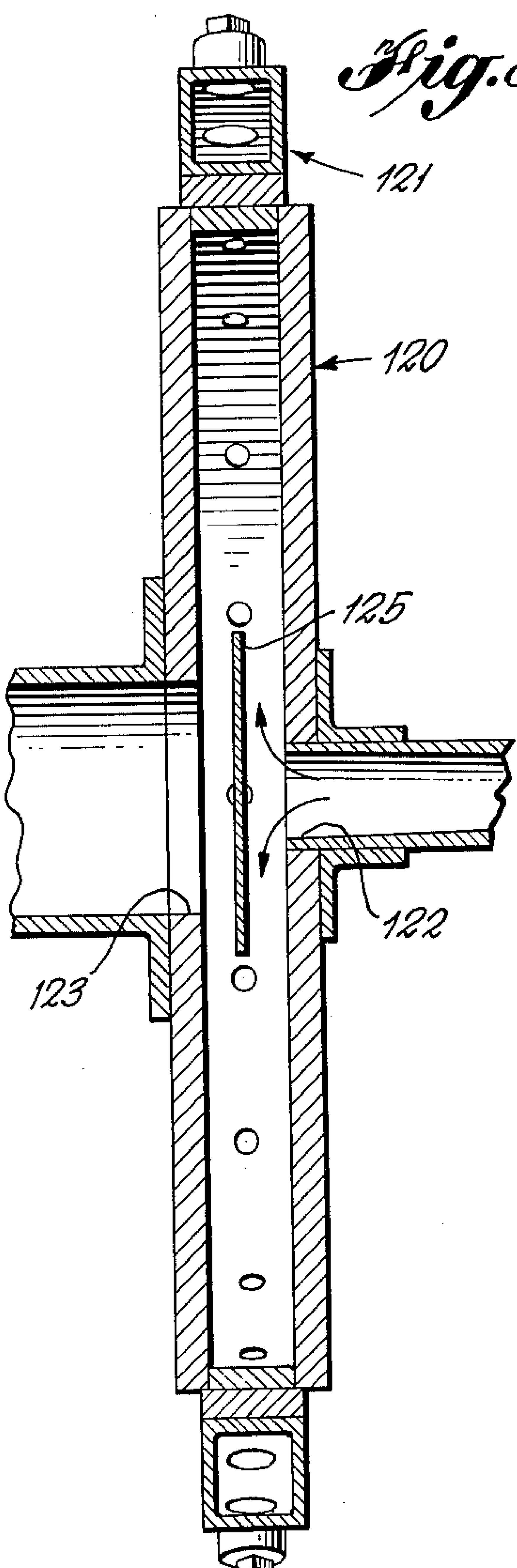


Fig. 9.

