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METHOD OF AND APPARATUS FOR THE CONTINUOUS PURIFICATION OF SUSPENSIONS OR SLUDGES, ESPECIALLY OF FIBROUS PULPS OF THE PAPER INDUSTRY
Filed Aug. 29, 1939

Serial No.
292,382
2 Sheets-Sheet 1

Fig.1

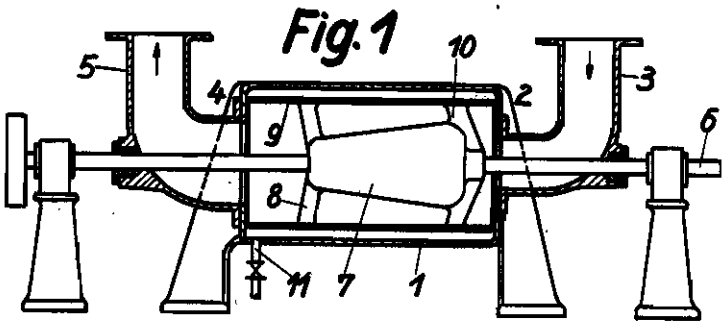

Fig.2

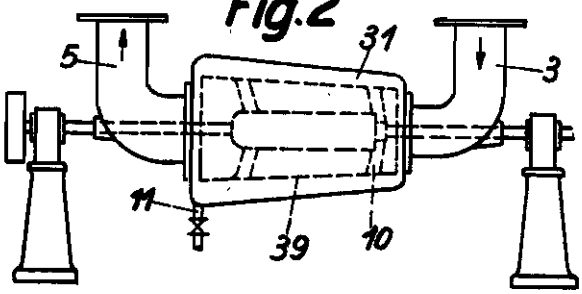

Fig.3

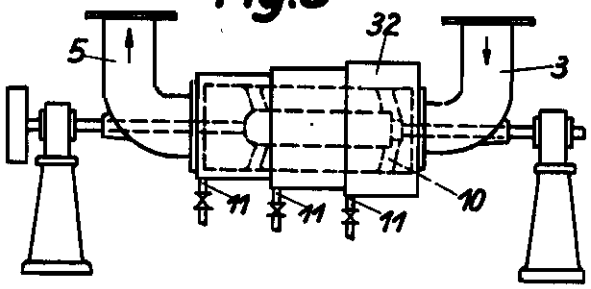

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Fig.4

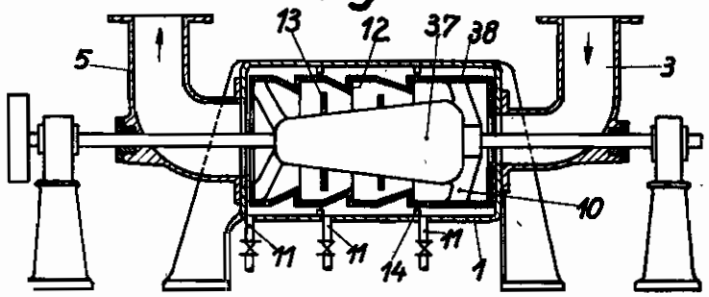


Fig.5

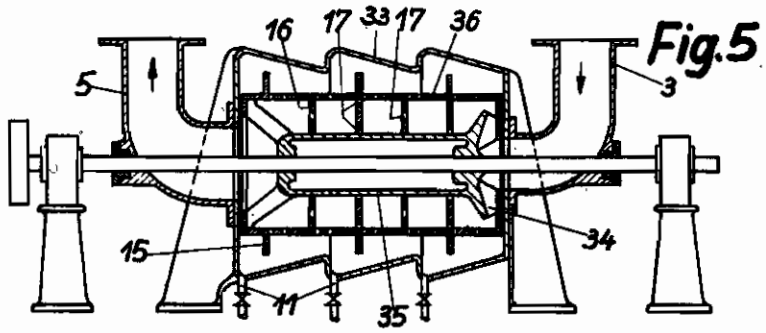


Fig.6

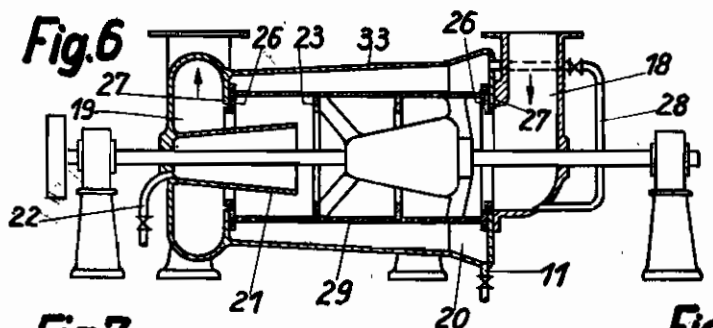
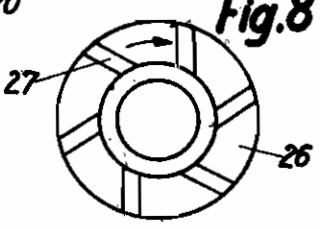


Fig.7

Fig.8



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ALIEN PROPERTY CUSTODIAN

METHOD OF AND APPARATUS FOR THE CONTINUOUS PURIFICATION OF SUSPENSIONS OR SLUDGES, ESPECIALLY OF FIBROUS PULPS OF THE PAPER INDUSTRY

Helmuth Banning, Duren, Germany; vested in the Alien Property Custodian

Application filed August 29, 1939

This invention relates to a method of, and apparatus for, the continuous purification of suspensions or sludges, especially of fibrous pulps of the paper industry, by means of a centrifugal apparatus having a fixed outer wall guiding the pulp. The invention aims at a centrifugal method which is not interrupted by a periodical emptying out of the heavy particles accumulated in the centrifugal spaces.

In the case of the known types of centrifugal apparatus a compacted firm cushion of fibres is formed at the closed wall of the rotary centrifugal drum, and the heavy contaminations accumulate in and on that cushion. This is disadvantageous in that the centrifugal drum becomes after a certain period of operation, filled with these retained particles of dirt, whereupon the apparatus has to be stopped for cleaning purposes.

Centrifugal machines are also known which act as centrifugal sorting machines, the suspension of pulp being forced through a rapidly rotating perforated drum. In the case of these sorting machines, the contaminations are only sorted out according to the widths of the perforations of the perforated drum. Contaminations are retained in front of the sieve (considered in the direction of the current) while the fine fibres pass through it. The apparatus of these known machines is due to the fact that the sieves are very liable to clogging.

