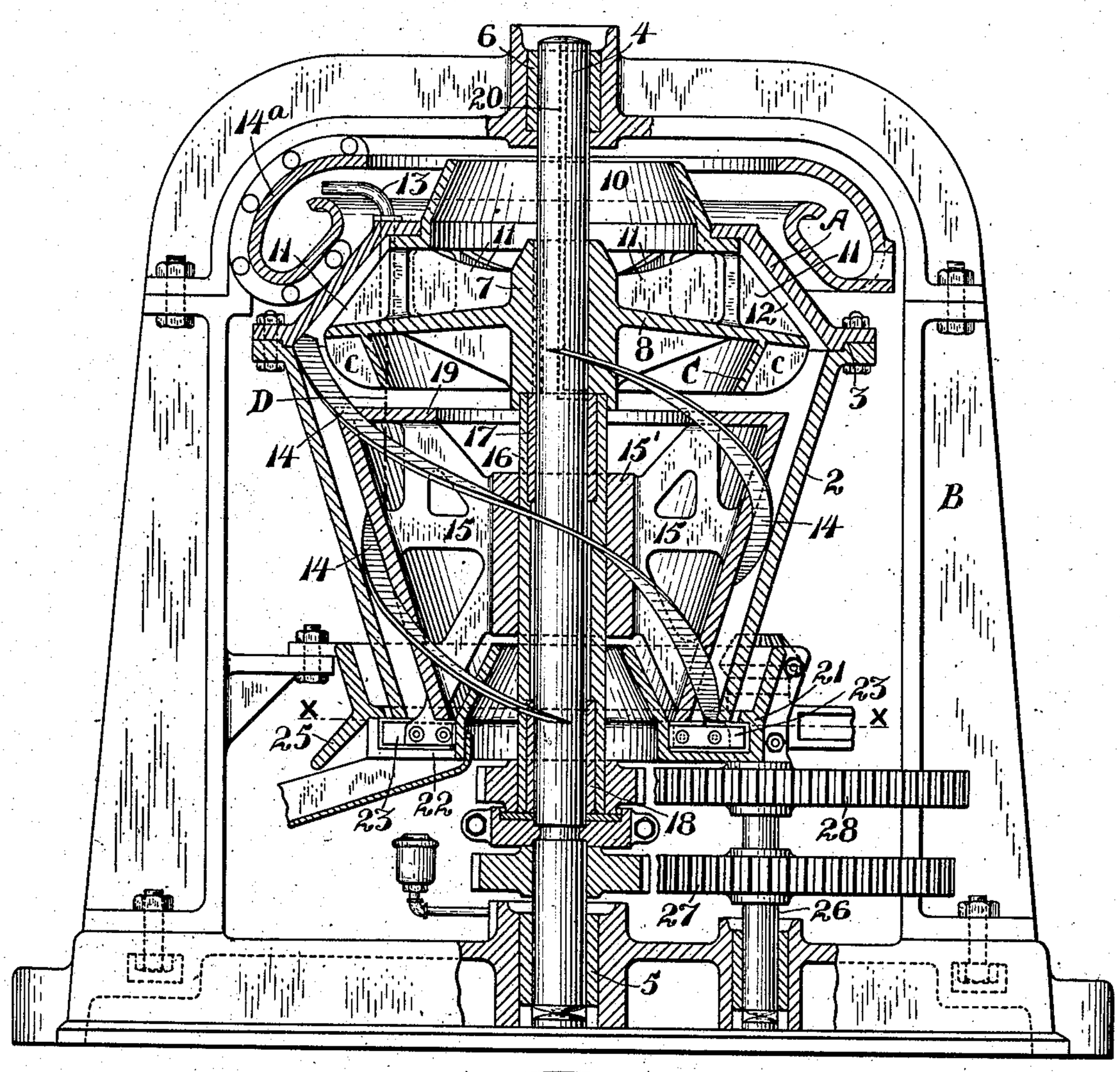
J. W. PHILLIPS.

CENTRIFUGAL SEPARATOR.

APPLICATION FILED AUG. 11, 1908.

924,376. Patented June 8, 1909.

Fig. 1.



