(No Model.) 4 Sheets—Sheet 1.

# B. HERSHEY.

## MACHINE FOR REDUCING ORES.

No. 257,132. Patented Apr. 25, 1882.

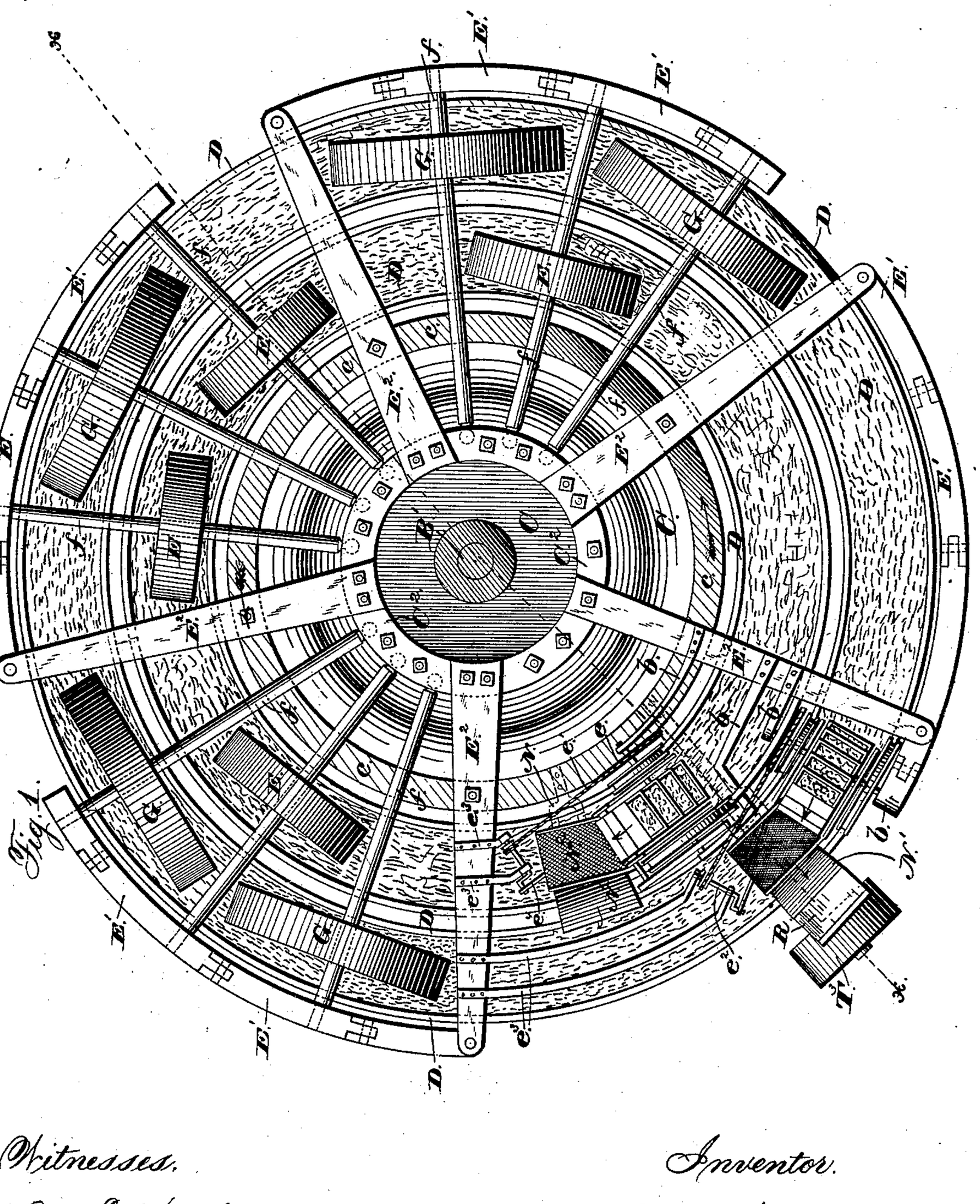

Fig. 1.

Witnesses.

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By his Attorney,

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(No Model.) 4 Sheets—Sheet 2.

