No. 688,229.

Patented Dec. 3, 1901.

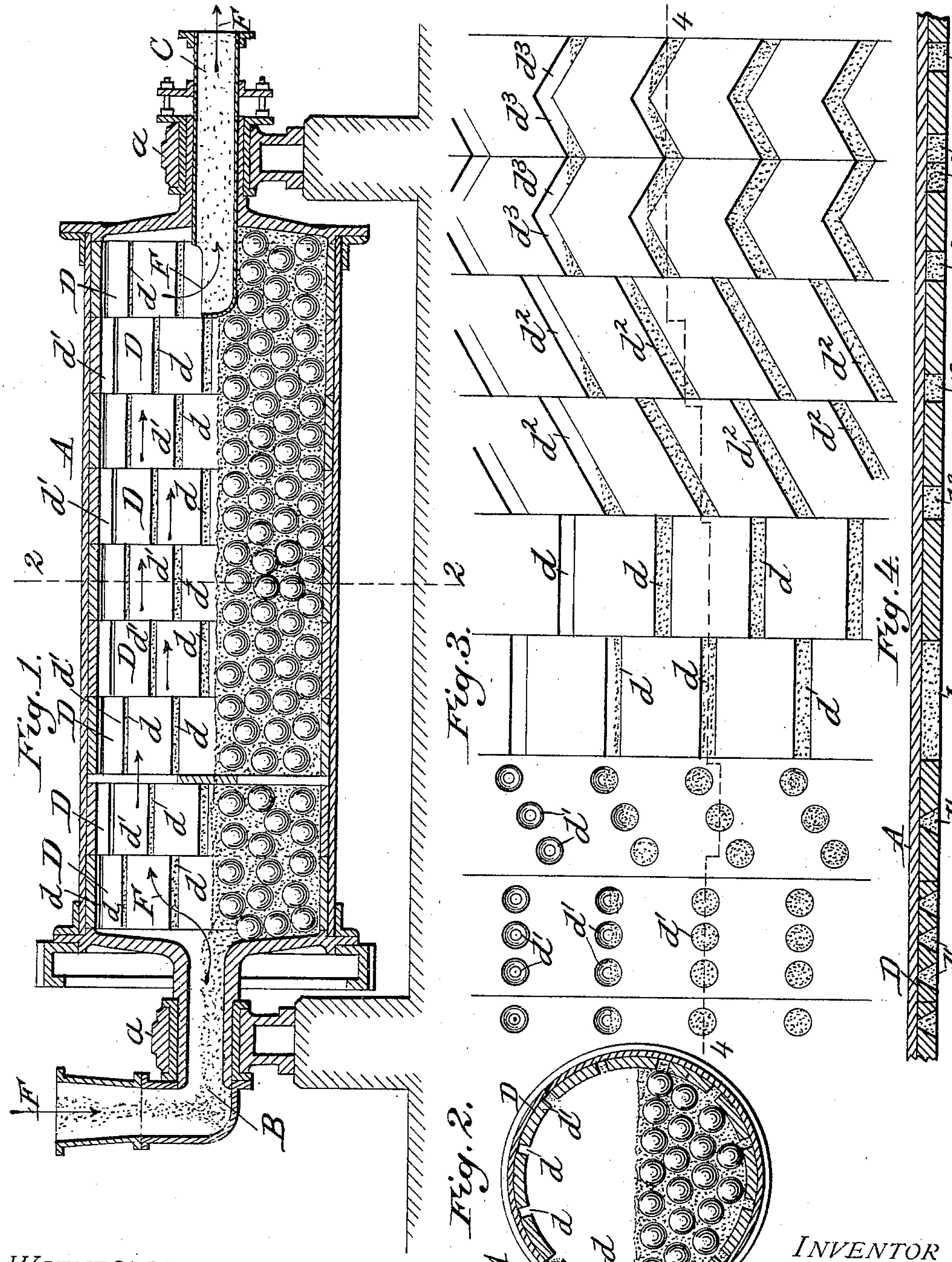
F. HUNDESHAGEN.

BALL GRINDING MILL.

(Application filed Aug. 6, 1901.)

(No Model.)

3 Sheets—Sheet 1.



WITNESSES:

F. H. Schott

Anton A Goetzer

INVENTOR

Fritz Hundeshagen

BY Max Georgii

his Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 688,229. Patented Dec. 3, 1901.

F. HUNDESHAGEN.

BALL GRINDING MILL.