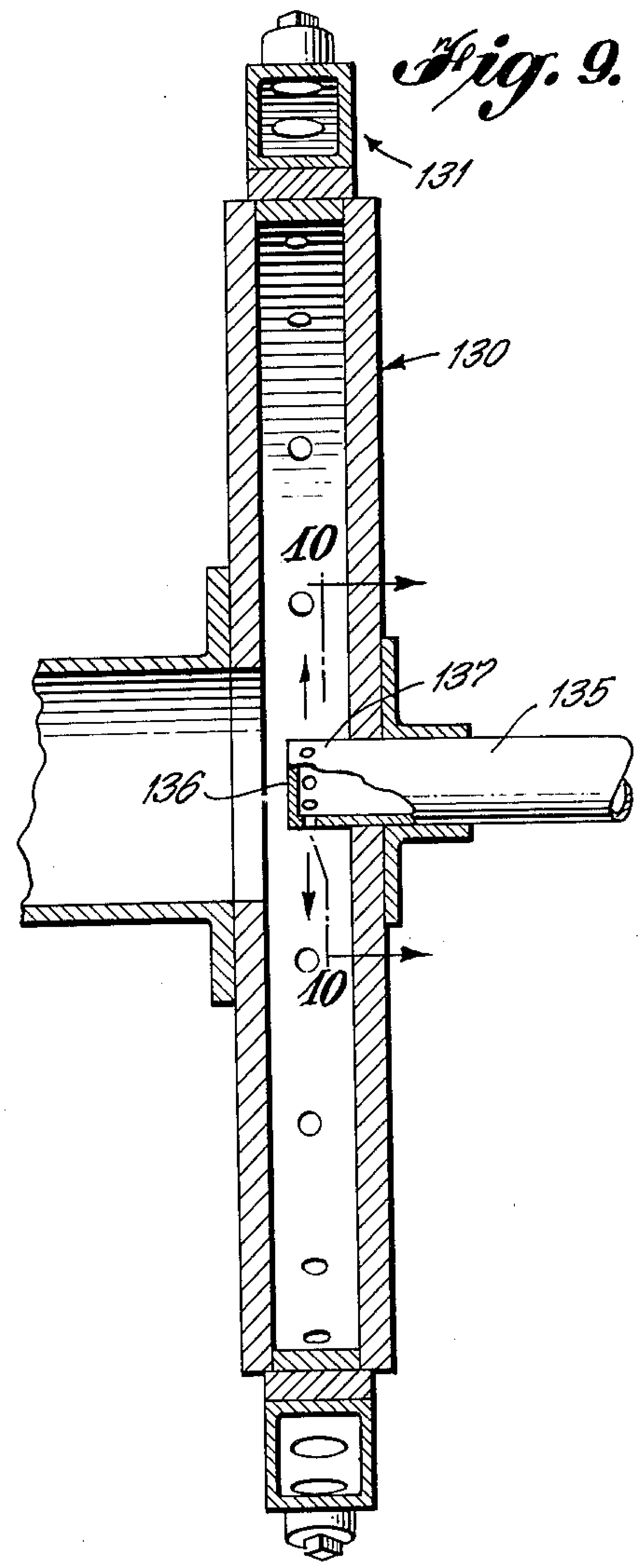
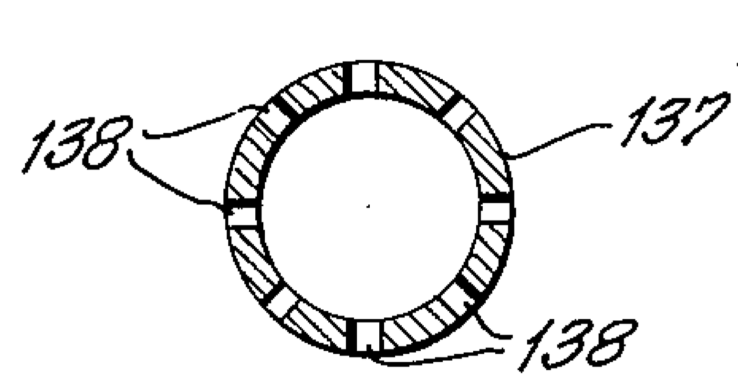


Fig. 10.



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APPARATUS FOR PULVERIZING MATERIAL

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5 Claims. (Cl. 241—39)

The present invention relates to a new and novel apparatus for pulverizing material, and more particularly to an arrangement wherein the material is fed into a treatment zone in a unique manner and relationship with respect to the outlet from the treatment zone.

The present invention is directed to arrangements for finely grinding material, such devices commonly being referred to as "micronizers." Such apparatus is employed for finely grinding various materials into a powder-like form and in typical applications, the apparatus may be used for grinding up coarse particles of silica sand, salt, calciner discharge pigment, and the like. The grinding action in micronizer devices is produced by attrition grinding or in other words, the particles of the treated material actually impact upon one another so as to physically tear the particles apart and reduce the size thereof.

