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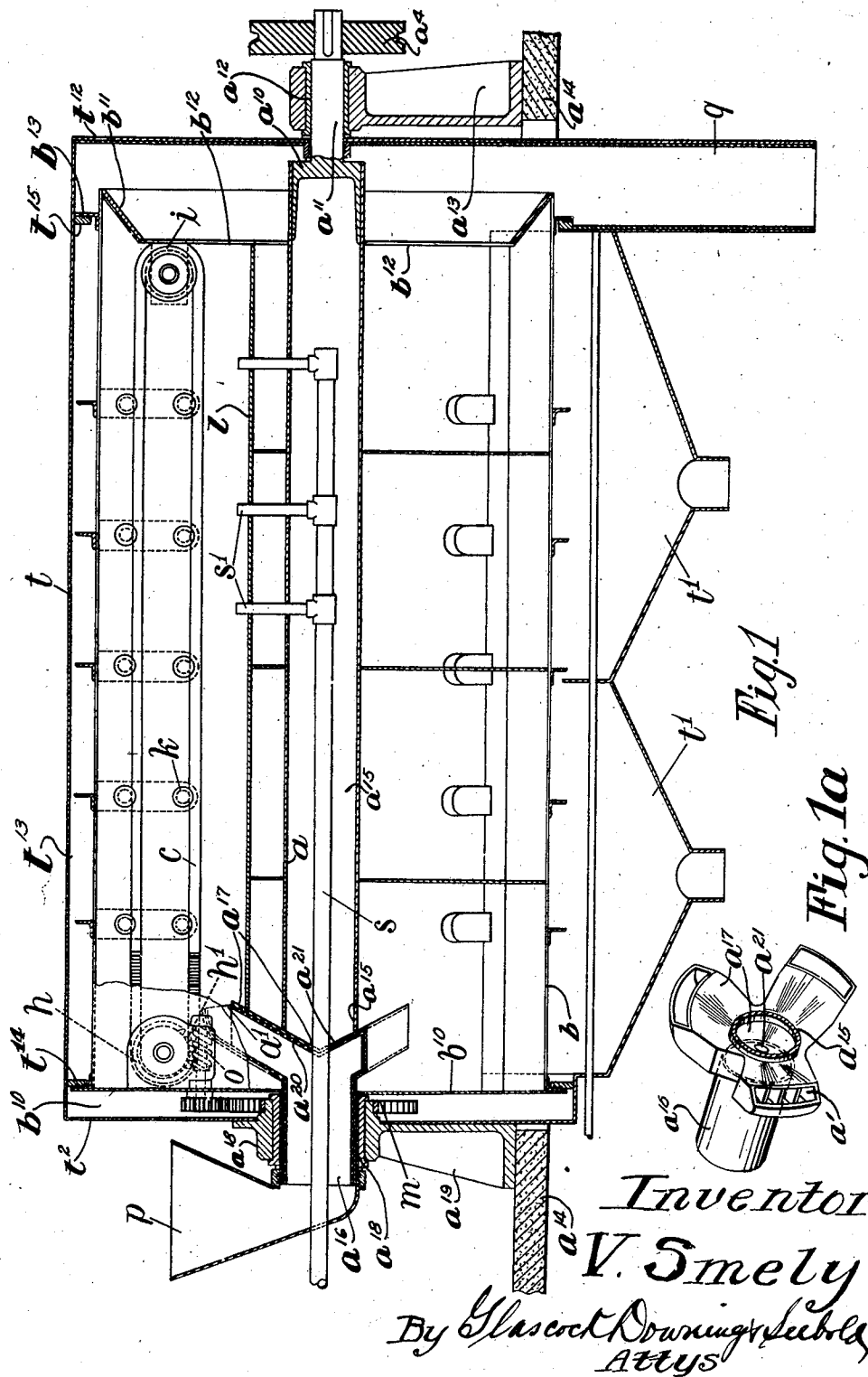
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CENTRIFUGAL SEPARATOR

