(No Model.) 2 Sheets—Sheet 1.

# M. B. CHURCH.

## GRINDING MILL.

No. 259,495. Patented June 13, 1882.

Fig 1.

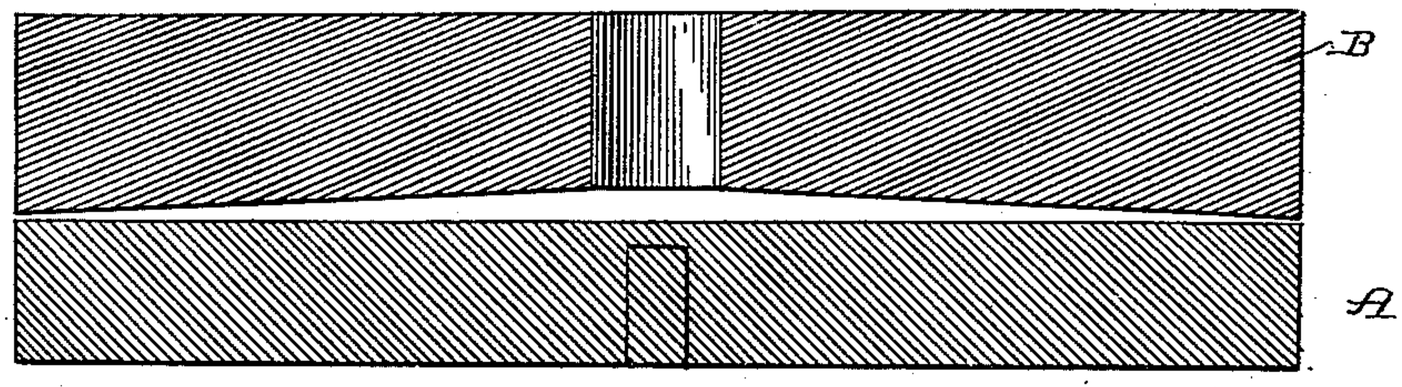
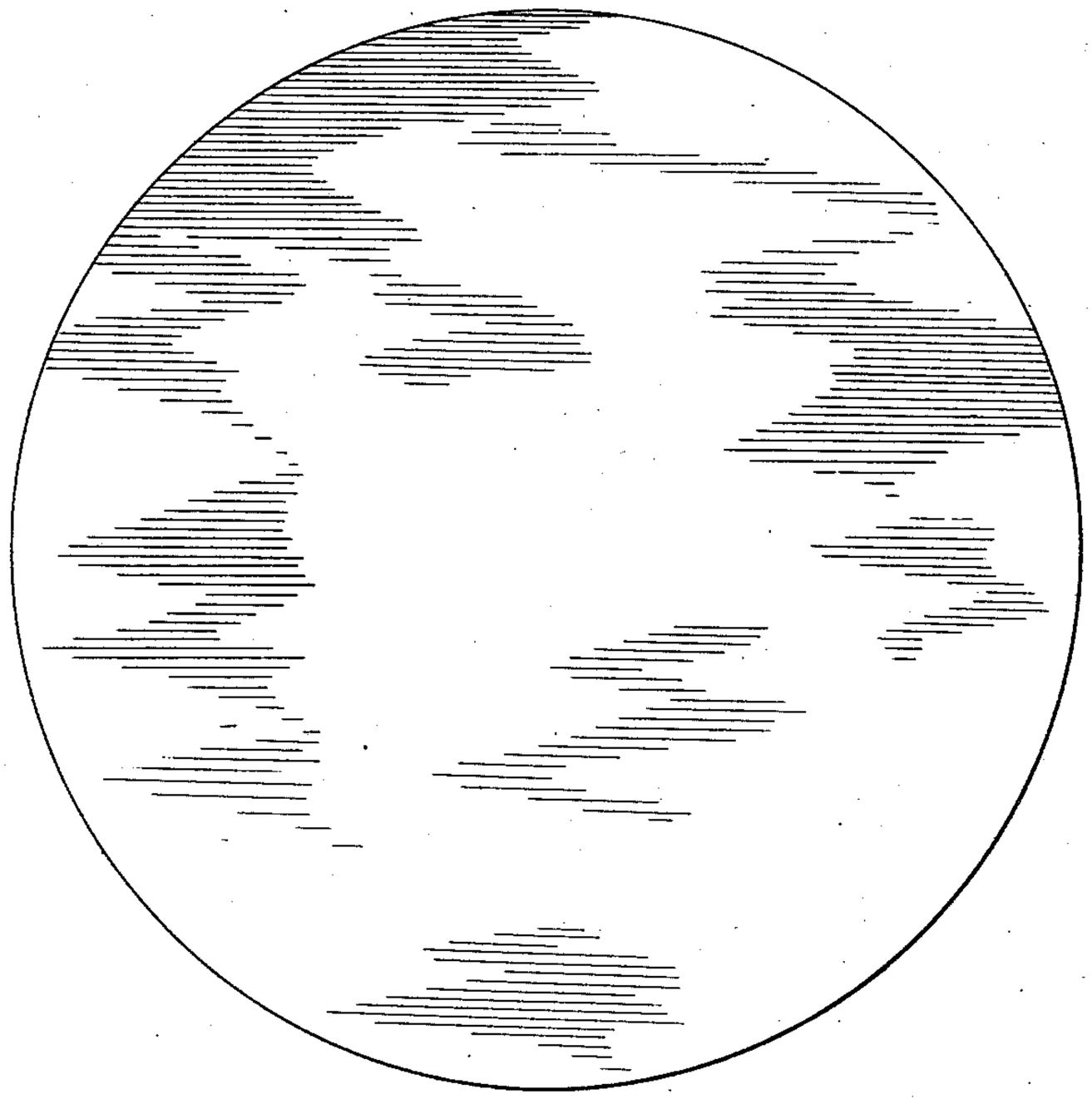