Conventional micronizers generally provide a grinding chamber into which is directed a plurality of streams of gas under pressure, these streams being directed in such a manner as to produce a vortex within the grinding chamber. The material to be treated is fed into the chamber and the vortex action therewithin causes the particles to impact against one another, the larger particles being carried outwardly by centrifugal force and the finer particles drifting inwardly until they are withdrawn from the central portion of the grinding chamber.

The present invention provides a unique and improved manner of feeding the material to be treated into the grinding chamber, and in this respect represents a radical departure from the manner in which material is fed into prior art devices. In the prior art, the feed arrangement is so constructed that the material is introduced near the periphery of the grinding chamber or in any event at a point spaced radially outwardly or laterally of the outlet of the apparatus. This has beeen considered to be necessary in order to prevent the outlet vortex from entraining coarse particles as they enter the grinding chamber. It is, of course, evident that any coarse particles which might travel from the inlet directly to the outlet would not be properly processed, and accordingly, the device would not function in the desired manner. Any tendency of the coarse particles to prematurely be withdrawn through the outlet is commonly referred to as "shortcircuiting."

In addition, the prior art feeding arrangements generally introduce the material to be treated at an angle such that the direction of movement is forwardly in the direction of rotation maintained within the grinding chamber by the streams of gas under pressure. This arrangement further assists in reducing the tendency for the coarse particles to be shortcircuited through the apparatus.

Notwithstanding the various arrangements and precautions which have been taken in prior art methods and apparatus, there still remains a marked tendency for coarse particles to shortcircuit through the apparatus thereby reducing the efficiency of operation. It is a particular feature of the present invention to provide a novel feed arrangement which minimizes such chort-circuiting, and in addition provides other advantages.

In the present invention, the inlet to the grinding chamber is disposed axially of the apparatus, and is axially aligned with and directly opposite to the outlet from the grinding chamber. Flow directing means is disposed adjacent the inlet for changing the direction of movement of the inflowing material. This flow directing means is so

constructed that the material is directed substantially radially of the grinding chamber toward the outer periphery of the grinding chamber and away from the outlet. In addition, the construction of the flow directing means is such that the inflowing material is distributed in all directions so as to get a very uniform distribution thereof within the grinding chamber.

As a result of the novel feeding arrangement of the present invention, the particles of material are initially directed radially outwardly such that they must completely reverse their direction of travel in order to reach the outlet of the grinding chamber. The outwardly directed force acting on the particles tends to cause the larger particles to move to the outer periphery of the chamber which is a desirable feature, and the inflowing material and the streams of gas under pressure are initially generally moving in directions normal one to the other. These combined factors produce a more uniform retention of the particles within the grinding chamber, thereby resulting in an increased number of impacts of the different particles upon one another thereby enhancing the attrition grinding effect.

As a result, a more uniform fineness of grinding is obtained, and the possibility of coarse particles being shortcircuited through the apparatus is substantially reduced.

With the novel construction of the present invention, it has been found that a greater throughput is possible thereby substantially increasing the productivity of the apparatus. Further advantages accruing as a result of the novel structural arrangement have been less wear on the annular side wall of the grinding chamber and the jet nozzles through which the streams of gas under pressure are introduced, and furthermore the consumption of gas, for example steam, under pressure has been found to be reduced from 10 percent to 40 percent.

An additional feature of the present invention is the construction of the annular side wall of the grinding chamber. This side wall is constructed so as to be a recessed annular central portion, which is preferably provided by forming the inner surface of the side wall with a substantially V-shaped cross-sectional configuration. This construction is provided since the treated material in prior art structures exhibited a tendency to ride along the portions of the side wall adjacent to the two end walls thereby slipping by the jets. This undesirable action is avoided in the present invention since centrifugal force will cause the material to be forced along the sloping surfaces of the side wall toward the central portion of the side wall whereat the jets are located thereby ensuring that the particles of material will be impinged upon by streams of gas under pressure.