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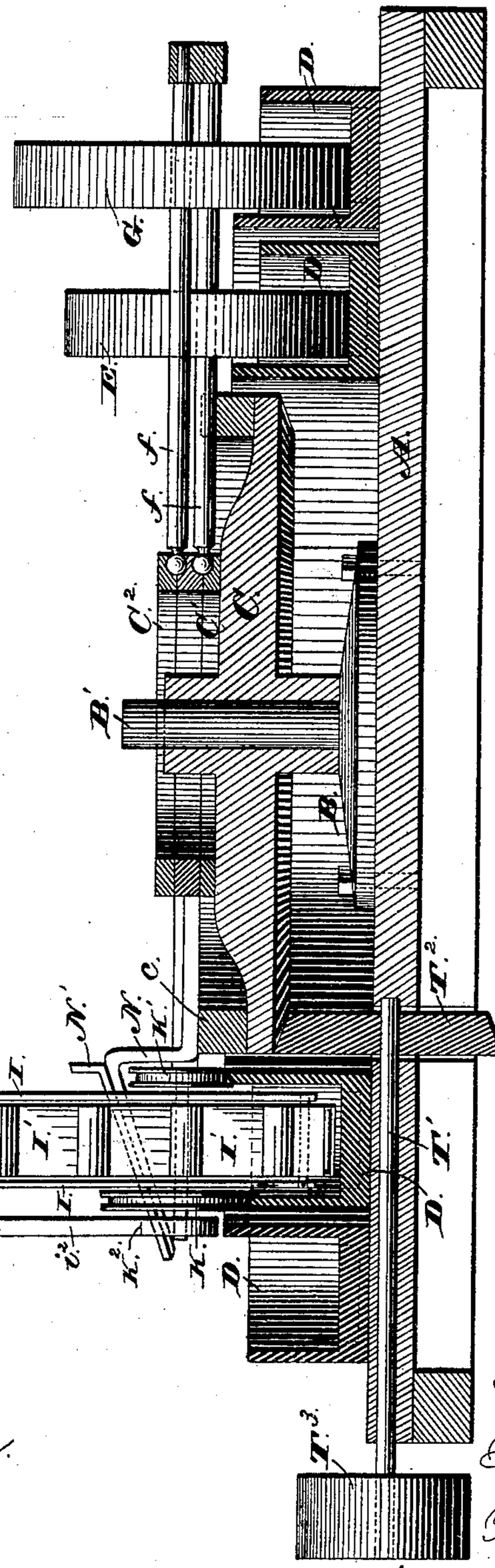


Fig. 2.

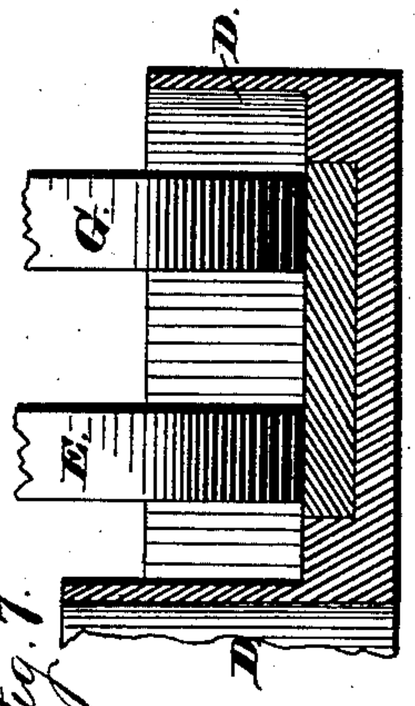


Fig. 4.

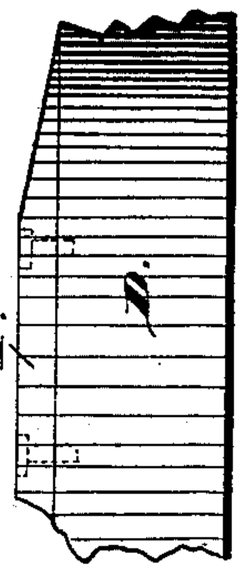


Fig. 6.

Witnesses.
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(No Model.) 4 Sheets—Sheet 3.

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Fig. 4.