(Application filed Aug. 6, 1901.)

(No Model.) 3 Sheets—Sheet 2.

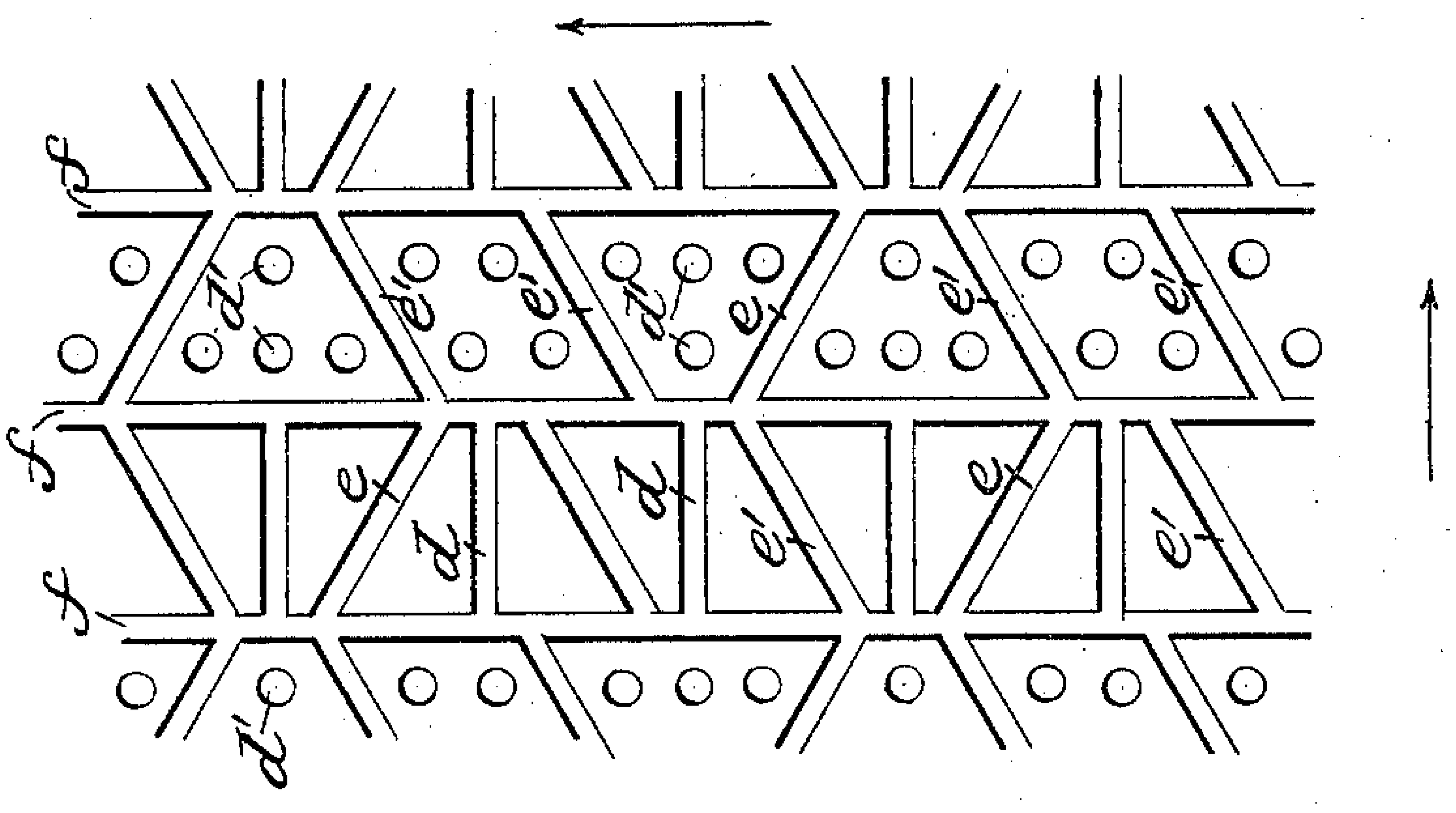


Fig. 7.