An object of the present invention is to provide a new and novel apparatus for pulverizing material which provides a substantially uniform fineness of grinding and which substantially eliminates internal shortcircuiting through the apparatus.

Another object of the invention is the provision of appartus for pulverizing material which permits a higher rate of production.

A further object of the invention is to provide pulverizing apparatus wherein there is less wear on the side wall and nozzle portions thereof.

Still another object of the invention is the provision of pulverizing apparatus which substantially reduces the consumption of gas under pressure utilized for producing the streams hereinabove referred to.

A still further object of the invention is to provide pulverizing apparatus which is quite simple and inexpensive in construction and yet efficient and reliable in operation.

Other objects and many attendant advantages of the present invention will become more apparent when considered in connection with the specification and accompanying drawings, wherein:

FIG. 1 is a top view partly broken away of pulverizing apparatus according to the present invention;

FIG. 2 is a sectional view partly broken away along line 2—2 of FIG. 1 looking in the direction of the arrows;

FIG. 3 is an enlarged sectional view taken substantially along line 3—3 of FIG. 2 looking in the direction of the arrows;

FIG. 4 is an enlarged end view of an inlet nozzle means employed in the present invention;

FIG. 5 is a sectional view taken substantially along line 5—5 of FIG. 4 looking in the direction of the arrows;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 4 looking in the direction of the arrows;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 4 looking in the direction of the arrows;

FIG. 8 is a sectional view similar to FIG. 3 illustrating in a somewhat schematic manner a modified form of the invention;

FIG. 9 is a view similar to FIG. 8 of a still further modified form of the invention; and

FIG. 10 is a sectional view taken substantially along line 10—10 of FIG. 9 looking in the direction of the arrows.

Referring now to the drawings wherein like reference characters designate corresponding parts throughout the several views, there is shown in FIG. 1 a system employing the micronizer apparatus of the present invention. The body means within which the grinding chamber is disposed is indicated generally by reference numeral **10**, and it should be noted that in the present invention, the wheel-like main body portion may be disposed vertically in contrast to prior art arrangements wherein the main body portion including the grinding chamber is usually disposed horizontally.

The main body portion is maintained in its operative position by suitable conventional brace means comprising a plurality of angle iron members indicated by reference numerals **11** which are suitably rigidly interconnected with one another.

An inlet conduit **12** is provided which is in communication with the central portion of the grinding chamber within the body means, and an outlet conduit **13** disposed in axial alignment with conduit **12** is in communication with the opposite central portion of the grinding chamber within the body means.

A feed hopper **15** is provided through which material to be treated is fed into the inlet conduit **12**, and a conduit **16** is connected with a suitable source of gas under pressure such as steam, which is employed for forcing the feed material under pressure into the grinding chamber of the apparatus.

Conduit **20** is suitably connected with a source of gas under pressure such as steam, this conduit being connected with a steam chest **21** which extends annularly about the side wall portion of the grinding chamber as will hereinafter more clearly appear.

Referring now to FIG. 2, and particularly to the broken-away portion in the lower lefthand part of this figure, it will be seen that the steam chest **21** includes therewithin an annularly extending recess or manifold **25** which is adapted to distribute gas under pressure such as steam received through the conduit **20** to various jet nozzles disposed about the grinding chamber and in communication with the steam chest. It will be noted that a plurality of fittings **26** are provided, and a threaded plug **27** is threadably mounted within fittings **26**.

Each of the plugs **27** may be removed for gaining access to one of the jet nozzles **30** such that the jet nozzles can be adjusted or replaced and cleaned as required. The jet nozzles themselves are threaded within a steel ring **31** which surrounds the side wall **32** of the body means which defines the grinding chamber.

The location of the jets for introducing gas under pressure within the grinding chamber is fairly conventional, and the jet nozzles are so positioned that the streams of gas under pressure are directed tangential to a theoretical circle, this circle generally being larger than the diameter of the outlet from the grinding chamber thereby producing a vortex within the grinding chamber of greater diameter than the outlet.