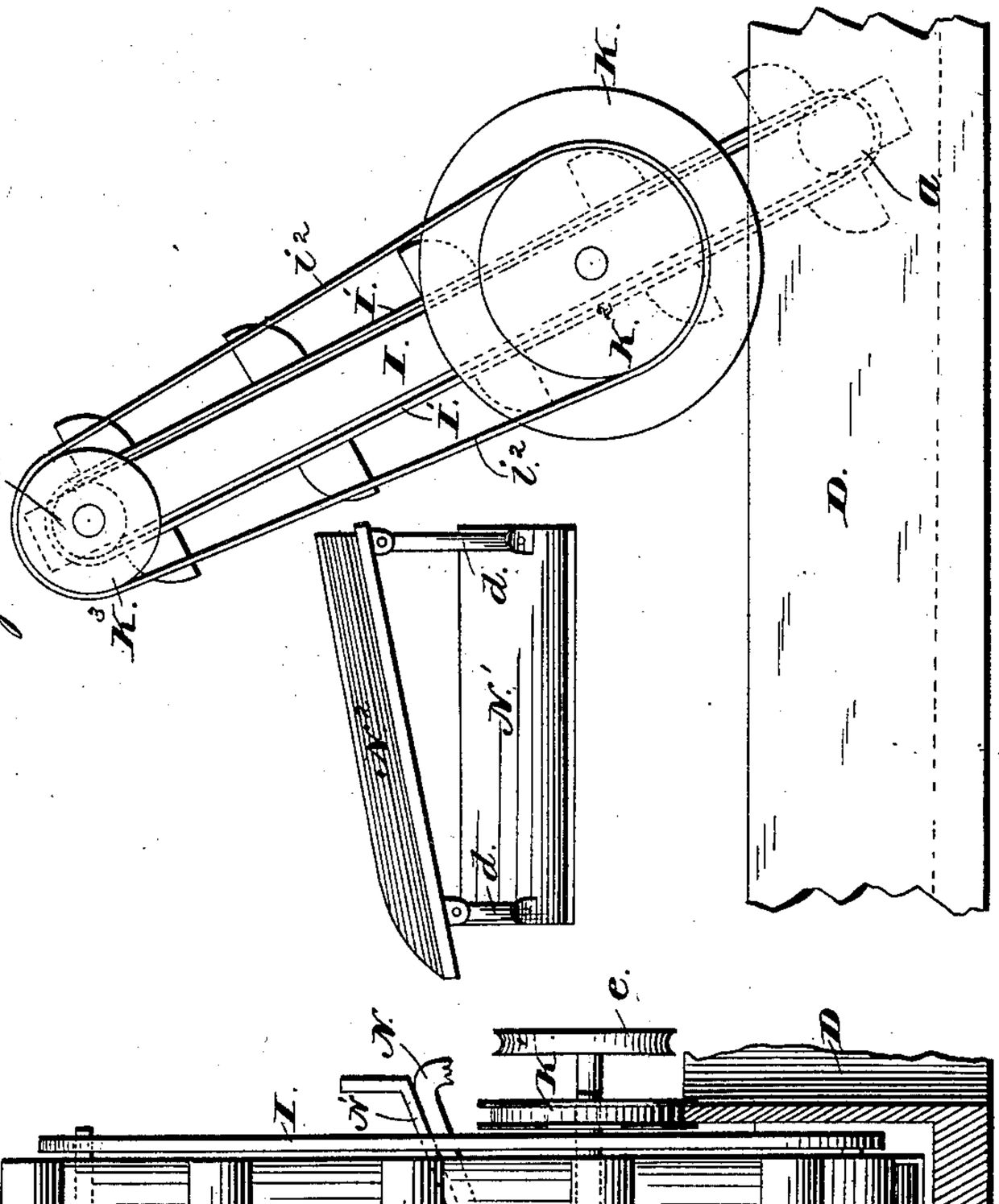