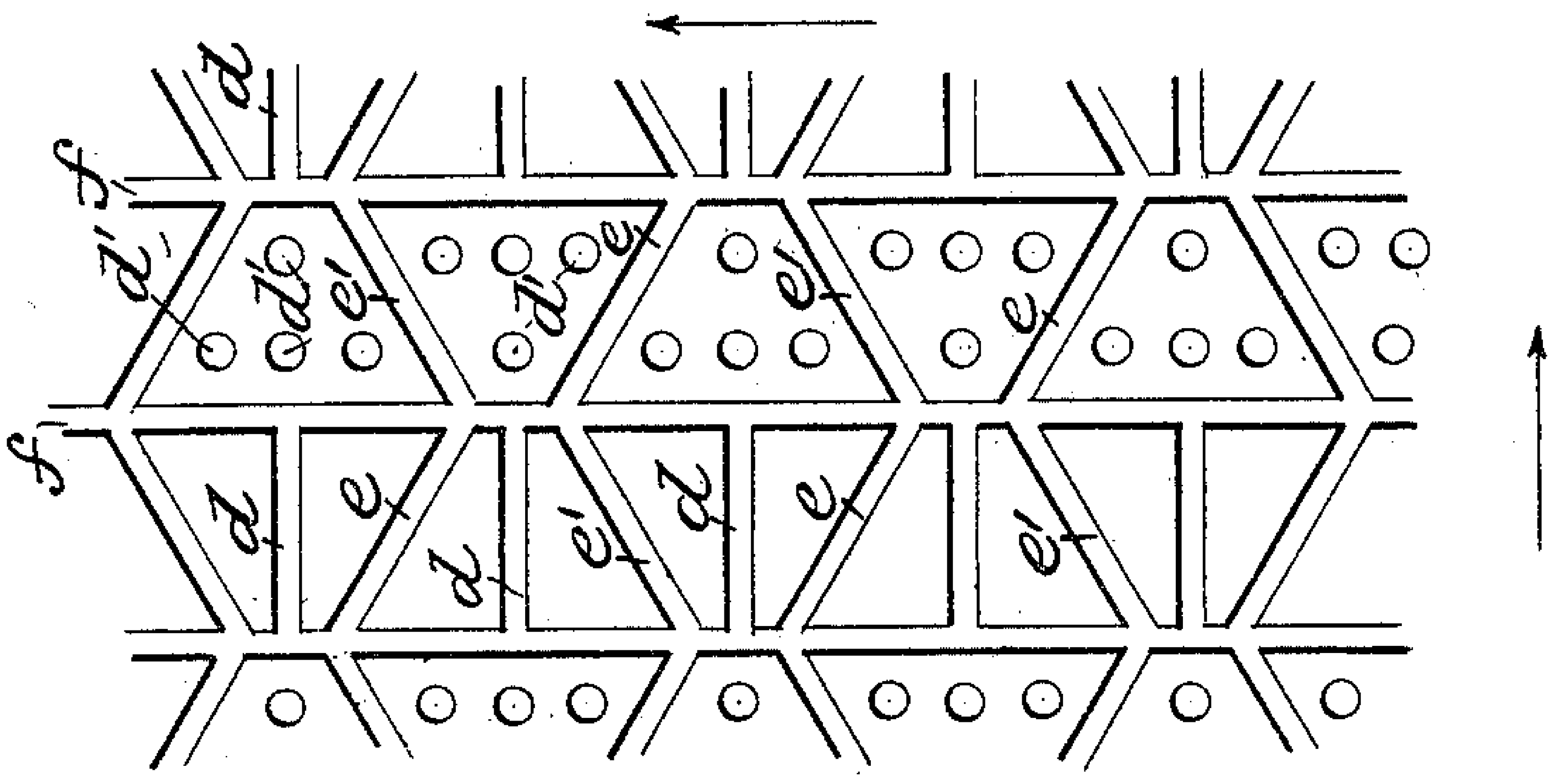


Fig. 6.