Fig 2.



Witnesses:
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Inventor
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(No Model.)

2 Sheets—Sheet 2.

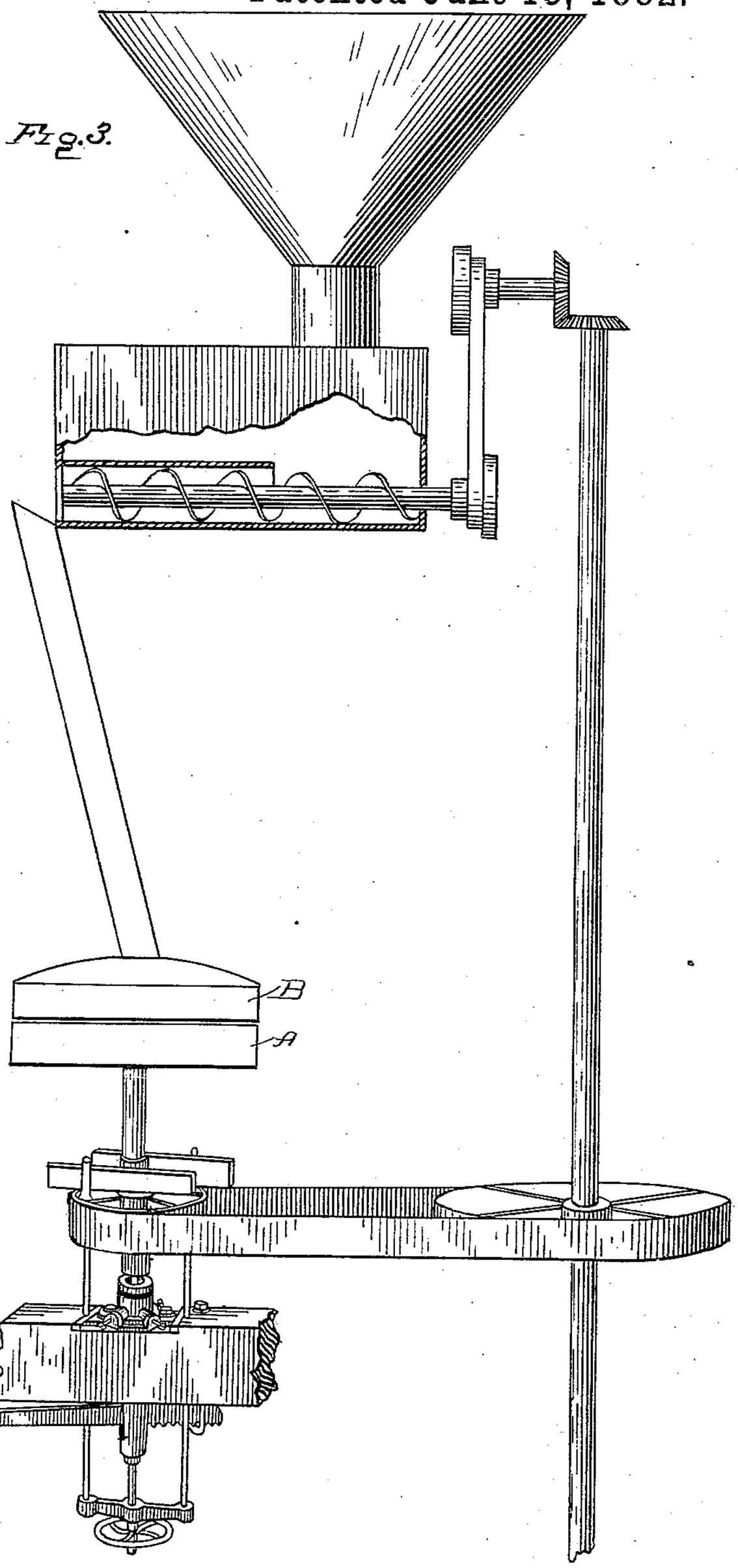
# M. B. CHURCH.

## GRINDING MILL.

No. 259,495.

Patented June 13, 1882.

Fig. 3.




Witnesses:
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Atty

# UNITED STATES PATENT OFFICE.

MELVIN B. CHURCH, OF GRAND RAPIDS, MICHIGAN.

## GRINDING-MILL.

SPECIFICATION forming part of Letters Patent No. 259,495, dated June 13, 1882.

Application filed December 15, 1881. (No model.)

*To all whom it may concern:*

Be it known that I, M. B. CHURCH, of Grand Rapids, county of Kent, and State of Michigan, have invented a new and useful Improvement in Grinding-Mills; and I hereby declare that the following is a full, clear and exact description of the same.

My invention relates to grinding-mills of that class in which the material is ground between upper and lower stones.

The improvements relate more particularly to the form of the stones, and also to their mode of operation, the invention consisting partly in the machine and partly in the art or mode of operating the machine. I contemplate principally the grinding and regrinding of substances which may be reduced wholly to a very fine dust or powder—such as gypsum, chalk, earth-paints, ores, and the like—though under some circumstances it may be applicable to other goods.

The object of my invention is to avoid the great amount of friction incidental to the old form of stones and great waste of power, the heating of the goods and the irregular grinding, by reason of which another expensive process is necessary—namely, that of bolting—in order to secure the necessary uniformity of fineness which is required of materials which are used for coating walls and for many other purposes.

The millstones heretofore commonly used have, as is well known, furrows approximately radial in the grinding-faces of the upper and lower stones, the effect of which is to act upon the material ground—technically called the "food" or "goods"—by a shearing action to crowd such goods upon the "lands," where they are abraded by surfaces held apart by the goods themselves, and also to regulate the outward flow of the goods from eye to skirt. It is the crowding action of these furrows and the friction of the closely-set stones in the land portions which cause the great friction. The uneven distribution of air creates a tendency to heat, and the grooves cause a discharge of a part of the material coarser than the rest, which interferes with the uniformity of the grinding and makes subsequent bolting necessary.