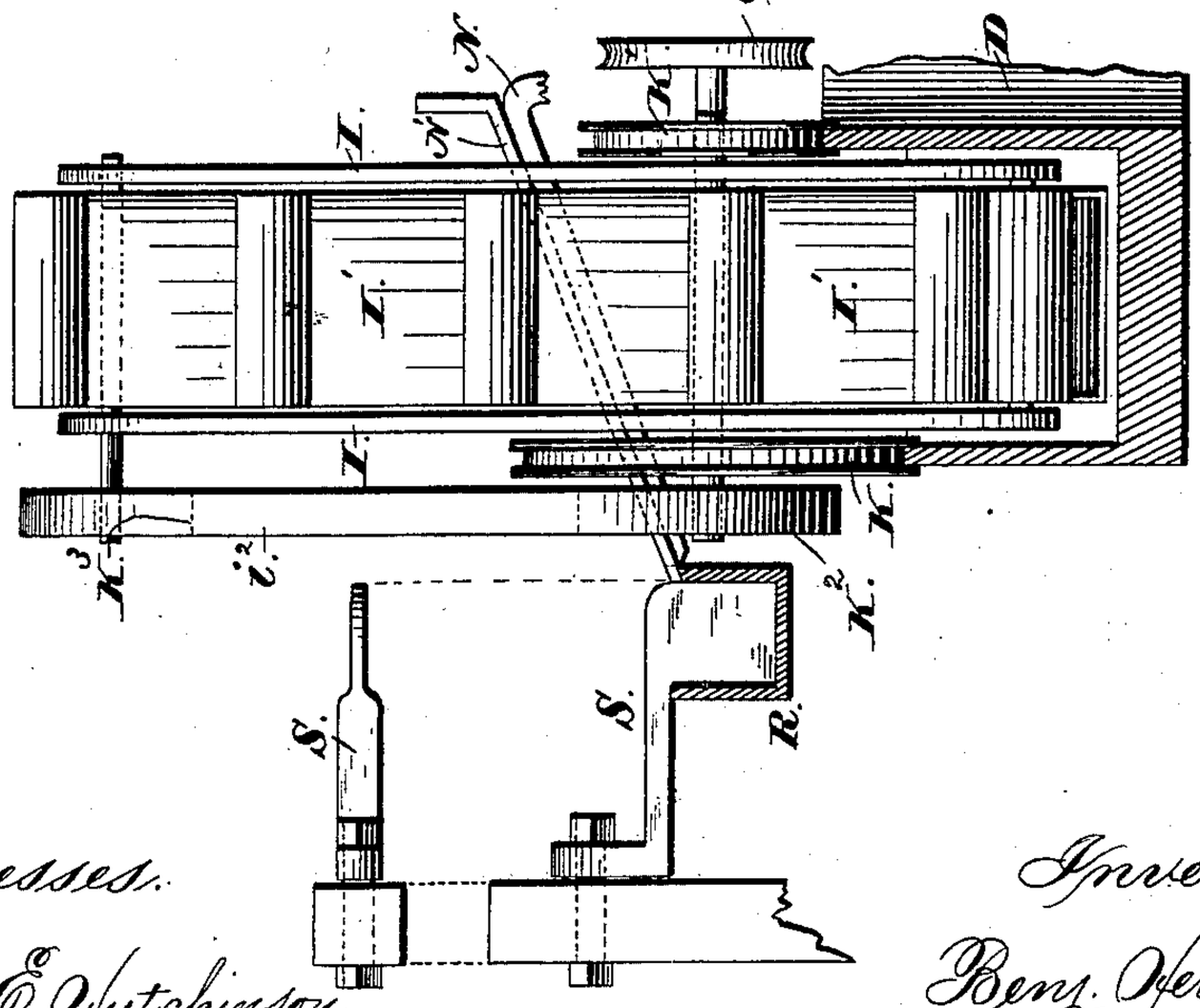



