No. 639,406. Patented Dec. 19, 1899.

E. KREISS.

DISINTEGRATOR.

(Application filed June 26, 1899.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

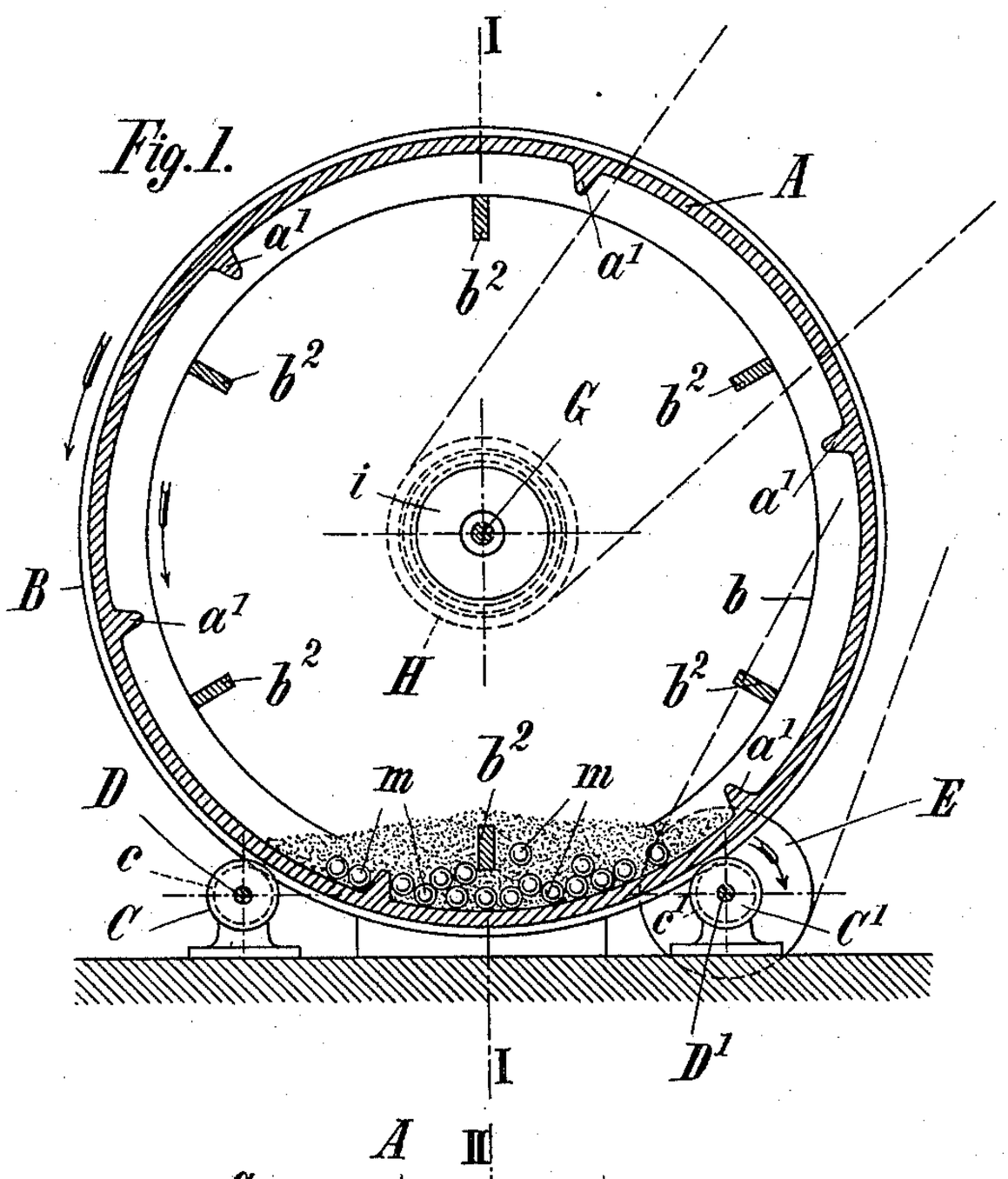
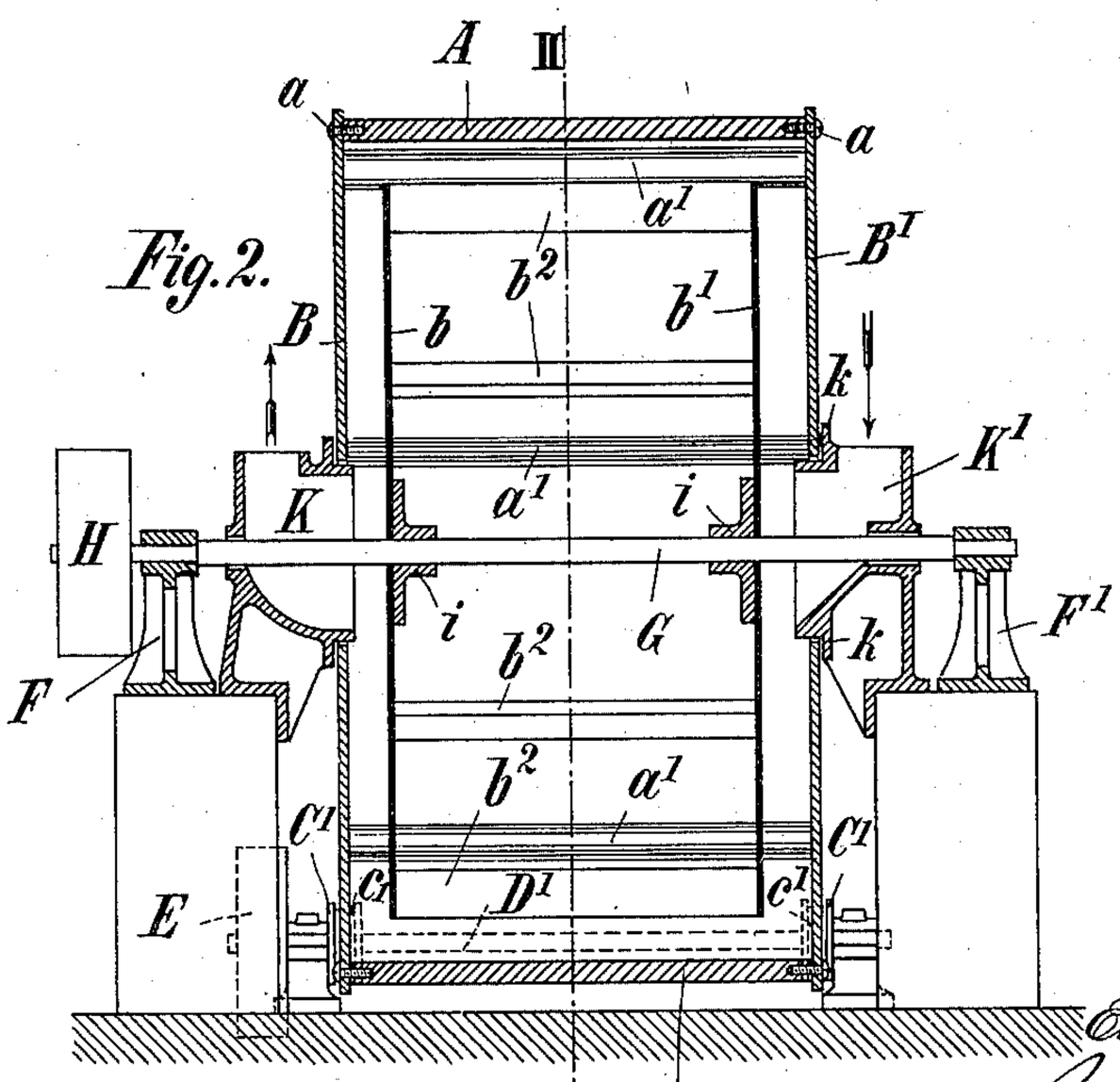