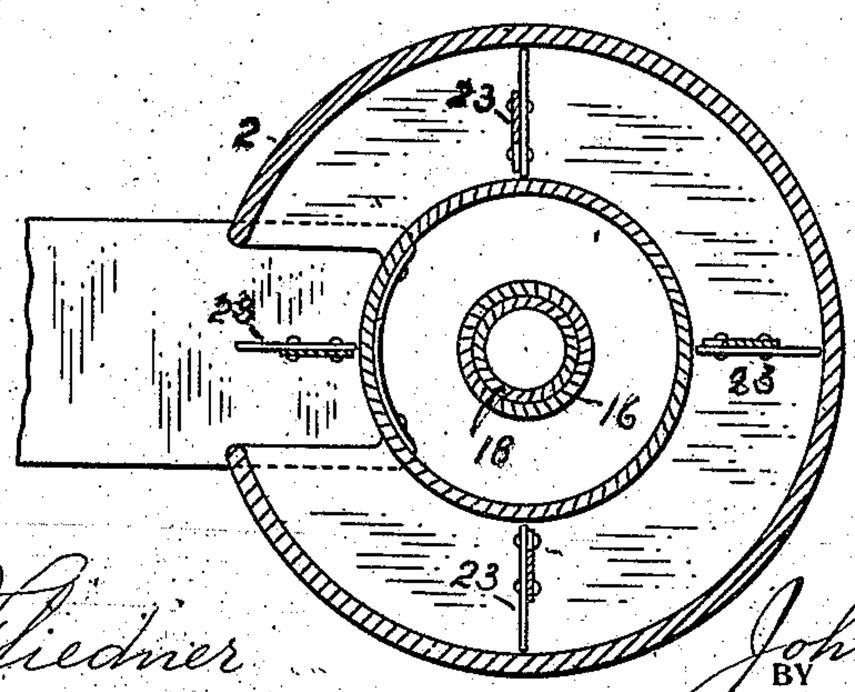


Fig. 2.

WITNESSES

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CENTRIFUGAL SEPARATOR.

No. 924,376. Specification of Letters Patent. Patented June 8, 1909.

Application filed August 11, 1908. Serial No. 447,972.

To all whom it may concern:

Be it known that I, JOHN WARNE PHILLIPS, citizen of the United States, residing at Silver City, in the county of Lyon and State of Nevada, have invented new and useful Improvements in Centrifugal Separators, of which the following is a specification.

My invention relates to centrifugal separators, and pertains especially to a separator of this type which is designed for mining and metallurgical purposes, breweries, sugar and oil refineries, and any uses where it is desired to separate solids from liquids.

The object of the present invention is to provide a centrifugal separator which shall be of simple construction, easy to operate, of maximum capacity, practical and durable; and especially to provide a machine of peculiar design and mode of operation whereby every bit of the material undergoing concentration or separation must pass outward first into and through a zone of maximum centrifuging force, the liquids being strained backward again through the zone of greatest energy to a point of discharge separate from the solids.

Another object is to provide a means for rapidly bringing the material to the same speed of revolution as the pan, and still not interfere with separation.

The invention consists of the parts and the construction and combination of parts as hereinafter more fully described and claimed, having reference to the accompanying drawings, in which—

Figure 1 is a central vertical section of my centrifugal separator. Fig. 2 is a section on line X—X of Fig. 1.

In the embodiment of my invention, I construct a shell made in two parts or sections A and 2. Each section is in the form of a truncated cone, with the bases of the two conical sections suitably secured together at 3. The shell so constructed is open at both top and bottom, and the area proximate to the union 3 of the sections constitutes a bulge in the shell between its ends, where concentration and separation take place. All this will be more particularly explained hereinafter. This shell is supported upon a vertical shaft 4, which latter is supported in suitable bearings 5—6 in the main frame B of the apparatus; a collar 7 being keyed to the shaft 4 and carrying an inclined disk 8 serves to support the shell upon said shaft. The disk 8 does not extend to the shell, there being a space 12 left between them all the way around, through which every bit of the material to be separated passes. The disk 8 constitutes the floor of the receiving hopper, and should not be perforated. All that part of the machine above the disk 8 constitutes the receiving hopper 10. The upper surface of disk 8 carries a number of radial webs or vanes 11 which may be either straight or curved. The function of these vanes 11 is to force all the material, both solids and liquids, heavy and light, through the space around disk 8 into the greatest diameter of the machine; thereby forcing all material through the area of greatest separating force. These webs or vanes 11 act similarly to the vanes of a centrifugal pump, pumping the affluent material through the stationary wall of water and solids in suspension which is formed at D above and below disk 8, when the machine is running; the line D being coincident with the mouth of the liquid outlet pipes 13 and parallel to the axis and extending both above and below the plate 8. The affluent material, instead of being drawn up against this wall D of liquid and material and allowed to flow up along it and out of the machine, must by the forcing action of these webs or vanes 11, and because of the construction of the machine, be driven through this barrier D, and all material subjected to the greatest separating action of the machine. No material can get out of the machine without it passes around the outer edge of this disk 8 which constitutes the bottom of the hopper space 10.