Fig. 3.

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(No Model.) 4 Sheets—Sheet 4.

# B. HERSHEY.

## MACHINE FOR REDUCING ORES.

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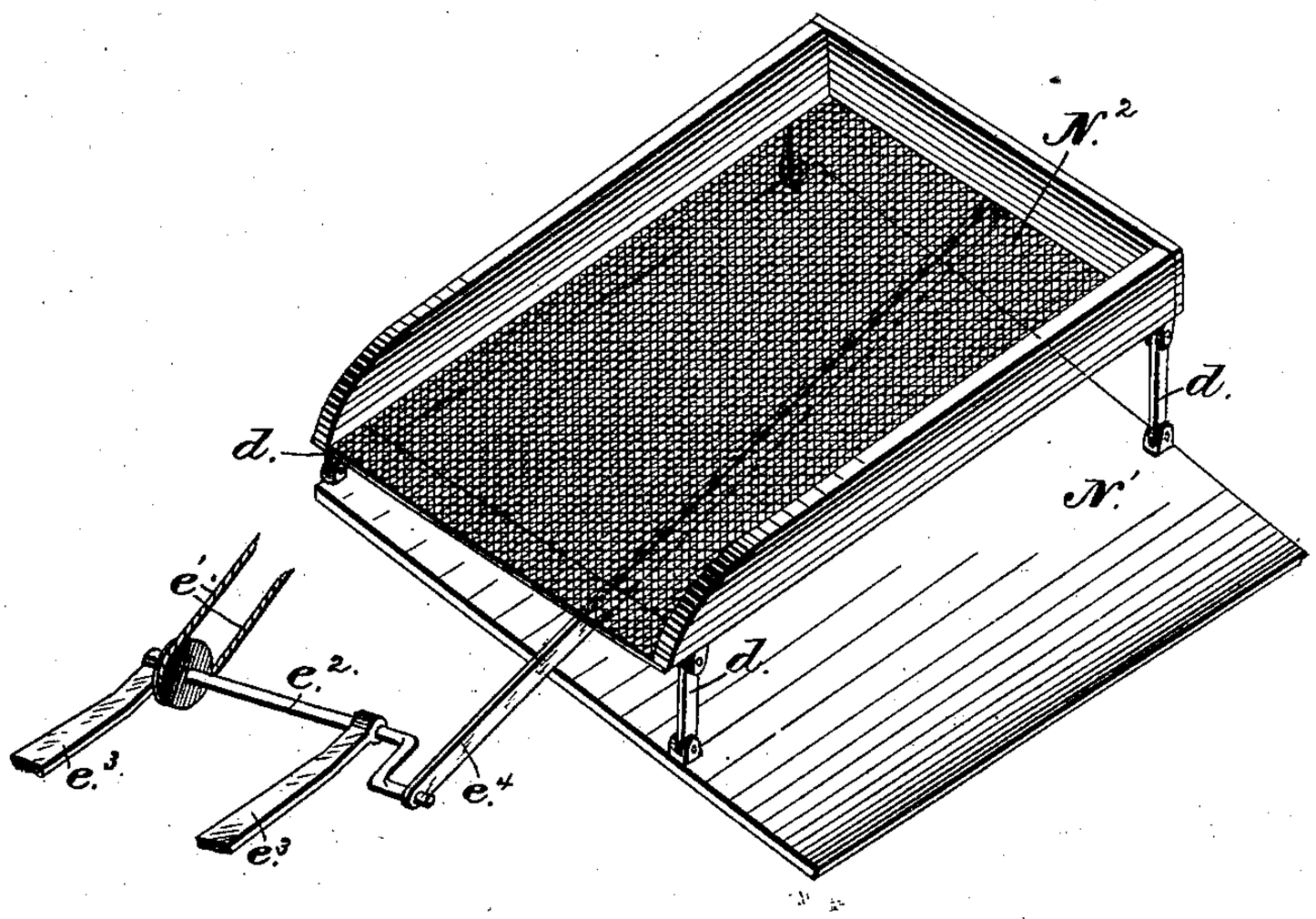
*Fig. 5.*




Witnesses.

Jas. E. Hutchinson.

Robt Everett.

Inventor.

Benj. Hershey.

By his Attorney,

James L. Norris.

# UNITED STATES PATENT OFFICE.

BENJAMIN HERSHEY, OF ERIE, PENNSYLVANIA, ASSIGNOR OF THREE-FOURTHS TO CHARLES A. HITCHCOCK, JOSEPH A. EGE, AND BENJAMIN F. THORNTON, ALL OF BRADFORD, PENNSYLVANIA.

## MACHINE FOR REDUCING ORES.

SPECIFICATION forming part of Letters Patent No. 257,132, dated April 25, 1882.

Application filed February 25, 1882. (No model.)

*To all whom it may concern:*

Be it known that I, BENJAMIN HERSHEY, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, have invented new and useful Improvements in Machines for Reducing Ores, of which the following is a specification.

The object of my invention is to produce a machine for crushing and grinding ore in which the ore as rapidly as reduced to the desired degree of fineness is automatically removed, that portion of the material remaining in the machine being subjected to the further action of the crushing and grinding devices to reduce it to the condition required.

One of the essential features of my invention consists in an elevating mechanism traveling in a trough or vessel and following the grinding or crushing devices in their traveling movements in the trough or vessel for the purpose of carrying the material upward and delivering it upon a screen or sieve which moves or travels in rear of the elevating mechanism.

My invention is clearly shown in the machine illustrated in the accompanying drawings, in which—

Figure 1 is a plan or top view; Fig. 2, a vertical sectional view on the line *x x* of Fig. 1; Fig. 3, a transverse section through one of the troughs or vessels, in front of the elevator, to show the latter and the arrangement of the inclined chute or conveyer, the receiver, and its scraper or clearer; Fig. 4, a side elevation, showing the relative arrangement of the trough or vessel, the elevating mechanism, the screen or sieve, and the inclined chute or conveyer below the latter; Fig. 5, a detached perspective view of the vibrating screen, the chute or conveyer below the same, and the crank-shaft which vibrates the screen. Fig. 6 is a broken view, showing a portion of the projection or device on the rim of the trough or vessel for lifting the elevating mechanism; Fig. 7, a transverse sectional view of a modification.