Fig. 2.



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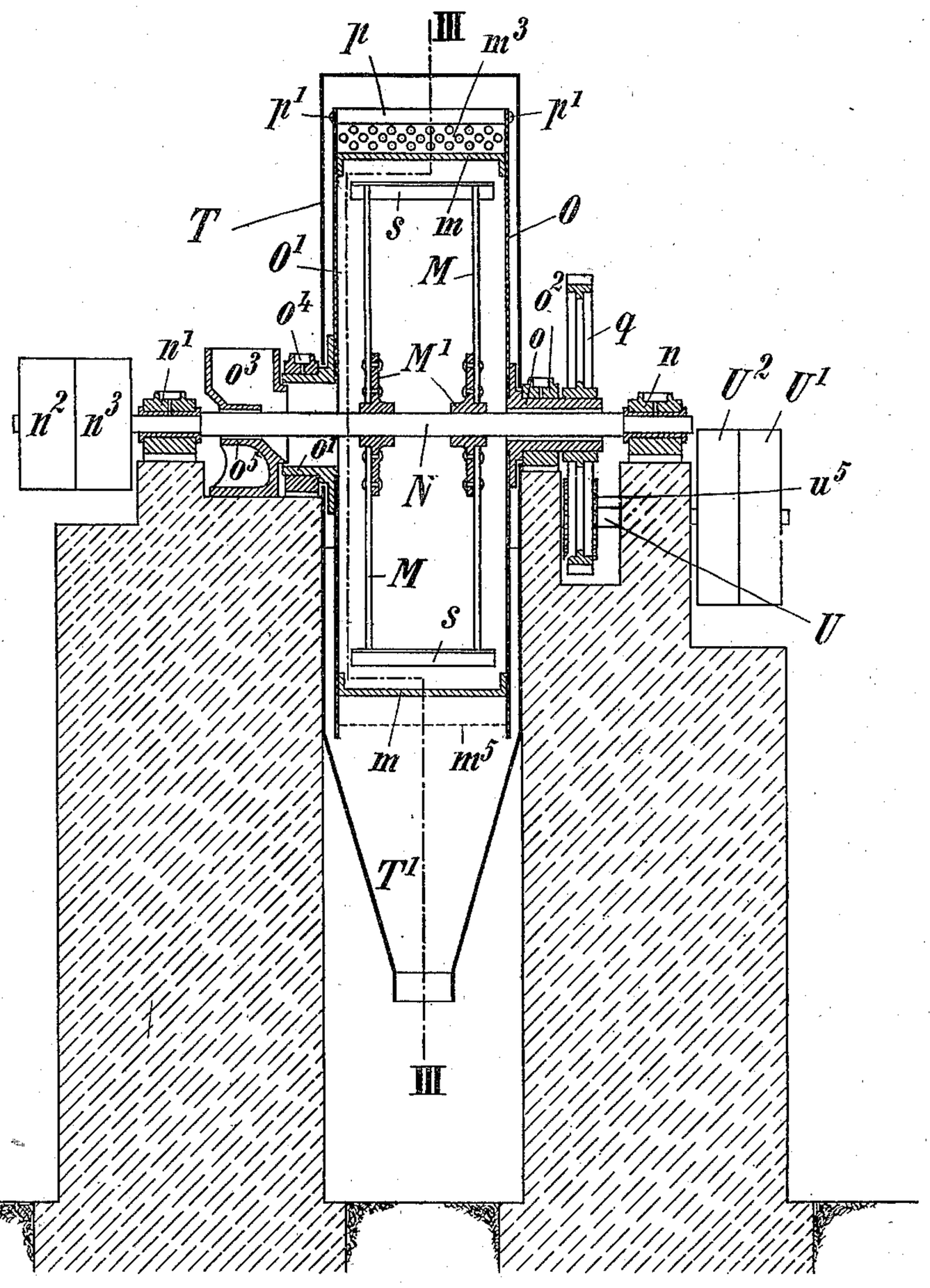
(No Model.) 3 Sheets—Sheet 2.

Fig. 3.



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DISINTEGRATOR.

(Application filed June 26, 1899.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 4.