The construction of the steam chest may also be seen in FIG. 3. It will be noted that member **32** forms the side wall of the grinding chamber and in combination with the steel ring **31** serves to provide a rigid outer framework for the body means.

It should also be noted at this point that the inner surface **35** of side wall **32** is provided with a central annular recess by forming the inner surface of a substantially V-shaped cross-sectional configuration such that it will provide a pair of sloping surfaces completely around the grinding chamber which is indicated by the reference numeral **36**. The sloping walls of the inner surface **35** may also be curved if desired, as long as the net effect is to cause particles thrown out by centrifugal force to move along the walls to the central portion of the side wall **32**.

The grinding chamber is defined by the side wall **32** and also is axially confined between a first end wall portion **40** and a second end wall portion **41**. End wall portions **40** and **41** may each be provided with a suitable liner **40'** and **41'** respectively formed of stainless steel or the like to reduce wear thereon.

It will be understood that the end wall portions **40** and **41** are suitably rigidly secured to the side wall and ring assembly **31**, **32** as by clamping and the like to provide a rigid unit.

A plurality of stud and nut assemblies **45** serve to connect end wall portion **40** with a radially extending flange formed on the outlet conduit **13**. An annular ring **46** is suitably secured as by welding within a central opening **47** provided through end wall **40**, and it will be noted that ring **46** includes an outer portion **48** which extends axially within the grinding chamber. This portion **48** serves as an annular barrier which will block the movement of particles along liner **40'** to the outlet opening **50** formed through the ring **46**. Some relatively heavy particles may tend to move along liner **40'** without being sufficiently comminuted in the vortex within the chamber, and accordingly, there is a tendency for some relatively large particles to move inwardly very closely adjacent to the liner **40'** out of the main vortex flow and thence to the outlet. Portion **48** prevents this movement of relatively large particles along the liner **40'** and ensures that such particles will not be short circuited through the device without being swept up into the vortex and sufficiently comminuted. It is apparent that a large space is provided between the annular barrier **48** and the remaining components of the device which permits a ready flow of fine particles into the outlet of the apparatus.

A plurality of stud and nut assemblies **51** connect a fitting **52** to the other end wall portion **41**, and a gasket **53** is mounted between fitting **52** and end wall **41**. Fitting **52** includes an axially extending hollow boss **55** having an internal thread **56** formed in the bore thereof. A first tubular member **57** having a thread on the outer surface thereof is threaded within boss **55** and includes a radially extending flange **58**. A second tubular member **59** has a radially extending flange **60** formed thereon, and the feed hopper **15** is formed integral with tubular member **59** and extends upwardly therefrom as seen in FIG. 3. A hollow member **61** has a venturi-shaped bore **62** formed therewithin and the radially extending flange **63** thereof is clamped between flanges **58** and **60**, the entire assembly being held in this clamped position by nut and bolt assembly **65**.

A radially extending flange **66** is formed at the outer end of tubular member **59** and is connected by nut and bolt assembly **67** to a radially extending flange **68** formed on the adjacent end of conduit **16**. A steam nozzle **69** is mounted within tubular member 59 adjacent the flange 66 thereof, the inner surface of tubular member 59 and the outer surface of steam nozzle 69 being provided with cooperating threads for mounting the steam nozzle in position. The feeding arrangement thus far described is fairly conventional since the material to be treated is fed downwardly through the hopper portion 15 as indicated by arrow A. Gas under pressure such as steam flowing through conduit 16 as indicated by arrow B then passes out through the open end of the steam nozzle 69. It will be noted that the open end of the steam nozzle is disposed beneath the forward end of the hopper A and as the steam escapes from nozzle 69, it will entrain material flowing down through the hopper, and in cooperation with the venturi bore portion 62 will carry the material under pressure into the grinding chamber.