In Figs. 1 and 2 of the drawings I have illustrated two troughs or vessels, D, arranged concentrically with relation to each other, and supported on a suitable foundation or frame, A, to the central part of which is securely bolted a metal disk or plate, B, provided with an upright cylindrical shaft or journal, B′, on which is arranged to rotate a crown-wheel, C, meshing with a pinion, $T^2$, secured to a horizontal shaft, T′, which is provided with a pulley, $T^3$, driven by suitable power for the purpose of revolving the crown-wheel.

To the upper side of the crown-wheel are securely fastened three ring-bearings, $C'C^2$, which are provided with coincident semicircular recesses, in which are arranged spherical heads on the inner ends of horizontal shafts *f*, so as to constitute a ball-and-socket joint. The outer ends of the shafts *f* are journaled and adapted to rotate in a series of link-bearings, E′, which are connected together by suitable pivots, one of the end links of each series being fastened to a radial arm, $E^2$, attached at its inner end to the ring-bearing before mentioned, said radial arms forming what I term "draw-bars," as they are the draft medium for impelling or drawing the grinding or crushing wheels or rollers and the moving parts of the apparatus, hereinafter described, around the trough or vessel. The shafts *f* overhang the troughs or vessels, and the grinding or crushing wheels or rollers E and G are securely fastened to and revolve with the same, so as to travel in a circular path in the troughs or vessels in which the material to be crushed or ground is placed.

As shown, the wheels or rollers for reducing the ore are arranged in series of three in such manner that one of the series shall run in the inner and two of each series in the outer trough or vessel, or vice versa. The vertical walls of the troughs or vessels are flat or smooth on their upper edges, and serve as a guideway or track for two flanged wheels, K, which support an elevating mechanism composed in the present example of an endless apron, I′, traveling around pulleys *a a*, supported in the frame-work I of the elevating mechanism by means of axial shafts, said apron being furnished with suitable buckets, as more clearly illustrated in Figs. 3 and 4.

The axial shafts of the wheels K and of the

upper pulley, *a*, are provided with pulleys $K^2$ and $K^3$, around which passes a belt, $i^2$, whereby a traveling movement is imparted to the apron carrying the elevating-buckets. The axial shaft of the wheels K is supported and rotates in arms *b b*, bolted to one of the draw-bars $E^2$, which arms serve to brace and support the elevating mechanism.

To a ring, *c*, on the upper side of the crown-wheel is attached a bar, N, which is bent upwardly and then outwardly to an inclined position, as shown in Fig. 2, and on said arm, which is preferably bifurcated, is attached an inclined chute or conveyer, N′, which is so arranged that it projects a sufficient distance to overhang the outer trough or vessel. (See Figs. 1 and 2.)

Above the inclined chute or conveyer N′ is located a screen or sieve, $N^2$, which is supported by the said chute or conveyer through the medium of pivoted rods *d d*, so that the screen is adapted to vibrate back and forth, and is so arranged as to be adjacent to the upper portion of the elevating mechanism. (See Fig. 4.)

The axial shaft of the wheels K is provided with a pulley, *e*, which transmits motion through a belt, *e′*, to a crank-shaft, $e^2$, supported by arms $e^3$ $e^3$, attached to one of the draft-bars $E^2$, a pitman, $e^4$, connecting the crank of the said shaft to the screen or sieve, whereby when the crank-shaft is rotated the screen will be vibrated back and forth above the chute or conveyer N′.

It will be seen that each of the troughs or vessels is provided with an elevating mechanism and a vibrating screen substantially alike, except that the inclined chute or conveyer of the outer trough or vessel is arranged to discharge the material passing through the screen or sieve into a suitable receiver, R, Figs. 1 and 3, from which it can be delivered into any suitable vessel.

For the purpose of clearing the receiver of the material and preventing accumulation therein of the same, I arrange a fixed scraper, S, to project downward, as shown in Fig. 3, so that as the said traveling receiver R is carried around the scraper will pass through it and clear it of all material therein, thus providing efficient means for discharging the material into some suitable receptacle or vessel located for its reception.