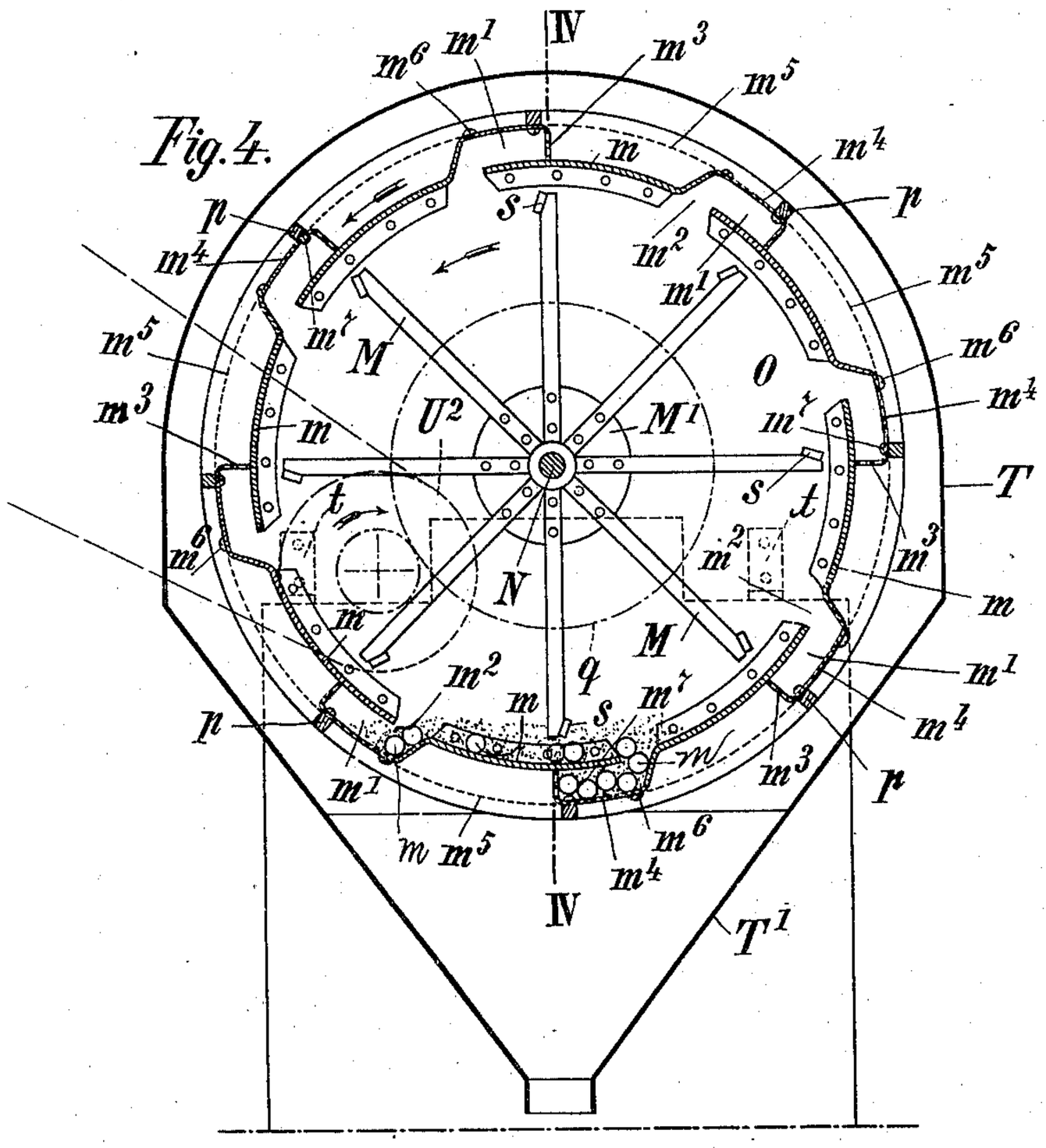
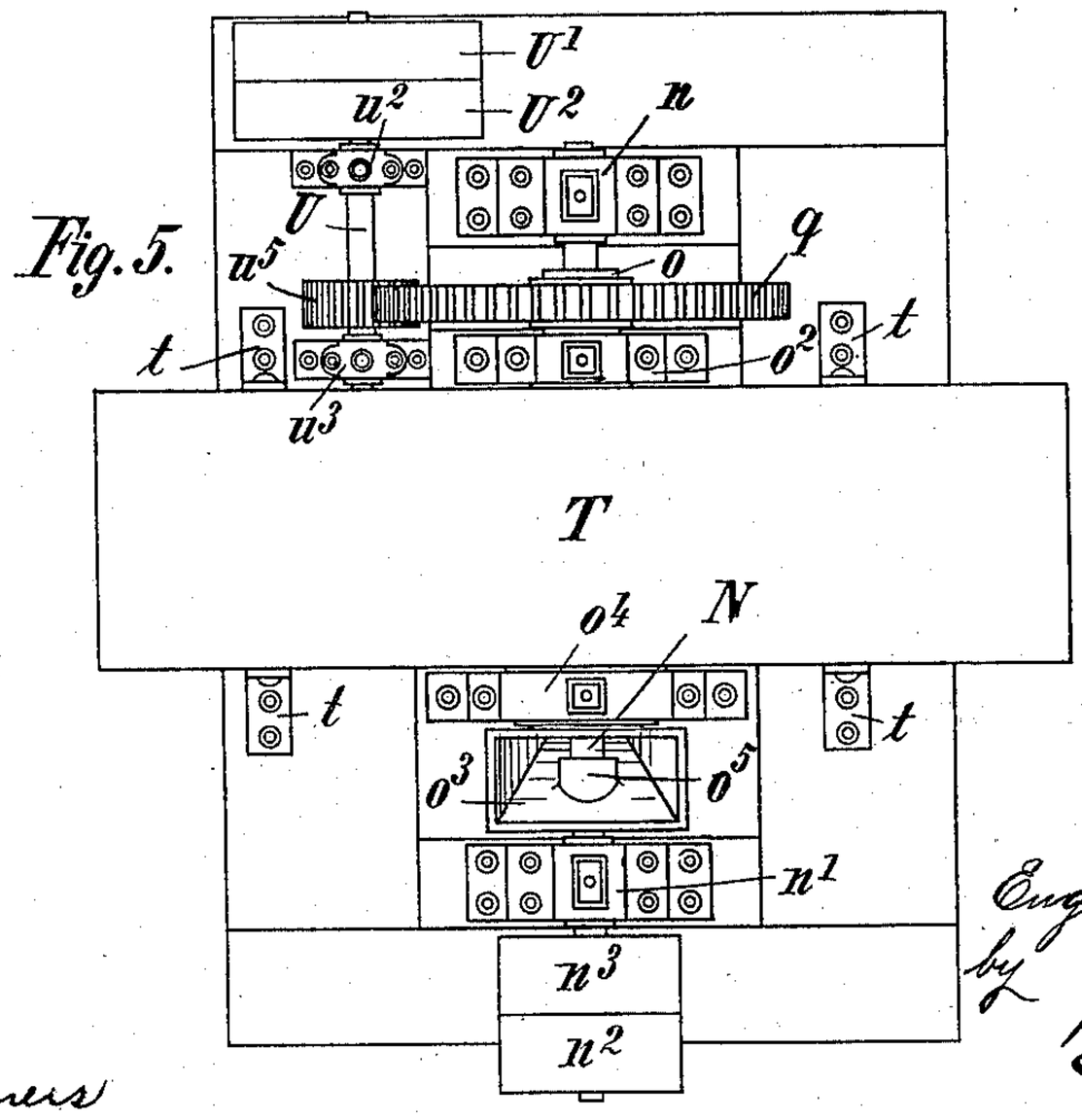