Centrifugal machines also acting as centrifugal sorting machines are also known, where the pulp and the contaminations of greater specific gravity pass through a rapidly rotating drum sieve to a chamber outside the drum. In such cases, the contaminations are mainly separated out by gravity in a casing which is conically widened in the direction towards the outlet. Thus, the outer chamber of the centrifugal machine contains the contaminations as well as the pulp to be purified, the two being not spacially separated. The drum sieve only serves the purpose of retaining contaminations of greater dimensions. As the contaminations and the pulp to be purified are present side by side, it cannot be avoided that contaminations get into the outlet for the pulp to be purified.

In order to avoid these disadvantages, it is, according to the invention, proposed to produce in a fixed casing a centrifugal field of force, comprising inner and outer zones, by means of a drum provided with apertures, the zones being separated by the wall of the drum. The contaminations of greater and lesser specific gravity contained in the suspensions, and the latter, are passed through the interior of the drum in axial direction, and the contaminations of greater specific gravity are allowed to pass through the apertures in the drum to the outside. In this connection it is convenient to keep in an axial movement the suspension which has passed to the outside and which contains the heavy contaminations.

In order to prevent contaminations from returning from the outer space into the inner space of the drum, and in order that the purified pulp and the contaminations are forced out of the casing, a super-pressure is conveniently maintained in the inner spaces of the zones.

As the spaces for the pulp to be purified and those for the contaminations to be separated therefrom are, to a large extent, separated from each other in the process according to the invention, and in contradistinction to the known processes, a particularly effective separation of the pulp to be purified and of the contaminations is obtained in a continuous operation. The purified pulp may be passed on for further use without being subjected to any further purifying operation. When purifying a suspension of paper pulp, the purified pulp may, for example, be passed on direct to the paper machine.