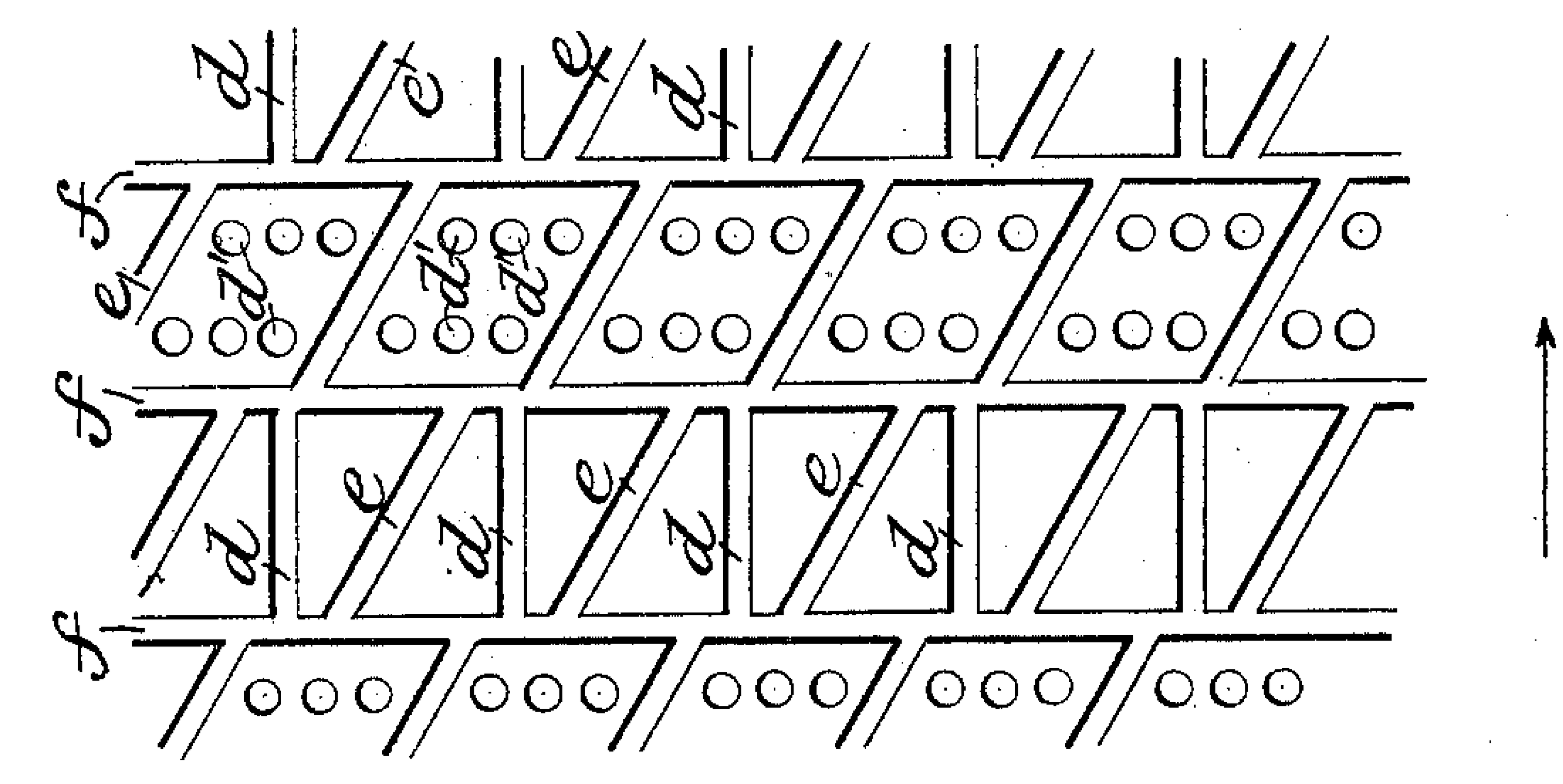


Fig. 5.

WITNESSES:

F. H. Schott

Anton A Gletzner.

INVENTOR

Fritz Hundeshagen

BY Max Georgii

his Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 688,229. Patented Dec. 3, 1901.

F. HUNDESHAGEN.

BALL GRINDING MILL.

(Application filed Aug. 6, 1901.)

(No Model.) 3 Sheets—Sheet 3.