Fig. 5.



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UNITED STATES PATENT OFFICE.

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DISINTEGRATOR.

SPECIFICATION forming part of Letters Patent No. 639,406, dated December 19, 1899.

Application filed June 26, 1899. Serial No. 721,929. (No model.)

To all whom it may concern:

Be it known that I, EUGEN KREISS, a subject of the Emperor of Germany, and a resident of Hamburg, in the German Empire, have invented certain new and useful Improvements in Disintegrators, of which the following is a specification.

My invention has relation to disintegrating or, more properly, grinding machines, and more particularly to machines for reducing hard substances, as cement rock, to a pulverulent condition.

It has before my invention been the practice to reduce hard substances in revolving drums through the medium of comparatively large and heavy metal balls lifted by the drum during its rotation to a certain height and then allowing them to drop. As is well known, the disintegrating or crushing action in machines of this class is theoretically conditioned upon the *vis viva* (mv^2) of the disintegrating devices—*i.e.*, the balls—while the effect is disproportionally greater relatively to the increase of mv^2. Thus, for instance, a ball of a given weight may drop an infinite number of times from a given height upon a hard body without crushing the same, while a single drop of such ball from a higher point will result in the crushing of said body, and this crushing effect will increase with the increase in the drop of the ball—*i. e.*, the increase of v or v^2. It follows that the effect of the drop of a number of balls upon the revolving drum will increase in accordance with the height to which the balls are lifted and with the weight of the latter, the result being that disintegrating-drums of large diameter—*i. e.*, great capacity—either built up wholly or partly of a foraminous material, are impracticable. On the other hand, such drums as are practicable require to be very strongly built to resist the impact of the balls, while the wear is very great. Furthermore, in the reduction of such substances as cement the attrition is so great that the balls are speedily worn away to such an extent as to render them useless by reason of their decrease in weight, and they have to be replaced by others, and this gives rise to considerable losses; but irrespective of all the disadvantages inherent to revolving-drum gravity-disintegrators, above referred to there is one still more serious—namely, the great amount of power required to perform a comparatively small amount of work. The balls are raised by the drum during one-half of its revolution, and drop before the completion of such half-revolution. The power applied has therefore to overcome the inertia of the drum and balls during the greater portion of the revolution of the drum, while the resistance to motion is materially decreased during a very small portion of the revolution of said drum—namely, while the balls and a certain quantity of the material being disintegrated are dropping. This, as is well known, gives rise to irregular motion and consequent increase in wear. Furthermore, as the effect of the impact of the balls in these machines is always exerted in a direction opposite to the direction of rotation of the drum, and hence antagonistic to such rotation, there is an increase in the load suddenly superimposed on the power applied, which likewise gives rise to irregular motion, while the amount of power necessary to drive the drum is disapportionately greater than the amount of work performed. It has also been proposed to reduce more or less friable substances by combining revoluble beaters with a revoluble drum, in some cases the beaters revolving in the same direction as, but at a different speed from, that of the drum, while in other cases the beaters and drum are caused to revolve in opposite directions. Practice has, however, conclusively shown—in fact, it is obvious—that such an arrangement would be absolutely impracticable for the reduction of such hard substances as cement rock, for instance. This not only because of the necessity of revolving the beaters at an abnormally great velocity relatively to the velocity of the drum, which in itself is very impracticable and detrimental to the operative devices, but also on account of the very rapid wear of the beaters and inner periphery of the drum, especially if the latter is composed wholly or partly of a foraminous material and the liability of such beaters being broken.