In the apparatus for carrying out the process according to the invention, the sludge or pulp suspension to be purified is introduced near the shaft into a fixed centrifugal casing which is closed on all sides. A drum perforated in some places rotates with high speed inside the centrifugal casing, imparts rotation to the pulp and divides the centrifugal space into two separate centrifugal zones. The suspension to be purified enters the inner centrifugal zone through an aperture in the end wall of the casing and leaves it, purified, at the other end. The contaminations pass through the apertures in the centrifugal drum and collect in a suspension of pulp at the wall of the outer casing, which suspension is also subjected to the centrifugal effect and becomes more and more dense towards the outer side. The contaminations are directly withdrawn from the outer centrifugal zone either continuously or periodically.

Sedimentation along the drum in the inner centrifugal zone may, in the case of the apparatus according to the invention, be repeatedly interrupted by substantially radial surfaces which deflect the current of pulp either towards the inside or towards the outside, thereby facilitating the separation of the contaminations. The contaminations are retained by the surfaces, in front of which the passage apertures in the drum are preferably arranged. The contaminations pass through these apertures into the outer zone. Sedimentation in the outer zone may also be effected in separate steps, the heavy substances being collected at the wall of the centrifugal body, perhaps by ribs or shoulders, from where they are led off separately.

The whole length of the two centrifugal zones

is fully utilized for purifying, the pulp in the inner zone being quickly accelerated to the rotational speed of the drum by means such as a pump, and, after purification, being removed from the centrifugal machine at once. As a further modification of the centrifugal machine, the outer wall thereof may, for example, be given a special conical shape so as to increase the percentage of contaminations in the pulp at the point of withdrawal. Similarly, a definite control of the centrifuging and of the sedimenting operations and of the withdrawal of the contaminations may be effected by providing inside the centrifugal space a circuit from the inner to the outer zone and back to the inlet side.

In the drawings, a number of embodimcnts of apparatus according to the invention are diagrammatically shown by way of example.

Fig. 1 is a vertical, longitudinal section of a centrifugal machine,

Figs. 2 and 3 are side views of centrifugal machines having modified casings,

Figs. 4 and 5 are vertical, longitudinal sections of centrifugal machines with different means for guiding the pulp,

Fig. 6 is a vertical, longitudinal section of a different embodiment of a centrifugal machine,

Fig. 7 is a cross-section of a centrifugal drum, and

Fig. 8 is a view of an end face of a centrifugal drum.

The centrifugal machine consists, for example, of a cylindrical casing **1**, at one end face **2** of which the suspension is admitted through a curved tube fitting **3**. The suspension leaves through the curved tube fitting **5** at the opposite end wall **4**. The centrifugal shaft **6** is situated inside the casing, has its bearings outside thereof, and is rapidly rotated by means of a suitable drive. Inside the fixed centrifugal casing, the shaft carries the displacement body **7** and, by means of radial arms **8**, the perforated centrifugal drum **9**. For the purpose of accelerating the pulp admitted through the tube fitting **3**, the arms at the front end of the displacement body **7** are shaped to form vanes **10**.

It is convenient to provide at the end of the rotary centrifugal drum **9**, connected either with the centrifugal drum itself, or with the casing **1**, an annullar shoulder, or to arrange the outlet for the pulp in such a manner, that the inner width of the pulp outlet aperture of the casing is smaller than the internal diameter of the rotary centrifugal drum. In the case of such an arrangement, a zone of reduced axial speed of flow forms in the inner space of the centrifugal drum near its wall, and the dirt particles to be separated out come to rest in that zone and can be forced radially to the outside. The inlet aperture leading into the inner space of the casing is of a smaller cross-section than the outlet aperture in order to utilize for the further movement of the pulp the excess pressure of the pulp which is being discharged and the kinetic energy imparted to the pulp.