The upper edges of the vertical walls of the inner trough are each provided for about half its circumference with a projection, P, which is inclined at each end, (see Fig. 6,) the object of which is to lift or raise the elevating mechanism in order that it will not operate to carry up any material for a certain length of time, which lifting or raising is effected by the wheels K riding up the inclines on the projections P, which will be obvious without further explanation. The object of this is to prevent the elevating mechanism from raising any material until the operation of grinding or crushing has advanced somewhat.

I will now proceed to describe the operation of the machine.

The ore to be ground or crushed is introduced in any suitable manner into the inner trough or vessel, and power is then transmitted to the pulley $T^2$, which, through the described devices, will rotate the crown-wheel C, and by means of the draft-bars $E^2$ a traveling movement around the trough or vessel will be transmitted to the grinding or crushing rollers and to the elevating mechanism, as well as the vibrating screen or sieve. At the commencement of the movement it is desirable that the elevating mechanism will be lifted by means of the projections P, so that the grinding or crushing operation will have advanced somewhat before the buckets of the elevator act to catch and carry up any of the material until the elevating mechanism has passed the projections P and rests directly on the upper edge of the vertical walls of the trough or vessel, at which time the material which has been acted on will be caught by the buckets on the traveling endless apron and carried upward and discharged upon the vibrating screen $N^2$, which will sift through the finer reduced ore upon the chute or conveyer N′, and as the outer end of the said chute or conveyer overhangs the outer trough the reduced ore will be discharged into the same, where it is again subjected to the action of grinding or crushing rollers or wheels, and is again elevated or carried upward by the elevating mechanism in the outer trough or vessel and delivered upon a second screen arranged above an inclined chute or conveyer, which latter delivers such reduced ore into a receiver, R, from which it can be discharged into any suitable receptacle by means of the clearer or scraper S. The receiver R is attached to or connected with the outer projecting edge of the chute or conveyer N′, so as to travel around therewith. Hence the fixed or stationary scraper S only acts to scrape or clear the receiver when the latter passes under the same.

The tailings from the respective screens or sieves are discharged from the rear end of the same and fall back into their respective troughs or vessels to be further subjected to the action of the grinding or crushing rollers or wheels, whereby they are further reduced, and the operations before described are repeated until the ore has all been reduced to the required fineness and discharged from the troughs or vessels in the automatic manner herein set forth.

It should be stated that the screens or sieves are of different degrees of mesh, the inner sieve or screen being the coarser, the object of which will be obvious.

The crushing or grinding wheels or rollers are preferably made of different diameters, and are so proportioned that the entire grinding-surface of the troughs or vessels is utilized and the machine brought into a compact shape.

It will be observed that by arranging the shafts of the grinding or crushing wheels or rollers in pivoted links and ball-and-socket

bearings, as before set forth, they are adapted to freely move vertically in their traveling movements, and thus accommodate the grinding or crushing rollers to the varying depth of the material in the troughs or vessels without liability of the shafts binding in their bearings.

The troughs or vessels are of circular form, and their bottom walls recessed or provided with central depressions, made narrower than the main portion of the trough, for receiving false bottoms, upon which the material is placed that is to be ground or crushed.

The troughs and the false bottoms may for convenience be made in sections for facilitating their removal from place to place, and for removal should they become worn.

If desired, scrapers may be secured in such relation to the grinding or crushing rollers or wheels as to keep the material to be acted upon at all times directly in the path of the same.

In Fig. 7 I have illustrated the false bottom, also the arrangement in a single trough or vessel of two grinding or crushing rollers.

I would here state that I do not desire to limit myself to the described method of driving the grinding or crushing rollers, the elevating mechanism, and the vibrating screen, as other constructions of driving devices can be employed without departure from the intent and spirit of my invention.

Any one familiar with the pulverization of quartz is aware that the force applied is most effective when delivered on a mass of material in which the interstices are not filled up with powder in as fine a state as that to which it is desired to reduce the entire body. The reason is that such portions of fine powder form a cushion in and on which the larger particles pack themselves, so that the grinding force brought to bear on them is not so effective as it would be if they were not thus surrounded. While many attempts have been made by various devices — such as screens, revolving brushes, and even by means of elevators and screens combined—to reach the desired end of keeping the mass free from fine powder, none have been yet introduced which so commend themselves as to be found in more than very limited use.