My invention has for its object a construction of disintegrator whereby all of the above-described serious disadvantages are overcome and whereby the power necessary to drive the machine is reduced to a minimum. This I attain by combining a drum and beaters re-

volving in one and the same direction at different speeds with a comparatively great number of comparatively small metallic spheres or balls, the arrangement being such that the balls instead of being merely lifted and allowed to drop will be driven about the drum in the direction of its rotation with the material by the beaters. Obviously the inertia to be overcome by the power is in a great measure compensated by the *vis viva* of the balls and of the material moving in the direction of rotation of both beaters and drum, while the latter, assisted by the beaters, lifts both material and balls to a certain height, the beaters then propelling or projecting a certain quantity of material and a certain number of balls at a comparatively great velocity in the direction of rotation of said drum and beaters, the *vis viva* of such material and balls assisting materially in the driving of the drum—*i. e.*, in overcoming the inertia—hence reducing the amount of power necessary to drive such drum to a minimum. There are, however, other very material advantages derived from the combination of disintegrating elements referred to. Not only is a portion of the material operated upon disintegrated by the drop of some of the balls, but also by the triturating or grinding of the material between the balls during their "flight," if I may so term it, about the drum in the direction of its rotation and the triturating or grinding of the material between both beaters and balls and the inner periphery of the drum, but also by the comparatively great impact of the balls upon the material under the propelling action of the beaters, while the great number of small balls used present extremely-increased reducing-surfaces as compared with a comparatively small number of large drop-balls. Furthermore, the small balls can be used and may remain in the machine until nothing is left of them—*i. e.*, until they are themselves entirely ground up—they remaining efficient until almost nothing is left, fresh balls being supplied from time to time, so that there is practically no loss in that respect, since the ground-up balls become gradually a part of the material disintegrated.

Machines constructed as above outlined have conclusively proved all that has been said in respect of their function and the amount of power saved as compared with drop-ball machines, and by reason of the combination of elements described, and particularly owing to the small dimensions of the balls used, I have been enabled to increase the dimensions of the drum, and hence its capacity, to an extent such as would render drop-ball machines absolutely impracticable. Finally, I may state that owing to the scattering of the material throughout the drum during its revolution by the beaters the finely-ground material is more readily separated and driven through the foraminous portions of the drum by the centrifugal action and the air drawn in than is the case in the well-known drop-ball disintegrators where a forced draft or blast of air is required for this purpose.

That my invention may be fully understood, I will describe the same in detail, reference being had to the accompanying drawings, in which—

Figures 1 and 2 are vertical sections at right angles to each other, the section Fig. 1 being taken on line II II of Fig. 2 and that of Fig. 2 on line I I of Fig. 1 of a disintegrating-machine embodying my invention. Fig. 3 is a vertical section taken on line IV IV of Fig. 4, which latter is a like section taken on line III III of Fig. 3; and Fig. 5 is a top plan view of the machine shown in Fig. 3, said Figs. 3 to 5 illustrating certain structural modifications.

The machine in its simpler form, as shown in Figs. 1 and 2, comprises a cylindrical drum A, provided on its inner periphery with a plurality of longitudinal inwardly-projecting ribs a' at equal distances apart, and two heads B B′, bolted by bolts a to opposite ends of said drum and of greater diameter than the latter to form flanges fitting grooves $c\,c'$ in wheels C C and C′ C′, of which there is a pair arranged at each end of the drum to support and rotate the same, said wheels being mounted on spindles or shafts D and D′ revoluble in suitable bearings, the shaft or spindle of one pair of wheels—as, for instance, the shaft D′—carrying a belt-pulley E, driven from any suitable prime motor, these features being well known.

In suitable bearings in standards F F′ is mounted a shaft G, that passes axially through the drum A and through a discharge-spout and a feed-hopper. The feed-hopper K′ is fitted in a suitable aperture in the head B′ of the drum and has a flange k overlapping said aperture, said feed-hopper being secured to the support for the standard F′.