Fitted to the outer wall of the casing is a tube **11** for the withdrawal of the suspension accumulated inside the wall, which suspension contains the particles of dirt. Withdrawal can either be effected continuously in small quantities, or the aperture is opened periodically as soon as considerable quantities of dirt have accumulated inside the outer wall.

The displacement body **7**, which may be rotary or fixed, forces the admitted pulp, which moves along the shaft, to flow outward, whereby it arrives in the zone of influence of the rotating centrifugal drum **9** and is also rotated. The current of pulp following it forces it along the drum having a perforated wall, so that it fills the entire internal space of the closed casing **1** of the centrifugal machine. While the pulp passes through the centrifugal zone along the wall of the drum which may, for example, be perforated, an increase in the density of the suspension occurs in the direction towards the outer wall, but this increase is limited when eddying currents near the fixed wall prevent further densification. The heavy contaminations contained in the current of pulp are separated through the apertures in the wall of the drum and collect in the suspension contained between the fixed wall and the rotating wall of the drum. The purified pulp on the other hand, flows along the inner wall of the perforated drum to the other end of the closed casing and leaves through an opening in the end wall.

It is advantageous to accelerate the admitted pulp initially, by a radial system **10** of vanes, to the circumferential speed of the rotating perforated drum, or nearly to that speed. This imparts to the pulp the required circumferential speed already at the front end of the rotating drum, so that the whole length of the latter may be utilized for the separation of the heavy particles. The fixed casing may be so constructed that the dirt separated out collects mostly in the vicinity of the connecting fittings of the pipe **11**. According to Fig. 2, the outer shell of the casing **31** is constructed conically, and the tube **11** is connected at a point where the diameter of the cone is the greatest, and where the particles of dirt mainly collect. The perforated drum **39** may also be constructed conically.

It is advantageous to have the outer wall of the casing widening in the direction towards the inlet and not in the direction towards the outlet, in order to keep the collecting point of the dirt as far as possible from the outlet *d* for the purified pulp.

Fig. 3 shows a centrifugal machine of this type having an outer shell **32** set off in steps. Tubes **11** are connected to each end of a step. Instead of a cylindrical outer shell, an outer shell having conical steps of any other type may also be employed (Fig. 5). A further improvement in the purifying process is obtained by arranging annular shoulders **12** inside the rotating drum **38**, or of rings **14** inside the fixed outer shell **1**, as is shown in Fig. 1. There, the displacement body **37** carries rings **13**, and the rotating drum **38** carries annular shoulders **12** projecting towards the inside, the pulp being alternatingly deflected to the inside and to the outside by the edges of these parts. The pulp flowing along is dammed up or obstructed by these rings, whereby a slower flow of the pulp is caused in these places and also eddying currents at the edge of the rings. This favours a deposition of the dirt in front of the rings and the passing thereof through the holes in the drum.

The rings **12** are conveniently arranged to widen conically in the direction of the axial flow, so that heavy particles may deposit behind the rings, being separated out of the pulp passing over the edges of the rings.

It is also advantageous to sub-divide the outer centrifugal zone by annular shoulders **14**, in order to prevent a movement of the dirt along the outer wall towards the outlet of the purified pulp.

The largest dirt particles will deposit in the first section of the outer centrifugal zone, and comparatively small proportions of dirt will be washed through the pipes 11 of the sections gradually nearing the outlet. The provision of the rings 12—14 results in that the dirt is thrown back into the preceding zone in which it was separated out, so that dirt, once it has been separated out, can no longer reach the outlet end of the centrifugal machine.

According to Fig. 5 the portions of the fixed casing 1 form conical sub-divisions. In order to obtain the advantages described above, the cones forming the casing widen in the direction towards the outlet for the purified pulp and are connected with the adjoining conical portion by radially disposed surfaces. The tubes 11 are attached at the bottom of the centrifugal machine in front of the respective radial surfaces. Radial ribs 15 are conveniently provided on the outer shell of the centrifugal drum 36, deflecting towards the outer wall the heavy particles separated out in the outer zone. In order to enhance the passage of the heavy particles through the drum, the axis of rotation of the drum may be slightly eccentrically arranged relatively to the casing so that reductions and increases of pressure alternate at the circumference of the drum.