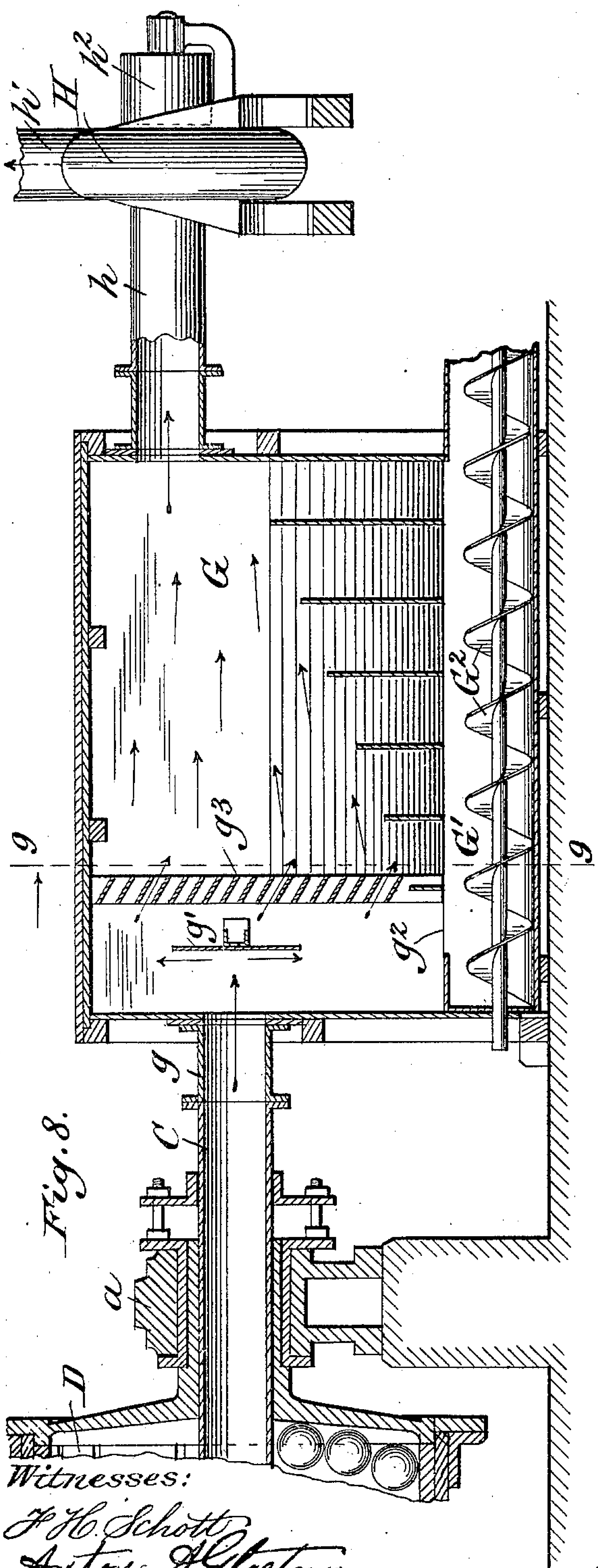


Fig. 8.