On the lower surface of disk 8 is a conical inverted frustum C, the lower edge of which is on the water-line D; in fact, locates the water-line. The affluent liquids strained inward from the greater diameter of the shell spill over the lower edge of the conical ring C and collect under disk 8, to be discharged through the pipes 13 which tap the space behind the ring C. All the liquid before it can be discharged from the machine, must pass first through the area of greatest separating force in the machine, and then it

must strain back to the outlets 13 against centrifugal force. In doing so the liquids are thereby separated from the solids, which latter are thrown against the casing 2 and removed by the scrapers 14. To increase this action on the liquids on their inward return, counter to the centrifuging force, a number of plates *c* are placed on the under side of disk 8, in the outer angle between the outside edge of disk 8 and ring C, but not so as to interfere with the scrapers 14 which work between the plates *c* and the casing. The liquid in passing out of the machine has to pass between these radial plates (which are spaced about 2 inches apart). In doing so any solids that the liquid may still carry, are thrown against the casing by these plates, where they are removed by the scrapers. Another object of the plates 11 and *c* is to so accelerate the whirling action of the liquid and bring it rapidly to and maintain it at the same speed as the casing. Since the shell, the hopper 10, the disk 8, vanes 11 and *c* and ring C, revolve in unison, the material takes up the speed of the machine almost immediately without splash or commotion, and consequently a separation begins more rapidly and continues more satisfactorily and efficiently than where the liquid and material is free to slip around inside the machine. The outward and downward flare of the upper section A causes the material to travel down to the line of union with the section 2, and through the annular space 12 between the outer rim of the disk 8 and the adjacent meeting edges of the sections A and 2. The tubes 13 discharge at the top into the annular stationary trough 14[a]. The solids are made to travel downward to the point of discharge at the lower end of the apparatus by the conjoint action of the spiral blades or scrapers 14 with the inside of the section 2. These spiral blades 14 are fixed to the radially disposed webs 15, which latter are carried by a hub 15′ secured to the sleeve or hollow shaft 16 rotatable upon suitable bearings 17—18 about the shell shaft 4; the shaft 4 and the sleeve or hollow shaft 16 having motion in the same direction, but at different rates of speed.

To the top of the supporting webs 15 is fixed a ring 19, suitably spaced from the disk 8 above. The disk 8 and ring 19 inclose a space opening outward to the shell for the reception of the separated liquid, which is drawn off through the pipe or pipes 13 carried by the shell. The ring 19 prevents the liquid which passes below it from rushing upward and out through the discharge pipes 13; this water beneath the ring usually being muddy, owing to the agitation caused by the blades 14 in scraping the solids through the water-line D. Ring 19 operates, however, to separate this lower muddy liquid from the clear separated liquid above, and deflects the muddied or partially separated liquid again into an area of greater centrifugal action around the shell.

The bearings 17—18 for the hollow shaft 16, are lubricated from the top of the main shaft through the oil passage 20.

Below the shell and hub 15′ is an annular catch pan 21 into which the solids are delivered by the spiral scrapers 14. This pan has an outlet 22 at one side, through which the solids collected in the pan are delivered by the scrapers 23 at the lower ends of the radial scraper conveyers 14. Just above the opening 22 is a radial deflecting lip 25, to insure the downward discharge of the solids into any suitable receptacle beneath. The discharge for the solids at the lower end takes place nearer the axis of the machine than the water-line D or discharge pipes 13. If this were not the case the liquid would come out with the solids and the discharge for the solids would locate the water-line instead of the pipes 13. The spiral scrapers or blades in scraping the solids downward to the outlet, work the solids along a space inside the water-line; the solids being dried by centrifugal force before discharge; the water or liquid passing back up into the machine being another cause for making the liquid muddy below the ring 19.

By making the discharge for the solids nearer the axis of the machine, it is impossible for the liquid to be discharged with them, unless the machine is overfed, and pipes 13 not large enough to carry the liquid fed. I also gain, as above stated, the advantage of drying the solids after they are separated from the liquid by centrifugal action before they are expelled from the machine.

The space between the disk 8 and ring 19 forms a protected space or chamber for the separated liquid proximate to the greatest diameter of the shell. Consequently, all the liquid reaching this space must pass through areas of greatest centrifugal energy, and the liquid which passes out through the pipes 13 is practically clear liquid.

Both shaft 4 and shaft 16 are driven from a shaft 26 by respective gearing connections 27—28; the shaft 26 being given constant motion through appropriate connection with any suitable source of power. The pitch of the respective gears 27—28 varies more or less, according to the difference in speed at which it is desired to drive the shell and the conveyer blades 14; as manifestly it is necessary that the conveyers operate at a slightly greater or slightly slower speed than the shell, in order to secure the downward movement of the solids in the shell.