In the head B of drum A is formed an aperture, in which is fitted a discharge spout or duct K, having likewise a flange overlapping the aperture in said drum-head B, said discharge-spout being secured to the support for the standard F, as shown. In practice the discharge-spout K is connected with a trunk or other suitable duct (not shown) for conducting the finely-ground material away from the machine, as is the common practice.

On the shaft G is secured a beater consisting of two circular heads $b\,b'$ and transverse flat beater-arms b^2, whose outer edge is substantially flush with the periphery of the heads, said beater-arms being arranged in radial lines and at equal distances from each other. As clearly shown in Fig. 1, the diameter of the beater-heads $b\,b'$ relatively to the distance between the inner edges of two oppositely-arranged ribs or ledges a' on the inner periphery of the drum A is such as to cause the outer edges of the beaters to barely clear said ribs as the beater revolves, or, in other words, so that there will be but a com-

paratively small space between the outer edge of the beater-arms b^2 and the inner edge of the ribs a', this relation being determined by the dimensions of the balls m used in the machine.

I have hereinbefore stated that for reasons set forth I make use of a comparatively great number of comparatively small balls m. Hence the space between the outer edges of the beater-arms b^2 and the inner edges of the ribs a' when juxtaposited should be less than the diameter of said balls, so that said beater-arms may take them up and throw them about the drum with a violence depending upon the velocity of rotation of the beater. It is obvious, therefore, that if the drum is rotated at a less speed than the beater, whether the latter revolves in the same direction as the drum or in an opposite direction, the beater-arms will take up some of the balls, together with some of the material, and throw the same with greater or less violence from one point of the drum to another, and if said beater is revolved at the proper velocity the greater portion, if not all, of the material in the drum will be kept constantly in motion. The material to be disintegrated is thus acted upon by different forces—first, by the crushing action of the beater-arms b^2 and the ribs a'; second, by the crushing action of the beater-arms and balls; third, by the crushing action of those balls which merely drop from the point to which they are lifted by the ribs; fourth, by the grinding of the material between the balls always at the lowest point of the drum, and, lastly, by the grinding of the material between the balls projected by the beater-arms and the impact of said balls upon the material on the inner periphery of the drum. Obviously a combination of triturating forces such as set forth will result in a much greater percentage of reduction to powder than would be the case in a drop-ball or beater disintegrator. In order, however, to attain the best and most economical results, I revolve the beater and drum in one and the same direction, the former being, however, rotated at a much greater speed than that of the drum. In fact, in practice I have found that the best results are obtained by rotating the beater at a high velocity as compared with the velocity of the drum, which is preferably rotated at a low velocity. This could not possibly be done if the balls were of the dimensions of those generally used in drop-ball machines, as the drum would be pounded to pieces, and for reasons previously stated the described results could not be obtained by means of a beater alone. In practice I make use of metallic (hard steel) balls of a diameter of from three-fourths of an inch to one inch, which are fed into the machine through the feed-hopper. These balls remain in the drum until they are completely ground up, and as they become a part of the material disintegrated there is no loss in that respect, fresh balls being supplied as the old ones disappear or become too small to be of any effect, though, however small they may become, they still exert a grinding action upon the material to be disintegrated.

The machine described may be said to be a combined beater, drop-ball, and flying-ball machine, and as the balls are small and comparatively light and are, together with the material, kept in constant motion at varying velocities the caking of the finer material liable to occur in the ordinary drop-ball machine and which proves a very serious inconvenience in the reduction of substances liable to cake when in a more or less finely-ground condition is also avoided. Finally, in view of the fact that the greater portion of the material is, so to speak, held constantly in suspension in the drum the finest is readily driven out through the discharge-spout K by the air-currents induced by the rotation of the beater, so that an imperforate drum can be used in many cases where this would otherwise be impracticable, while a blast apparatus is also dispensed with.