Filed Oct. 27, 1942

3 Sheets-Sheet 1



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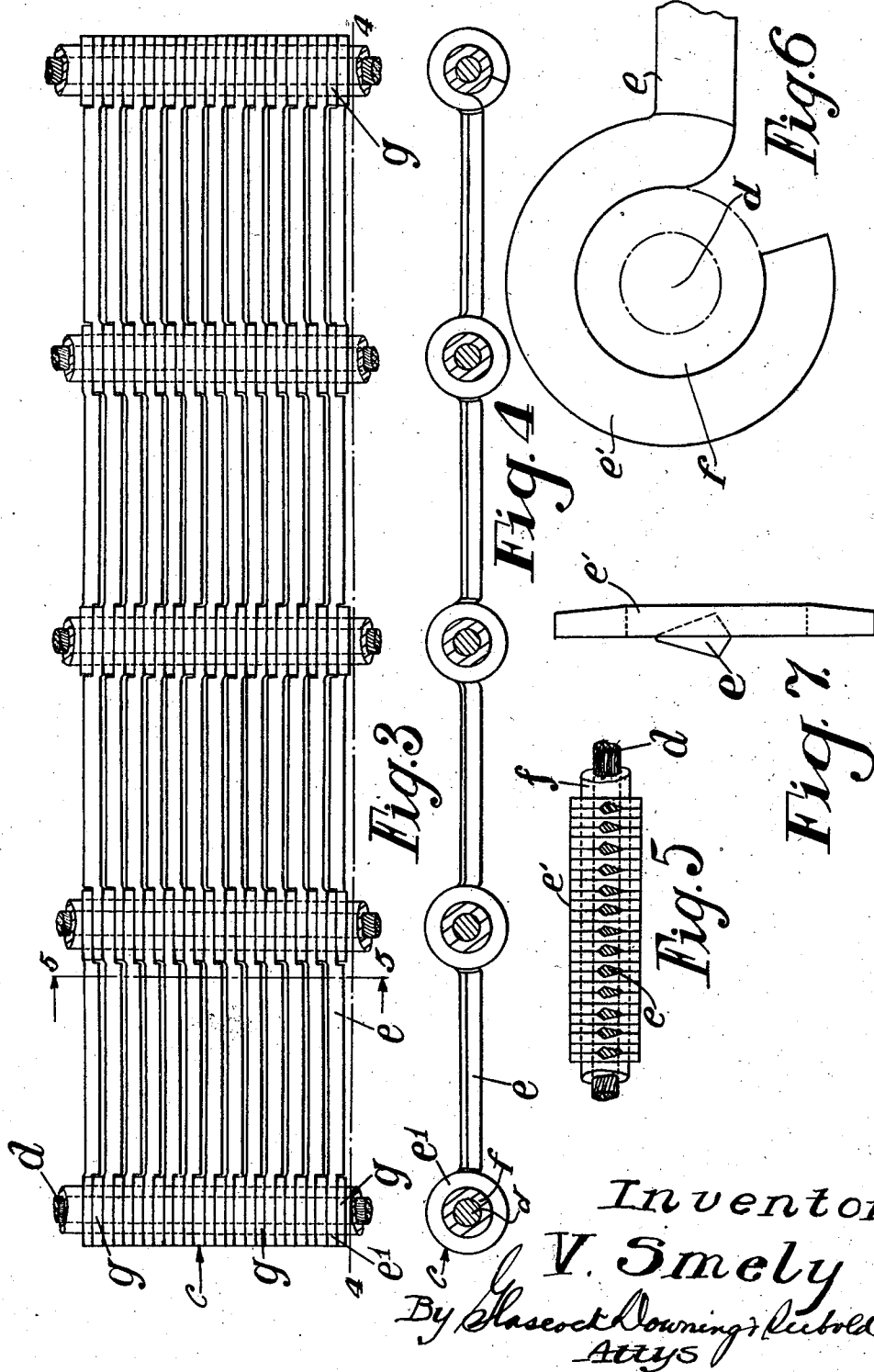
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UNITED STATES PATENT OFFICE

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CENTRIFUGAL SEPARATOR

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Application October 27, 1942, Serial No. 463,515
In Great Britain October 30, 1941

4 Claims. (Cl. 210—68)

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This invention relates to centrifugal machines particularly for separating solid material from liquids and such as are used, for example, for separating sugar crystals from the mother liquor or for drying small washed coal by separating the water therefrom to reduce the moisture content of the coal.

In general such driers are intermittent in operation and while some continuously operating machines have been proposed they are not altogether satisfactory in that in addition to requiring a high power consumption and being subject to relatively rapid wear they have the further disadvantage that due to the scraping action involved they cause the crushing of the particles with consequent diminution in size and hence are unsuitable for use in the sugar industry for example.

The object of the present invention is to devise an improved centrifugal machine which will be free from the defects and disadvantages noted above.

The accompanying drawings illustrate one convenient form of apparatus in accordance with the invention.

Figure 1 is a longitudinal sectional elevation from which parts are omitted.

Figure 1^a is a perspective detail of the connection between the two sections a^{15} and a^{16} of the main shaft A showing the spout structure, section a^{15} being broken away and shown in section.