The inlet opening into the grinding chamber is indicated at 70, this inlet opening being formed through the central portion of an annular member 72 having an arcuate inner surface 73 of the configuration shown. A flow directing means in the form of an inlet nozzle indicated generally by reference numeral 75 is supported in position as hereinafter more fully described adjacent to member 72 and is provided with an arcuate surface 76 which in cooperation with arcuate surface 73 on member 72 defines an annular passageway 80 which discharges at 81 in such a direction that particles of material leaving the discharge portion 81 are directed substantially radially outwardly toward the side wall of the grinding chamber and away from the outlet thereof.

It will be noted that a tapered recess portion 85 is formed in the end wall portion 41 adjacent the outlet of the inlet nozzle means to ensure that there is sufficient clearance for the particles to smoothly flow into the grinding chamber.

Referring now to FIGS. 4–6, the construction of the inlet nozzle means may be more fully understood. As seen in FIG. 4, the inlet nozzle means 75 has a substantially circular outer configuration, and as seen in FIG. 5, the outer surface 83 may be substantially flat, while the inner surface 84 tapers from the discharge portion 81 substantially uniformly to a point 85 whereupon the arcuate surface 76 slopes upwardly to an apex or point 86. It will thus be seen that as the stream of inflowing material passes through the inlet opening 70, it will be diverted gradually by the arcuate surface 76 and the sloping surface 85 to a direction substantially normally to the axial inflow whereby the material will be directed radially outwardly of the nozzle means within the grinding chamber.

As seen particularly in FIG. 4, four similar attaching abutments 90 are provided for securing the inlet nozzle means in operative position as shown in FIG. 3 for example. These four abutments 90 are equally angularly spaced from one another and terminate at apex portions 91 from which they extend outwardly from the sharply tapered portions of surface 76. The inner portions of the abutments adjacent to the apex portions 91 are substantially triangular in cross-section as seen in FIG. 7 thereby defining a pair of oppositely sloping side surfaces 92. The rear portions 93 of the abutments which extend to the outer periphery of the inlet nozzle means are substantially rectangular in cross-section, and two sloping surfaces 95 connect the surfaces 92 with the rectangular rear portion 93.

This particular configuration of each of the abutments 90 provides a minimum of resistance to flow of the material passing through the inlet opening 70 and impinging upon the inlet nozzle means. As seen in FIG. 5, a hardened sleeve 100 is provided in an opening formed through each of the abutments 90, the bore within the insert sleeves being threaded. Aligned counter bored openings 101 are provided in member 72 and four cap screws 102 extend through openings 101 and are threaded within the sleeves 100. In this manner, the four cap screws securely retain the inlet means in operative position, and at the same time the four spaced abutments 90 still permit ready flow of the material thereabout and thence radially outwardly within the grinding chamber.

The flow directing means thus far described is in the form of an inlet nozzle means. It is apparent that the construction of the flow directing means can be wisely varied as long as the end result is to change the direction of the axially flowing material so as to direct it substantially radially outwardly within the grinding chamber.

Referring now particularly to FIG. 8 of the drawings, the body means 120 within which the grinding chamber is disposed and the surrounding steam chest 121 may be identical with the previously disclosed arrangement. In the modification shown in FIG. 8, the inlet opening is indicated by reference numeral 122 and the outlet opening is indicated by reference numeral 123.

The flow directing means in this modification may take the form of a flat plate or baffle 126 which may be suitably supported in position as shown, the baffle being, of course, disposed between the inlet and the outlet of the grinding chamber. It is evident that as indicated by the arrows in FIG. 8 the flow of material under pressure will be deflected by the plate 125, and since the material is flowing in under pressure, it will thereby be directed substantially radially outwardly within the grinding chamber. The modification shown in FIG. 8 will obtain the desired end result, although it is considered preferable to gradually change the direction of flow with a construction as shown for example in FIG. 3.

Referring now to FIGS. 9 and 10, a further modification of the invention is illustrated wherein the body means 130 and steam chest 131 associated therewith may be identical with the previously discussed structure.