According to Fig. 5, the inlet side of the displacement drum 35 is constructed as a rotor 34 of a pump. A different system of guiding the pulp in the inner zone of the centrifugal drum 36 is obtained by an alternating arrangement of radial partition walls 16 between the drum 36 and the displacement body 35. Openings 17 are provided in the partition walls and are alternatingly disposed near the drum and near the displacement body, or half way between the two, whereby passages for the pulp are formed at different distances from the axis of rotation. This results in that even the finest contaminations are separated out, the specific gravity of which approximates that of the pulp fibres.

Fig. 6 shows a construction of the casing 31 having a helical inlet 18 for the pulp and a helical outlet 19 for the pulp. This permits a utilisation of the kinetic energy of the pulp as admitted, in order to impart a rotary movement to the admitted pulp, whereby a saving in energy is obtained. Constructing the outlet portion spirally permits achieving a higher outlet pressure. In the case of this embodiment, the casing 33 is, for example, conically widened in the direction towards the inlet, slightly first and more later, whereby an annular pocket 20 is formed from which the dirty pulp is withdrawn. A conical tube 21 surrounding the shaft is provided for the retention of the light constituents. That tube receives the light contaminations which, in view of the centrifugal force, move towards the shaft, so that they may be withdrawn through the pipe 22.

The construction of the rotary perforated drum 9 may also vary, depending on the type of suspension to be purified. For the separation of finer contaminations it is sufficient to use a shell perforated by fine holes, while larger perforations are provided for the purification of pulp having coarser contaminations.

When purifying pulp containing a small proportion of contaminations, it suffices to provide the perforated drum with a rotating row of holes of a suitable diameter closely in front of the rings 23 projecting inwardly in the drum. A suitable embodiment is also obtained if the drum is provided on the inside or on the outside with ribs extending in the direction of the axis, and if circularly closed slots or else interrupted slots are milled in the shell of the drum.

A convenient embodiment of a centrifugal drum is shown in Fig. 7. Rings 24 serving for the retention of the contaminations of the suspension carry ribs 25 which extend axially and leave between each other slots through which the heavy particles pass.

An undesired circulation of the pulp from the outer to the inner centrifugal zone, particularly at the outlet end of the rotating drum is prevented thereby that the rotating drum 29 is provided at its end with annular rings 26 which are opposed by inwardly extended flanges of the casing 33.

Fig. 8. Channels 27 are provided in the outer surfaces of the annular shoulders 26, or corresponding ribs are attached thereto, their direction being approximately radial. By means of a suitable width of these rings, it is possible to produce a suitable current between the flange of the casing 33 and the rotating annular shoulder 26, which forces the purified pulp from the inner zone into the outer zone so that separated particles of dirt are safely prevented from passing from the outside to the inside into the purified pulp.

The passing of dirt through the drum, and an improvement in the purification of sorted pulp, or an increase in the output, is obtained by a pipe-connection 28 (Fig. 6) between the outer zone and the pulp inlet, through which pipe connection a certain proportion of partly purified pulp is continuously withdrawn from the outer part of the casing and supplied back to the inlet. In this connection it is convenient to withdraw that quantity of pulp not at the outer circumference of the casing, where the greatest proportion of dirt collects, but at a point somewhat nearer to the axis.

On the other hand, it is also possible to withdraw continuous current of pulp at a point of the outer centrifugal casing, and to purify it in a second apparatus, the purified pulp being either supplied to the inlet of the first centrifugal machine or passed into manufacture as purified pulp. In the case of large plant it is also possible to arrange a number of centrifugal machines side by side, and to serve them, if desired, by a common supplementary centrifugal machine or other purifying device.

A further mode of procedure is characterized by the supply of water under pressure to the outer purifying zone of the centrifugal machine. By means of such water, the separated heavy particles may be washed to free them from good pulp, thereby reducing the proportion of pulp leaving the centrifugal machine along with the heavy material. The centrifugal process according to the invention is suitable not only for the purification of fibrous material, but also for sludges of all kinds, e. g. for the purification of kaolin.

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