Figure 2 is an end elevation of Figure 1 looking on the left hand end of that figure but showing the top part of the end walls of the outer and inner drums at this end thereof broken away to reveal the interior of one of the troughs containing an endless perforated apron, this trough and its associated apron and spout for delivering to the endless apron the material required to undergo treatment, being shown in section.

Figure 2a is an enlarged transverse section on the line 2—2 of Figure 2.

Figure 3 is a fragmentary plan view of a section of one of the endless perforated aprons, showing how the surface of the apron is made up from bar elements secured to extend transversely between the transversely spaced endless ropes which are incorporated in each endless apron.

Figure 4 is a transverse section on the line 4—4 of Figure 3.

Figure 5 is a section on the line 5—5 of Figure 3.

Figure 6 is an enlarged end elevation of one of the bar elements and showing the eye formation of the ends thereof.

Figure 7 is an end view of the bar seen in Figure 6 and looking on the left hand end of that figure.

Figure 8 is a detail of the planetary gearing.

In carrying my invention into effect in one con-

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venient manner as illustrated in the drawings I provide a stationary or non-rotary outer drum t , having annular end walls t^2 , t^{12} through which the ends of the hollow shaft a extend in a rotary manner and upon which shaft a second drum b is mounted to rotate with the shaft a and within the outer drum t , there being an annular space t^{13} formed between the inner rotary drum and the outer stationary or non-rotary drum.

The end of the rotary hollow shaft a adjacent the end wall t^{12} of the outer drum t is closed by a plug a^{10} having a central shaft a^{11} which extends in a rotatable manner through the center of the end wall t^{12} and is supported in a journal bearing a^{12} on a pedestal a^{13} fixed on a foundation or floor a^{14} .

The shaft a carries the inner drum b and extends from one end of the outer drum t to the other, passing through the ends of the outer drum, and is composed of two hollow or tubular sections, namely a major section a^{15} and a minor section a^{16} joined by a series of radially extending spouts a^1 carried with a dividing plate a^{17} which insures passage of material from section a^{16} through the spouts a^1 and prevents passage of the material into the section a^{15} . The pipe section a^{16} is rotatably supported in a journal bearing a^{18} in the center of the annular end wall t^2 of the outer drum, such journal bearing being provided upon another pedestal a^{19} fixed upon the foundation or floor a^{14} . The section a^{16} and the spouts a^1 as well as the plate a^{17} have an interior lining a^{20} of rubber. Incidentally the plate a^{17} is provided with a central opening a^{21} for the passage of pipe s to be hereinafter described.

The cylindrical wall of the inner rotary drum b is perforated and at one end this drum is fitted with an annular end plate b^{10} secured at its center upon the hollow shaft a and arranged to have sealed rotary engagement at its outer periphery with a ring t^{14} fixed to the inside of the outer non-rotary drum t . At its opposite end the inner rotary drum b is fitted with a ring b^{11} having a central opening b^{12} forming one side of the upper portion of a spout q , the opposite side of which is closed by the end wall t^{12} of the outer casing and which spout serves to receive material discharged thereinto from the inner drum during the operation of the centrifuge.

The upper end of this delivery spout is sealed off from the annular space t^{13} between the inner and outer drums by the inner drum being fitted on its outer surface with a ring b^{13} arranged to have rotary sealing engagement with a ring t^{15} fixed to the inside of the outer drum.

The shaft a and chutes a^1 and the inner drum b are rotated together from a pulley a^4 .

The drum b forms the vessel in which the centrifuging operation is carried out upon material introduced into the interior of the drum from

one end thereof and carried along to the opposite end, while the drum is being rotated, by the material being driven by centrifugal action against the surface of an endless perforated apron *c* mounted to travel longitudinally of the interior of the drum and to be carried by the latter so as to be rotatable therewith as the apron is itself made to travel longitudinally of the drum.

A preferred arrangement consists in the provision of the three such endless aprons arranged in uniformly spaced circumferential relation to one another about the center of the rotary inner drum.

Each apron is provided with perforations and any liquid separated from the material being carried by the apron will percolate through the apertures in the apron due to centrifugal action and may be either deflected sideways or may be allowed to pass through the return side of the apron thus assisting in dislodging any particles which may become wedged in the perforations of the endless apron. Moreover since the centrifugal force acting on the return side of the apron is about double that on the carrying side centrifugal force alone should keep the apertures clear.