In this modification, the inlet conduit 135 may terminate in a closed end 136. The cylindrical portion 137 of the conduit which extends within the grinding chamber may be provided with a plurality of radially extending openings 138 as seen most clearly in FIG. 10 of the drawings. As shown, these openings are eight in number, it being apparent that the number of openings may be varied as desired.

It is evident that as the material is forced under pressure through conduit 135, it will be forced out through the openings 138 in the outermost end portion 137, and that the material ejected through openings 138 will be directed substantially radially outwardly within the grinding chamber.

It is apparent from the foregoing that there is provided a new and novel method of and apparatus for pulverizing material. Uniform fineness of grinding is obtained and internal shortcircuiting is substantially reduced. Greater production rates are possible with the apparatus and less wear occurs on the side wall and nozzles of the apparatus. The steam consumption has also been found to be reduced from 10 percent to 40 percent. The apparatus is simple and inexpensive in construction, and yet is efficient and reliable in operation. A new and improved method of pulverizing material is provided wherein the material to be treated is introduced into a confined generally circular treatment zone in a radial direction such that it is directed toward the outer periphery of the treatment zone.

A plurality of streams of gas under pressure are also discharged into an outer portion of the treatment zone, and the treated material is withdrawn from the central portion of the zone. As illustrated in the drawings, the method may be carried out with many different structural arrangements and the flow directing means may be widely varied as will be apparent to one skilled in the art, the essential feature being that the inflowing material is radially directed outwardly from a central portion of the grinding chamber opposite to the outlet of the grinding chamber.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, and since the scope of the invention is defined by the appended claims, all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents are therefore intended to be embraced by those claims.

I claim:

1. Pulverizing apparatus including a substantially cylindrical grinding chamber, means for admitting a plurality of angularly spaced streams of gas under pressure into an outer portion of said chamber, said grinding chamber being defined between opposite end wall portions and a side wall portion, one end wall portion having an outlet formed therethrough, the opposite end wall portion having an inlet formed therethrough substantially aligned with said outlet, and flow directing means adjacent said inlet for directing material flowing through said inlet under pressure outwardly toward the outer periphery of the chamber and away from said outlet, said side wall portion including a centrally recessed annular portion, said means for admitting a plurality of streams of gas under pressure opening through said recessed portion.

2. Pulverizing apparatus comprising a body means including a first end wall portion and a second end wall portion and an annularly extending side wall portion disposed between said end wall portions to define a substantially cylindrical grinding chamber, said first end wall portion having an outlet formed through the central portion thereof, said second end wall portion having an inlet formed through the central portion thereof and being axially aligned with said outlet, and flow directing means disposed adjacent said inlet and between said inlet and said outlet for directing a stream of material flowing through said inlet under pressure radially outwardly of

the chamber toward the outer periphery of the chamber and away from said outlet.

3. Apparatus as defined in claim 2, wherein said flow directing means comprises an arcuate deflecting surface for deflecting and changing the direction of an inflowing stream of material.

4. Apparatus as defined in claim 2, including an annular barrier extending into said chamber from said first end wall portion for defining an annular barrier about said outlet.

5. Pulverizing apparatus comprising a body means including a first end wall portion and a second end wall portion joined by an annular side wall portion, said side wall portion including an inner surface the central portion of which is recessed, a plurality of jets mounted in said side wall and opening through said recessed portion of the side wall for admitting gas under pressure into an outer portion of said chamber, said first end wall portion having an outlet formed through the central portion thereof, said second end wall portion having an inlet formed through the central portion thereof directly opposite to and axially aligned with said outlet, flow directing means disposed adjacent said inlet, said flow directing means including a surface for directing an inflowing stream of material under pressure radially outwardly of the flow directing means toward said side wall and away from said outlet to thereby prevent short-circuiting of material to be treated through the apparatus.

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