In practice, the operation of the device is as follows: The shell and blades are made

to revolve at high rates of speed. The material to be treated is allowed to flow in through the opening at the upper end of the hopper space 10, and is prevented from passing directly down through the machine by the disk 8. It is thereupon thrown to the sides by centrifugal force, aided by the vanes 11, and thence passes downward along the inclined surface of the upper section A until it meets the oppositely inclined surface of the lower section 2. Passing through the annular space 12, the separated liquid collects in the space between the disk 8 and ring 19, thence to be discharged through the pipes 13 into the annular trough 14ª, which latter has an outlet 14′. In the passing of the liquid into the space between the ring 19 and disk 8, it is made to work its way through portions of the greatest energy, so that it becomes freed of the solid matter in reaching the outlet to the tubes 13. All the solids that collect on the inside of the upper shell A are drawn into the angle formed by the meeting slopes of the two sections, and this angle is kept clean by the upper sections of the spiral blades 14, which latter extend a little above the angle, and scrape down the whole lower surface of the portion 2 of the shell. These spiral conveyers 14 carry the solids down into the pan 21, from whence they are discharged from the machine through the outlet 22 by the scrapers 23.

When the machine is in operation, the infeed of the material is so regulated that the material and liquid will fill an annular space which is substantially triangular in section, with the inner vertical base of the triangle substantially in line with the discharge pipes 13, and which base line is the aforesaid water-line D. The solids are scraped directly out of the machine and discharged downwardly beneath and at the opposite end of the machine from the liquid, there being no transverse projections or bottom to the apparatus.

By this apparatus it is apparent that there is only a single shell, open at both ends, and expanded at any suitable point between its ends to form a separating portion through which all the material, both solids and liquids, must pass. It is in this expanded portion that all the material normally tends to collect, and were it not for the action of the scrapers 14, and pumping vanes 11, the material would be held in this expanded waist portion of the shell by centrifugal force alone. However, the rapid rotation of the shell, and the corresponding differential motion given to the scrapers 14, together with the infeed of fresh material at the top, and the forcing or pumping afforded by the vanes 11, cause the final separation of the solids from the liquids at opposite ends of the apparatus. No solids can pass out with the water, since in order to do so they would have to be drawn through the machine against centrifugal force.

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

1. In a centrifugal separator, the combination of a rotatable shell open at the ends and having an enlarged circumferential portion between its ends, a shaft to which the shell is fixed, spirally arranged blades inside the shell, means for giving the shell and the blades a differential rotary motion to discharge the solids at the lower end of the apparatus, and an imperforate disk within the shell and fixed to the shaft, and having its outer edge proximate to the greatest diameter of the shell, said disk being separated from the shell to provide an opening for the passage of all the material fed in from above and through which opening all the material must pass, the space below said disk having a discharge for the liquids extending above the disk and exterior to the shell.

2. A centrifugal separator comprising a shell open at the ends and having an enlarged circumferential portion between its ends, a shaft to which the shell is fixed, spirally arranged blades inside the shell, means for giving the blades and the shell a differential rotary motion, an imperforate disk rigid with the shaft and shell and within the latter and having its outer edge proximate to the greatest diameter of the shell and separated therefrom to provide an opening around which all the material fed into the apparatus above the disk must pass, and the space below the disk having a liquid discharge separate from the discharge of the solids.

3. A centrifugal separator comprising a shell open at the ends and having an enlarged circumferential portion between its ends, a shaft to which the shell is fixed, spirally arranged blades inside the shell, means for giving the blades and the shell a differential rotary motion, an imperforate disk rigid with the shaft and shell and within the latter and having its outer edge proximate to the greatest diameter of the shell and separated therefrom to provide an opening around which all the material fed into the apparatus above the disk must pass, the space below the disk having a liquid discharge separate from the discharge of the solids, and said disk provided with rotary vanes.

4. A centrifugal separator comprising a shell open at the ends and having an enlarged circumferential portion between its ends, a shaft to which the shell is fixed, spirally arranged blades inside the shell, means for giving the blades and the shell a differential rotary motion, an imperforate disk rigid with the shaft and shell and

within the latter and having its outer edge proximate to the greatest diameter of the shell and separated therefrom to provide an opening around which all the material fed into the apparatus above the disk must pass, the space below the disk having a liquid discharge separate from the discharge of the solids, said disk having radial vanes on its under side between the scrapers and the shaft, and a conical ring behind the said vanes and inclosing said liquid discharge.

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

JOHN WARNE PHILLIPS.

Witnesses:

C. E. MACK,

FRANK P. LANGAN.