The essential principle of my invention lies in grinding between substantially smooth surfaces of stones with the under stone smooth and the upper dished and slightly separated in a space kept uniformly and constantly crowded full, whereby the goods are caused mainly to grind by attrition and crushing of particle with particle of their own substance. In order to accomplish this I have found, by long study and experiment, that certain forms and conditions of the stones are essential and effective. The approximate form of stones is shown in the accompanying drawings, in which—

Figure 1 represents a section taken vertically through the stones. Fig. 2 shows the face of the stones. Fig. 3 shows in the upper part the adjusting and regulating devices for the feed, and in the lower ordinary devices for driving the lower stone and for adjusting the stones. The devices shown in this last figure are not new in this application, and therefore require only general reference. The upper part of the figure shows my improved devices for adjusting the feed to the condition of the stones hereinafter particularly referred to, and the lower part represents ordinary devices for driving the lower stone, and for adjusting the relative position of the stones.

In these figures the lower stone, A, which must always be the moving stone, is made with a perfectly plain level surface from eye to skirt, which surface is either perfectly smooth or formed with a very fine shallow cracking, for the purpose of helping the stones to stick to the goods and whirl them about and prevent them from packing down on the stones. The upper stone, B, is formed very slightly dishing from eye to skirt, and the surface of it may be cracked in a manner similar to the lower. I have said that the upper stone is dished very slightly and uniformly from the eye to the skirt. It is better in practice to form a slight pocket immediately about the eye sufficient in size to admit the granules of the material to be ground full between the upper and lower stones when they are in position for work. Ordinarily, as for regrinding plaster, I dish the upper stone about one-eighth of an inch at the eye, gradually lessening in not more than two inches toward the skirt to one-sixteenth of an inch, and from that line the dish grad-

ually decreases to the skirt. These dimensions are for a stone of thirty-six inches in diameter. These stones are provided with suitable mechanisms for feeding the material uniformly thereto, for giving rotary motion to the lower stone, and for bringing the stones together. It is also essential, as will hereinafter appear, that the feed should be perfectly adjustable to the stones, and should be automatically varied to suit the variations of the speed of the stones when running. I prefer to accomplish this by means of the apparatus shown in application filed by me in the United States Patent Office on the 7th day of October, 1881, in which the feeding apparatus is regulated or adjusted by means of cone-pulleys to any required speed, and is varied in its movements with the variations in the speed of the stones by connecting the feed mechanism with the power which drives the stones. By means of this apparatus the feed can be regulated to the stones, and afterward all the variations are automatic.

It will be understood from the statement heretofore given as to the conditions required—namely, that the material shall be caused to crush or grind itself mainly against its own substance, and crush and grind its whole substance to a condition of uniform fineness—that all the parts of the space between the stones must be filled and crowded with the goods. If there be any place in any part of that space between the stones not thus filled, there will be no action, or only imperfect action, about that place. Wherever the goods lie upon the lower stone, and not in close contact with the upper, no crushing or grinding will take place, since the stones run nowhere in contact. It follows, therefore, that the dish of the stone must be such that every part of the space will be kept full. This is accomplished by exactly proportioning the dish, which proportions have been given above; but the principle is that as the goods move outward they will have the same space (decreased in depth in proportion to the increase in length) in zones of a given width at every point from center to skirt, for if the goods occupying a zone, say, one inch in width at the distance of six inches from the eye, quite fill that space, as they are whirled round and reach a space one foot from the eye, where the zone of an inch width would be much longer, they would find, if there were no dishing or too little dishing, much larger space, and they would not be crowded. On the other hand, if the dishing were too great they would be overcrowded and clog. Again, it is essential that the surface of the lower stone should be a perfectly plain surface, since the goods rest upon that surface and are carried outward by the centrifugal action alone, which would be insufficient if this stone were dishing. With the stones as formed a speed of three hundred and fifty to four hundred revolutions per minute is required to give the proper motion to the goods. I have found that with this construction there is no heating of the goods, as the air is furnished uniformly over the whole surface.