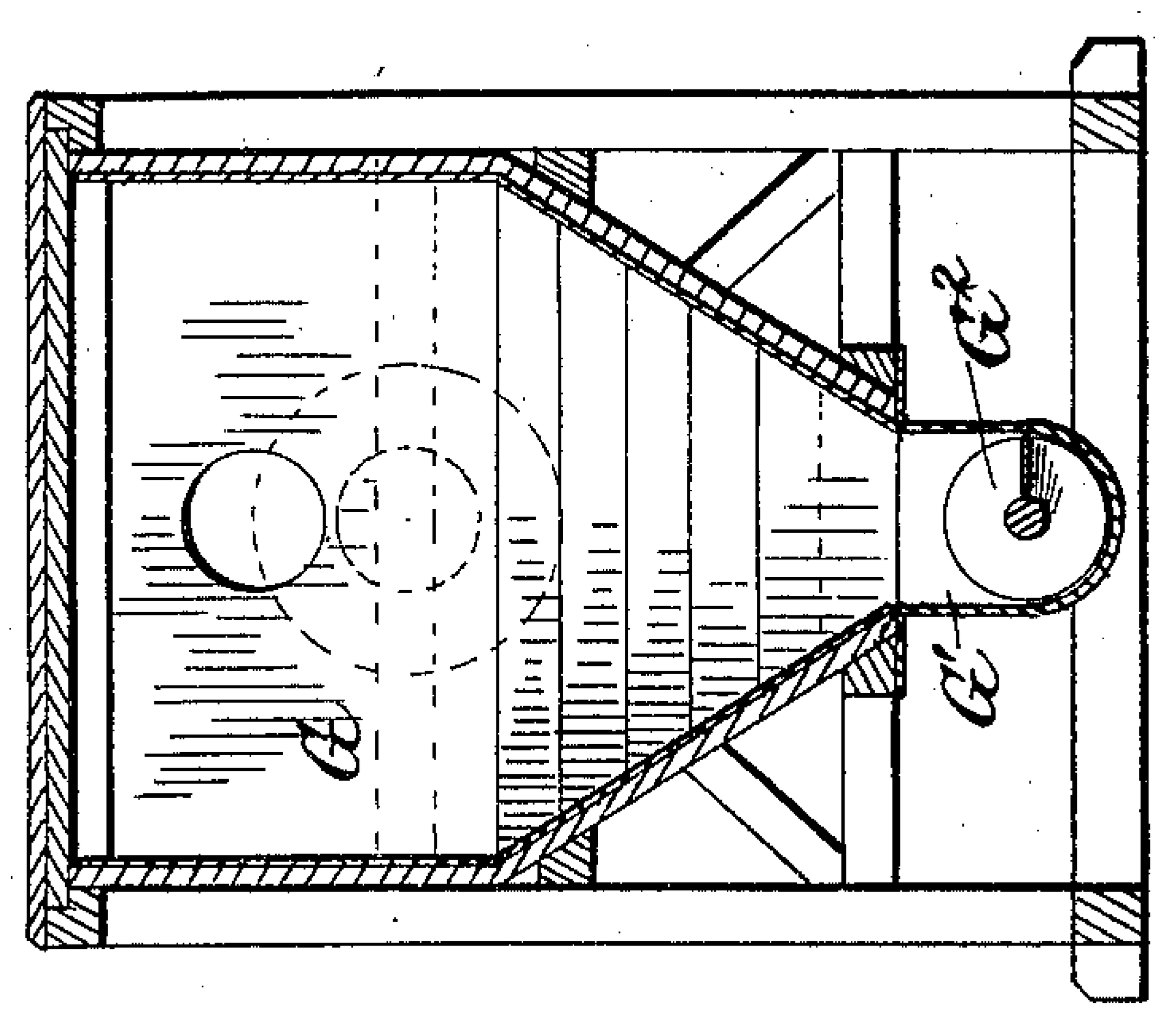


Fig. 9.

Witnesses:

H. H. Schott

Anton A. Goetzner.

INVENTOR

Fritz Hundeshagen

BY Max Georgii

his Attorney

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

FRITZ HUNDESHAGEN, OF MÜLHEIM-ON-THE-RHINE, GERMANY.

BALL GRINDING-MILL.

SPECIFICATION forming part of Letters Patent No. 688,229, dated December 3, 1901.

Application filed August 6, 1901. Serial No. 71,034. (No model.)

To all whom it may concern:

Be it known that I, FRITZ HUNDESHAGEN, a citizen of Saxony-Weimar, residing at Mülheim-on-the-Rhine, Germany, have invented certain new and useful Improvements in Ball Grinding-Mills; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to ball and drum mills for grinding or comminuting grain and other material.

The object of the invention is to feed the material from the feed end of the drum to the discharge end in such a way that the grist will be discharged in a uniform and desired degree of fineness and that this result will be obtained with the greatest possible amount of economy and power.

With this object in view the present invention contemplates the utilization of a blast or air-current passing through the drum in connection with devices for continually tumbling or projecting the material during the process of the comminution into the open space through which the air-current passes. By this combination of agencies the comminuted material is not only gradually fed forward toward the discharge, but is sorted according to the degrees of fineness of the particles, so that the finer particles are carried forward at a more rapid rate than the heavy ones. This sorting can be carried to any desired degree of precision and gradation. Air-blasts have been used in connection with mills formerly; but in no case have they been used to effect the results above set forth. In one class of mills the blast simply served to carry off the comminuted particles after they had attained a degree of fineness which enabled them to be practically suspended in the air. In another class of machines the blast is utilized to keep the meshes of the screens free from the obstructing fine meal or flour or where a foraminated drum without screens is employed to blow the fine meal out from between the coarser particles. In the present case the blast serves an entirely different purpose. It is not designed merely for the purpose of separating the fine material, but for the radically-different purpose of causing any material which is being ground to gradually move forward, the velocity of the particles being graded according to the degrees of fineness of the same, since the coarser particles will not be impelled as far out of the vertical line as finer ones. Hence the present invention solves the problem of feeding the particles of the grist forward in such a way that none of them will pass to the discharge before they have been ground to the desired degree of fineness. It is, moreover, the object of my invention to devise means whereby the particles will be intimately and constantly commingled during the grinding operation and also to provide means whereby the material to be ground can be first broken up into coarse granular form and then finally ground to meal.