There are many ways in which the apron may be constructed. Since, however, there are very large stresses developed in the apron I prefer to form the same as shown in Figures 3 to 7 from a plurality of longitudinally disposed endless loops of wire rope *d* to which are attached transverse wedge-shaped bars *e* forming the apron surface.

In order to protect the wire ropes *d* from abrasion I preferably cover them with rubber sheathing *f* and this sheathing also serves the further purpose of retaining graphite or other lubricant with which the wire rope is impregnated before being covered with the sheathing.

The transverse bars *e* are preferably of double wedge or substantially lozenge shape as clearly shown in the drawings, or any other suitable cross section may be employed provided that however the apron may bend the width of the apertures between adjacent bars will remain substantially constant.

The bars *e* must be secured in place upon the ropes in such a manner that they are not likely to be detached due to the centrifugal forces developed. This may be effected by forming the bars with eye ends *e'* by which they may be threaded upon the rubber sheathing *f* on the ropes, there being intervening washers *g* between the adjacent eyes and on the outside eyes as shown in Figure 3. The longitudinal ropes *d* are spliced to form endless loops and are then covered with the rubber sheath.

The aprons are arranged upon end drums *h* either or both of which may be driven, and during the rotation of the drum they are supported by rollers *k* at intervals along the length of both the carrying and return side, and since the loads upon the rollers will be heavy I prefer to form the same from steel tubes covered with rubber sleeves *k³* (Figure 2) and provided with peripheral grooves *k'* in which the eyes *e¹* and washers *g* on the wire ropes engage, the rollers being supported by bearings *k²* (Figure 2) which may be of aviation type needle bearings. The driving drum or drums may also be formed tubular and are preferably provided with rubber covers grooved similarly to the idlers *k* above referred to, the metal tubes in these cases being grooved or splined as at *k⁴* upon their external surfaces

to ensure a good grip between the tube and the outer rubber covering.

As shown in Figures 1 and 2 the aprons, drums and pulleys are disposed in U-shaped tunnels or troughs *l*, the side walls of which are flanged outwardly as at *l²* and secured to the inner surface of the inner drum *b* and as the latter is carried by the shaft *a* rotate therewith.

Any convenient means may be employed for imparting translational motion to the endless aprons. In Figures 1 and 8 this is shown as being effected by planetary wheels *n* carried upon the end wall *b¹⁰* of the rotary drum *b* and engaging a stationary sun wheel *m* mounted about the hollow shaft *a* and secured upon the pedestal *a¹⁹*, the planets operating to drive worms *o* engaging worm wheels *h¹* on the aprons supporting drums *h*.

For the purpose of feeding the material to be centrifuged to the aprons I provide a hopper *p* fixed relative to the bearing *a¹⁸* by which the material may be fed to the interior of the minor section *a¹⁶* of the hollow shaft *a* and the latter will be formed with or have secured thereto spouts *a'* which extend through the adjacent ends of the adjacent troughs and by means of which the material is directed on to the aprons. In order to facilitate even distribution of the material across the width of the aprons the spouts may be provided with rubber-lined diffusers *a²* as shown in Figure 2.

The material having been carried the length of the centrifuge is discharged into the collecting hopper *q* and as the material is flung out with considerable force I prefer to line the collecting hopper and its outlet *q¹* also with rubber as at *q²*.

When the aprons or other internal parts of the machine require to be flushed with liquid or steam the flushing medium may be introduced as by the pipe *s* through the hollow shaft *a* and thence through any number of jets or sprays *s'* disposed along the carrying side of the apron.

The particles of water ejected from the material under the action of centrifugal force may tend to splash and rebound from the casing and in order to guard against this as far as possible I may introduce metal troughs or the like on the inside of the stationary cover or casing *t* whereby the liquid will be conducted down the sides of the cover without being splashed by the droplets from the rotating elements. The liquid is finally collected in and escapes from the troughs *t'* in the outer casing *t*.

In the operation of the centrifuge the inner drum *b* will be rotated at high speed within the outer drum and at the same time the supporting drums *h* of the perforated endless aprons *c* will be driven, by the engagement of the planets *n* with the sun wheel *m*, whereby the endless aprons are caused to traverse the troughs *l* within the inner drum, in the direction of the arrows in Figure 1, and while these aprons are being carried around with the drum. The material required to undergo treatment is introduced into the centrifuge by way of the hopper *p* and is discharged from the delivery spouts *a¹* direct upon the inner runs of the endless aprons at a point near one end of the troughs containing these aprons. The material will be held against the apron surfaces by the centrifugal forces generated and at the same time will be made to traverse the troughs by being carried along the same by the translational motion imparted to the endless aprons. While this is taking place the liquid separated from the material will pass through the perfora-

tions in the apron surfaces and through the perforated outer walls of the troughs (these walls being constituted by the perforated wall of the rotating drum) into the annular space t^{13} . From this space the separated liquid passes into the troughs t^1 . Meanwhile the material remaining adherent to the aprons will be delivered from the aprons into the delivery spout q , by being discharged from the aprons into the upper portion of this spout through the openings b^{12} in the inside wall thereof.