The mode of operation of these stones has been partially indicated in the description of their form and movement. It may be further stated that the goods must be fed in quantity or amount exactly sufficient to keep the space between the stones constantly crowded full and no more, and this must be done at all times and under all variations of the speed of the stones. When the feed is once established and adjusted to satisfy these conditions the material is ground to any desired degree of fineness and of such perfect uniformity that no bolting is afterward required; and, further, I have found by actual experiment that the mill can be run with about one-fourth the amount of power to grind the same amount and class of goods, and there is the further saving in the cost of dressing the stones.

In running these stones according to my improved method the operator will be able to adjust the feed and the stones by carefully observing their action and the condition of the material escaping from the discharge-spout. Supposing the mill to be provided with an automatic feed-regulator, such as heretofore referred to, and the stones with the ordinary adjusting and driving mechanisms, the operator will start the feed, turning the spout aside and observing the discharge. If the stones have been set properly and the feed properly adjusted, the discharge, after a slight delay while the space is filling, will appear of a proper degree of fineness and uniformity; but if, as may happen, especially if the operator be inexperienced, the stones are not properly set at the start, he should gradually bring the stone up until the proper degree of fineness and uniformity is attained. If before reaching that point he find that the stones begin to clog in the eye and check the motion, he will then understand that the feed is too great for that degree of fineness. He will then lessen the feed by means of the cone-pulleys or by any other equivalent mechanism which may be used. Having reduced the feed, the operator will again proceed and raise the stone until he arrives at proper results, or will continue this method of adjustment until he finds the feed properly regulated to the stone. This being once reached can be maintained for the same class of goods, but might have to be varied for another class. If the operator find that the stone clogs at the eye without being checked, he will understand that the feed is too great for the eye, or that the granules of the goods are too large for the pocket or dish immediately about the eye. To remedy this and to fit the stone for such granules, the eye and the pocket immediately about the eye must be increased, for it will be understood that in this respect the stones must be varied for different sizes of granules. In regrinding plaster thirty-six-inch stones with five-horse power will grind one ton an hour finer than can be obtained with the finest flour-

bolt. If the stones should not appear to be performing their full amount of work, the operator should increase the feed, and, if necessary, readjust the stones until the desired results are obtained.

I am aware that stones have been made smooth with dishing in the upper and lower surfaces, but only part way from eye to skirt, and with the upper stone running for the purpose of scouring and hulling but not grinding; also, that a smooth dress on the outer surface and furrows about the eye half-way to skirt with the upper stone running and with a blast to force the feed is not new; also, that a smooth dress is not new in connection with a lower stone in the form of the frustum of a cone when the discharge is obtained by gravity.

Having thus described my invention, what I claim as my invention is—

1. In a grinding-mill, a lower stone adapted to be driven and formed with its face perfectly plain from center to skirt, in combination with an upper stone, said stones having a substantially smooth dress, and the upper stone dished substantially from eye to skirt in the manner described, whereby the spaces between the stones in zones of a given width on any part from center to skirt are made of equal capacity, all as set forth.

2. The improvement in the art of grinding, which consists in feeding the material to be ground between the stones, the lower one revolving and having a plain face and the upper one having a dished face, the dishing giving equal capacity to zones of equal width at different distances from the center in adjusting and regulating the feed to the speed of the stone, keeping them crowded full, in adjusting the speed of the stone to accord with the pressure necessary to the degree of fineness required, and in discharging the finely and uniformly ground material by centrifugal force, substantially as described.

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

MELVIN B. CHURCH.

Witnesses:

F. L. MIDDLETON,

E. A. DICK.