With these objects in view my invention involves the use of the air-blast in combination with means for tumbling the material to be ground and throwing it into the path of the blast. Such means may consist of a series of grooves or recesses arranged on the inner periphery of the drum of the mill. These grooves or recesses may be made in various forms, as will be hereinafter described, and may serve, besides the purpose of tumbling, for the further purpose of commingling the grain and also of retarding its progress, so as to subject it to the grinding operation for a more lengthy period of time, if desired.

My invention also involves such features, means, and combination of parts, as will be hereinafter set forth, and pointed out in the claims.

In the drawings accompanying this description, Figure 1 represents a longitudinal central vertical section of a grist-mill embodying my invention; Fig. 2, a transverse section of the same on line 2 2, Fig. 1; Fig. 3, a view of a portion of the inner periphery of a drum developed or spread out into a plan, several modified forms of grooves and recesses being illustrated as combined in one machine; Fig. 4, a longitudinal section of the same on line 4 4, Fig. 3. Figs. 5, 6, and 7 represent diagrammatic views of the inner periphery of a drum having modified arrangements of tumbling channels or recesses and feeding and commingling grooves; Fig. 8, a longitudinal central section showing the means for producing a blast of air in the grinding-mill and for removing the ground meal; and Fig. 9, a transverse section on the line 9 9, Fig. 8.

Referring now to Figs. 1 and 2 of the drawings, it will be seen that the same represents a mill consisting of a drum A, adapted to rotate on the bearings *a a* and having an axial air-inlet B and air-outlet C, said inlet and outlet serving for the passage of the air-blast, as indicated by the arrows F, and also serving for the introduction of the coarse material and the discharge of the finely-ground material, respectively. The grinding-beds D, forming the inner periphery of the drum A, are, as shown, provided with grooves *d*, which in the present instance are represented as horizontal and which are arranged in the series of zones *d'*, the grooves of each zone preferably breaking joint, as shown. Instead of providing the grinding-beds D with the grooves *d* the inner periphery of the drum A may be provided with such grooves by making such grinding-beds in sections and attaching them to the drum, so as to leave spaces or grooves between them, as shown in Fig. 4.

In operation as the material is being ground by the attrition between the balls E and the grinding-beds D and between the balls themselves it fills the grooves or recesses *d*, and as these grooves emerge above the level of the material in the drum and are carried to the top of the drum it is dropped or tumbled back into the free space existing above the main mass of the material and into the path of the blast. The blast has a tendency to divert the falling particles from their path, and since this operation is constantly repeated the particles are gradually fed along to the discharge-opening C. The forward feed of the particles is, however, governed by their weight, so that the finer particles are fed forward faster than the heavy ones, which is exactly what is necessary in order to insure the complete comminution of every part of the grist material. It will be noted that this interaction between the tumbling devices and the blast alternates with the grinding operation. Thereby the operation is graded off into a series of stages, each of which consists of a comminuting and a feeding step. It is also to be noted that these stages for the same drum are each more numerous for the coarser particles than for the finer particles, so that the latter will reach the outlet in the final condition earlier than the former. This result radically distinguishes this invention from the former ball-mills, in which all the parts, whether coarse or fine, were fed forward to the discharge in the same period of time. In consequence of this new effect a mill constructed according to my invention will permit the use of much coarser grist material than hitherto admissable and will give a greatly-enhanced yield. A great advantage under my construction consists in the fact that by changing the velocity of the blast the yield and fineness of the product may be regulated according to desire.

Instead of making the tumbling devices in the shape of horizontal grooves, as shown in Fig. 1, they may be made in the shape of circular recesses *d'*, as shown in Figs. 3 and 4, or in some instances the grooves may be made with a backward incline, as shown at d^2 in Fig. 3, whereby the forward feed may be somewhat retarded. In this case under equal conditions the air-blast would have to be stronger than where the tumbling-grooves are horizontal, as shown at *d*. Moreover, the grooves may be arranged as shown at d^3 in Fig. 3—that is to say, made up of forward and rearward inclines. This arrangement would result in a more complete commingling of the grist material.