It is important to provide a machine whereby the mass may be subjected to the action of grinding or pulverizing devices, sifted or separated, and reground as often as may be necessary to reduce the ore to the required degree of fineness. This I accomplish by means of the elevating mechanism and vibratory screens hereinbefore described, which will at each revolution around the trough or vessel separate the finer from the coarser portions of all, or nearly all, the entire mass under treatment.

I have described and shown a series of grinding or crushing rollers or wheels arranged in each trough or vessel; but I do not desire to limit myself to any definite number, as the grinding or crushing operation could be effected by the employment of a single roller or wheel in each trough or vessel, which of course would travel in advance of the elevating and separating mechanism.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination of a series of troughs for receiving the material to be crushed or ground, devices arranged in said troughs or vessels for grinding or crushing the material, and devices for elevating or lifting the material from one trough or vessel and discharging it into the other for the purpose of regrinding, substantially as and for the purpose described.

2. In an ore-crushing machine, the combination of a trough or vessel for receiving the material to be ground, a traveling roller or wheel for grinding or crushing the material, an elevating mechanism traveling in the trough or vessel and following the grinding or crushing roller or wheel for carrying the material upward, and a screen or sieve moving with the elevating mechanism, arranged to receive the material therefrom, substantially as described.

3. The combination of a series of concentrically-arranged troughs or vessels for receiving the material to be ground or crushed, a series of traveling grinding or crushing rollers or wheels arranged in said troughs or vessels, an elevating mechanism traveling in one of the troughs or vessels and following the rollers or wheels for carrying the material upward from said trough or vessel, and a screen or sieve moving with the elevating mechanism, arranged to receive the material therefrom, substantially as described.

4. The combination of a series of concentrically-arranged troughs or vessels for receiving the material to be ground or crushed, a series of traveling grinding or crushing rollers or wheels arranged in said troughs or vessels, an elevating mechanism traveling in one of the troughs or vessels and following the said rollers or wheels for carrying the material upward from said trough or vessel, a screen or sieve moving with the elevating mechanism and arranged to receive the material therefrom, and a chute or conveyer located beneath the screen and arranged to discharge the material from the inner into the outer adjacent trough, substantially as described.

5. The combination of a trough or vessel for receiving the material to be ground or crushed, a traveling roller or wheel moving in said trough or vessel, an elevating mechanism traveling in the trough or vessel and following the said roller or wheel, and a vibrating or shaking screen traveling in rear of the elevating mechanism and arranged to receive the material which is carried up by the same, substantially as described.

6. The combination, in an ore crushing or grinding machine, of a central rotary wheel, a series of radial shafts connected at their inner ends with said wheel, a series of grinding wheels or rollers supported by said shafts, troughs or vessels provided with upright rims,

elevating mechanism mounted on wheels which travel on said rims, and a screen or sieve traveling in rear of the elevating mechanism and arranged to receive the material which is carried upward by the latter, substantially as described.

7. The combination, in an ore grinding or crushing machine, of a circular trough or vessel, provided with upright rims having upon each an inclined plane or projection, with a traveling grinding or crushing roller or wheel, a traveling elevating mechanism mounted on wheels arranged to travel on the said upright rims, and a sieve or screen traveling in rear of the said elevating mechanism, substantially as and for the purpose described.

8. The combination of a circular trough for receiving the material to be ground or crushed, a traveling grinding or crushing roller or wheel arranged therein, a traveling elevating mechanism, a screen or sieve moving in rear of the latter, an inclined chute or conveyer moving with and located beneath the screen or sieve, and a traveling receiver connected and moving with the chute or conveyer to receive the material therefrom, substantially as described.

9. The combination of a circular trough for receiving the material to be ground or crushed, a traveling grinding or crushing roller or wheel arranged therein, a traveling elevating mechanism, a screen or sieve moving in rear of the latter, an inclined chute or conveyer moving with and located beneath the screen or sieve, and a traveling receptacle connected and moving with the chute or conveyer to receive the material therefrom, and a stationary scraper arranged to clear the said receiver, substantially as and for the purpose described.

10. The combination of ring-bearings, the radial shafts having a ball-and-socket connection at their inner ends in said ring-bearings, a series of jointed links connecting the outer ends of the shafts, and grinding or crushing rollers or wheels mounted on said shafts, substantially as described, whereby the shafts are capable of rising and falling and of traveling in a circular path, as and for the purposes set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

BENJAMIN HERSHEY.

Witnesses:
ALBERT H. NORRIS,
JAMES A. RUTHERFORD.