In the construction of the machine shown in Figs. 3, 4, and 5 the revoluble drum has tubular axial journals o o', the latter of sufficient cross-sectional area to serve as a feed-duct and communicating with a stationary feed-hopper o^3, mounted on the supports for the bearings n n' of the beater-shaft N, which passes axially through said drum and its journals and through said feed-hopper. The journals o and o' revolve in bearings provided with lubricating cups and ducts o^2 o^4, and the journal o carries a gear-wheel q, meshing with a gear u^5 on a counter-shaft U, which carries the usual fast and loose belt-pulleys U' U², such fast pulley being driven from any suitable motor, while the beater-shaft N carries fast and loose belt-pulleys n^2 n^3 and may be driven from the motor which drives said drum. The drum-journals o and o' revolve in openings in a housing T, the side walls of which below the drum converge to form a discharge spout or hopper T'. The beater in this case is constructed of a series of arms M, radiating from hubs M', secured to shaft N, the beaters proper, s, being secured to the outer ends of said arms—that is to say, each beater-blade is secured near one end to an arm M on one of the hubs and near its opposite end to a corresponding arm on the other hub. The drum itself is composed of a series of imperforate segments m, bolted to the heads O and O' in such a manner as to form a cylindrical structure having a longitudinal passage or slot m^2 between each two segments m, the sheet metal of the sections being bent outwardly, then curved backward to form segments m^4 of a circle of greater diameter than that of the body of the drum, and then inwardly on radial lines, as shown at m^3, the latter portion being secured to the next succeeding drum-segment m some distance from its forward edge in the sense of the direction of rotation of the drum and beater, as indi-

cated by arrows, Fig. 4. In this manner segmental pockets m' are formed on the outer periphery of the drum, the entrance to which is formed by the space between two drum-segments m, said pockets extending backward some distance over the next adjacent drum-segment. The outer curved faces of the pockets also form bearings for sections of a foraminous cylinder m^5, secured to said pockets by screws m^6, while the curved outer wall m^4 of the pockets, near their rear radial wall m^3, is secured to cross-bars p by means of screws m^7, and said cross-bars are bolted to the drumheads O O' by bolts p', said drumheads being of course of the proper diameter. The rear wall m^3 of the pockets m' is perforated to afford passage to the finely-ground material from the pockets m' to the pockets formed by the foraminous sections m^5, the material being finally discharged through the meshes or perforations of m^5 into the housing T.

The pockets m' in the described construction serve as lifting devices for the small balls, and in view of the construction of said pockets the balls cannot move out of them until a pocket has passed the vertical dead-center above the axis of rotation of the drum, as is obvious, and in view of the fact that the beaters revolve at a much higher velocity than the drum and quite close to the inner periphery of said drum the balls (or some of them) and material (or some of it) carried along with the balls in the pockets as they drop out are struck by the beaters and projected violently against the imperforate walls of the drum or about the same, thus producing the same results as hereinbefore described, while the finely-ground material is violently driven out through the perforations in the rear wall m^3 of the pockets m'.

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

1. In a disintegrator, a revoluble drum containing a comparatively large number of comparatively small balls, and means causing the latter to be carried from a lower to a higher level by said drum during its rotation, and to be then released; in combination with beaters revoluble at a greater speed than the drum in the path of the balls as they drop from such higher to a lower level, for the purpose set forth.

2. In a disintegrator, a revoluble drum containing a comparatively large number of comparatively small balls, and means causing the latter to be carried from a lower to a higher level by said drum during its rotation, and to be then released; in combination with beaters revoluble at a greater speed than and in the same direction as the drum in the path of the balls as they drop from such higher to a lower level, for the purpose set forth.

3. In a disintegrator, a revoluble drum provided with peripheral pockets parallel with its axis of rotation and having a perforated radial end wall, and a comparatively large number of comparatively small balls contained in said drum; in combination with beaters revoluble at a greater speed and in the same direction as the drum in the path of the balls as they drop out of the aforesaid pockets, for the purpose set forth.

4. In a disintegrator, a revoluble drum provided with peripheral pockets parallel with its axis of rotation and having a perforated radial end wall, a foraminous material covering the space between the pockets and forming a chamber between them, and a comparatively large number of comparatively small balls contained in said drum; in combination with beaters revoluble at a greater speed and in the same direction as the drum in the path of the balls as they drop out of the aforesaid pockets, for the purpose set forth.

5. In a disintegrator, a revoluble drum composed of two heads and a plurality of segments secured thereto to leave a space between each two segments, a pocket exteriorly of each space having a perforated end wall, a foraminous material covering the spaces between said pockets, and a comparatively large number of comparatively small balls contained in the drum; in combination with beaters revoluble at a higher speed than and in the same direction as the drum and in the path of the balls as they drop out of the aforesaid pockets, for the purpose set forth.

6. In a disintegrator, a revoluble drum composed of two heads and a plurality of segments secured thereto to leave a space between each two segments, a pocket exteriorly of each of said spaces extending therefrom over the adjacent segment in a direction opposite to the direction of rotation of the drum, said pockets having perforated end walls, a foraminous material covering the spaces between the pockets, and a comparatively large number of comparatively small balls contained in said drum; in combination with beaters revoluble at a greater speed than and in the same direction as the drum in the path of the balls as they drop out of the aforesaid pockets, for the purpose set forth.

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