Having thus fully described the invention what is claimed and desired to be secured by Letters Patent is:

1. A centrifugal drier or separator comprising a stationary or non-rotary outer drum, a rotary drum mounted within said outer drum to extend longitudinally of the latter and spaced from the outer drum so that an annular space is formed between the outer and inner drums, the cylindrical wall of the inner drum being perforated to provide communication between the interior of the inner drum and the said annular space, a hollow shaft rotatably mounted in the end walls of the outer drum and carrying the inner drum, the said shaft extending longitudinally through the interior of the said inner drum, trough forming members secured to the inside of the cylindrical wall of the inner rotary drum at uniformly spaced circumferential distances apart and forming separate hollow troughs extending longitudinally of the inner drum, an endless perforated apron mounted within each said trough to extend and travel longitudinally thereof, gearing means for connecting the hollow shaft to the aprons for imparting translational movement to said endless aprons as the same are carried around with the inner rotary drum, an inlet hopper at one end of the outer drum and communicating with the interior of the adjacent end of said hollow shaft, delivery spouts open at their inner ends to the interior of the said shaft at said end thereof and open at their outer ends to the interior of said troughs at the ends thereof adjacent the said hopper, there being one said delivery spout provided for each trough and each said spout being adapted to deliver the material required to undergo treatment, and fed into the hopper, directly onto its corresponding endless perforated apron at one end thereof, a discharge spout for the centrifuged material, said discharge spout being provided at the opposite end of the outer drum remote from the inlet hopper and being open to the adjacent end of the inner drum, whereby the centrifuged material is able to pass from the troughs into said discharge spout after the material has been constrained, by said translational movement of the perforated aprons, to traverse the length of the troughs, and outlets in the cylindrical wall of said outer drum adapted for the discharge from the said annular space of the matter delivered, during the centrifuging operation, into such space from the troughs and entering such space through the perforations in the cylindrical wall of the inner rotary casing, the perforated wall of the latter constituting the outer wall of the said troughs.

2. A centrifugal drier or separator as claimed in claim 1 comprising a pipe arranged within the said hollow shaft to extend longitudinally thereof, and branches from said pipe opening into the troughs, the said pipe serving to convey washing fluid which is directed onto the aprons in said troughs via the said branches.

3. A centrifugal drier or separator as claimed in claim 1 comprising rollers in the troughs at each end thereof and supported by the inner rotary drum to rotate therewith, the said rollers being adapted to support the opposite ends of the perforated endless aprons, a sun wheel on said outer drum and planetary wheels on said inner rotary drum meshing with the sun wheel and geared to the apron supporting rollers to drive the latter so as to impart the desired translational motion to the aprons.

4. A centrifugal drier or separator comprising in combination an outer drum and an inner drum both horizontally disposed and the inner drum being rotatably mounted within the outer drum and being spaced from the latter so that an annular space exists between the two drums, a hollow shaft carrying said inner drum and rotatably mounted in the end walls of the outer drum, a trough extending along the inside of the inner drum from end to end thereof and bounded on its outer periphery by the cylindrical wall of the inner drum, the said cylindrical wall being perforated to provide communication between the interior of the trough and the said annular space and the trough being closed along its inside wall within the inner cylinder, an endless perforated apron mounted within said trough to extend longitudinally thereof, rollers within the trough at the opposite ends thereof for supporting the endless apron, gearing means connecting the hollow shaft to one of the apron supporting rollers to produce translational movement of the apron longitudinally of the trough during the rotation of the inner drum, a hopper at one end of the outer drum and discharging into the adjacent end of said hollow shaft, a spout open to the said end of the hollow shaft and extending outwardly therefrom and through an opening in the wall of said trough near the end thereof adjacent said hopper, whereby material fed into the latter can be directed from said spout directly onto the apron surface, and a discharge spout for the centrifugal material, the upper portion of said spout being formed at the end of the said outer drum remote from the said inlet hopper and being situated between the adjacent end wall of the outer drum and the adjacent end wall of the inner drum, the last mentioned wall having openings through which the material may be discharged into the discharge spout from the said troughs.

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