In Figs. 5, 6, and 7 I have shown other methods of combining different forms of tumbling-grooves and receiver. In the construction shown in Fig. 5 I have represented the interior periphery of the drum with horizontal tumbling-grooves *d*, alternating with forwardly-inclined feed-grooves *e*, both sets of grooves communicating with vertical annular grooves *f*, two of such annular grooves forming the boundary of a zone of alternating tumbling and feed grooves *d e*. As shown in this figure, such a zone may alternate with a zone in which the feed-grooves *e* alternate with a series of circular tumbling-recesses *d'*. The effect of a combination of grooves, as shown in this figure, is that a portion of the comminuted grain as it is lifted above the level of the contents of the drum in the annular grooves *f*, the tumbling-grooves *d*, and recesses *d'* and dropped into the path of the blast is fed forward in the manner above described. At the same time as the material drops out of the annular grooves *f* the meal in the inclined groove *e* is fed forward toward the annular grooves *f*, thus assisting the feeding action of the blast and increasing the rate of discharge of the apparatus. This mode of arrangement is, however, only suitable in cases where it is advisable to use long drums.

In Fig. 6 I have shown an arrangement which differs from that just described and represented in Fig. 5 in that the forwardly-inclined feed-grooves *e* of one zone of the drum are followed by a series of reversely-inclined grooves *e'* in the next zone, and so on. In this case the forward-feeding effect of the groove *e* is counteracted by the retarding action of the grooves *e'*, and the feed of the grist material is performed solely by the tumbling grooves or recesses *d d'* and the air-blast, the inclined grooves *e e'* serving only for the purpose of intimately mixing the grist.

In the modification represented in Fig. 7 the number of rearwardly-inclined retarding-grooves *e'* and their capacity are in excess of the forwardly-feeding and oppositely-inclined grooves *e*, so that the tendency is to continually feed the material away from the discharge and opposite to the direction of the blast. The feed is thereby in general retarded, and the resultant forward feed is due to the difference between the forward feed brought about by the blast and the said backward feed. While the deviation of the particles from the vertical line as they fall out of the grooves varies inversely according to the size of these particles, the backward feed of the particles, due to the grooves e' e', must be considered as substantially constant in view of the repeated action of these grooves. By this arrangement the operator has it in his power to regulate the feed so that the particles which have attained a certain degree of fineness will be gradually fed forward, while particles having an intermediate degree of fineness remain stationary and the coarsest grained are being constantly fed backward. The latter are therefore held in position at the feed end of the mill and cannot move forward until they have attained the necessary degree of fineness, whereupon they gradually move forward toward the discharge, the forward movement increasing as the fineness increases. By the above arrangement one is enabled to grind grist material whose grains vary within the widest limits with regard to size, so that the final meal as it emerges from the discharge will be of uniform fineness. This enables one to dispense with the laborious processes of screening and grading grist material before introduction into the mill, which of course results in a great reduction of labor and expense. The feed-dust or meal is being constantly removed from the mill, so that the same is not carried along with the material to be ground as an unnecessary and injurious incumbent.

In Figs. 8 and 9 I have illustrated one means for producing an air-blast through the grinding-mill, which means comprises a dust-removing chamber G, connected to the grinding-mill by a conduit g, which connects with the axial discharge-pipe C. (Shown in Fig. 1.) The dust-removing chamber G has a baffle-plate g' for deflecting the stream of incoming dust and air so as to cause it to drop the heavier particles of meal, which fall to the bottom and pass through an opening g^2 into a conveyer-box G', provided with a suitable conveyer G^2. Those heavier particles of meal which are not thus deposited pass through a lattice deflecting-screen g^3 and are directed downward toward partitions g^4, increasing in height toward the outlet, whereby the remaining particles of meal are deposited and dropped into the conveyer-box. The draft or blast of air is produced by an exhaust-fan H, having its inlet connected to the outlet of the dust-removing device by a conduit h, the outlet or discharge pipe h' of the fan H being led to any suitable point. The fan is provided with a pulley h^2, by which it may be driven by any suitable power.

What I claim, and desire to secure by Letters Patent, is—

1. In a grinding-mill, the combination of a drum provided on its inner periphery with grooves for lifting and then dropping the grist material with means, operating during the movement of the drum, to reduce the material and means for producing a blast through said drum.

2. In a grist-mill, a drum provided with a series of horizontal grooves for raising and then dropping the grist material, in combination with means, operating during the movement of the drum, to reduce the material and means for producing a blast through said drum.

3. In a grist-mill, the combination of a drum provided on its inner surface with grooves or recesses for lifting and then dropping the grist material arranged in zones, means, operating during the movement of the drums, to reduce the material, and means for producing a blast through the drum to act on the material falling from said grooves or recesses.

In testimony whereof I affix my signature in presence of two witnesses.

FRITZ HUNDESHAGEN.

Witnesses:
CHARLES LE SIMPLE,
CARL SCHMIDT.