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 [33] **Denmark**
 [31] **73/68**

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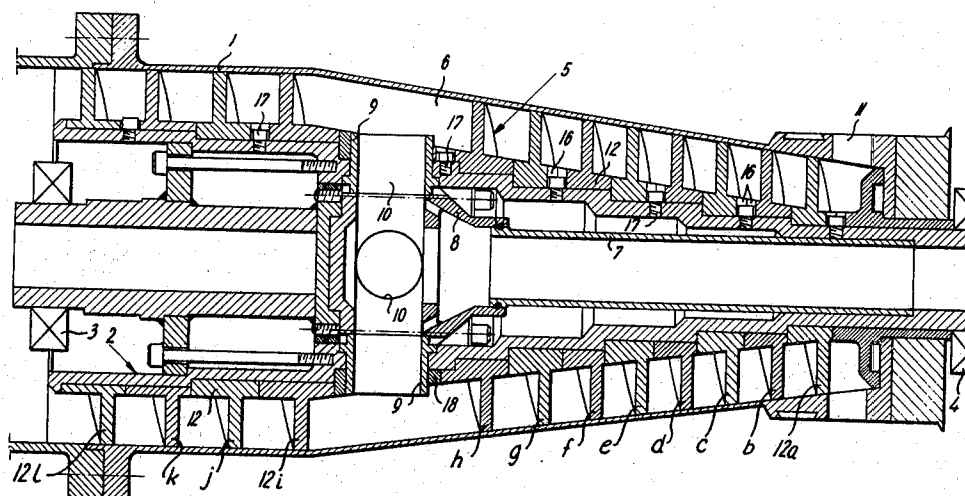
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Attorney—Stevens, Davis, Miller & Mosher

[54] **SCREW CENTRIFUGE**
5 Claims, 4 Drawing Figs.

[52] U.S. Cl..... **233/7**
 [51] Int. Cl..... **B04b 1/00**
 [50] Field of Search..... **233/7, 8, 9,**
6; 259/9, 10, 109, 110

ABSTRACT: A screw centrifuge comprising inner and outer centrifuge rotors rotating at differential rotational speeds with a screw secured to the outer surface of the inner rotor for conveying separated solid matter. The screw comprises a plurality of axially adjoining sections individually secured to the internal rotor and located angularly with respect to one another to form a substantially continuous helix.



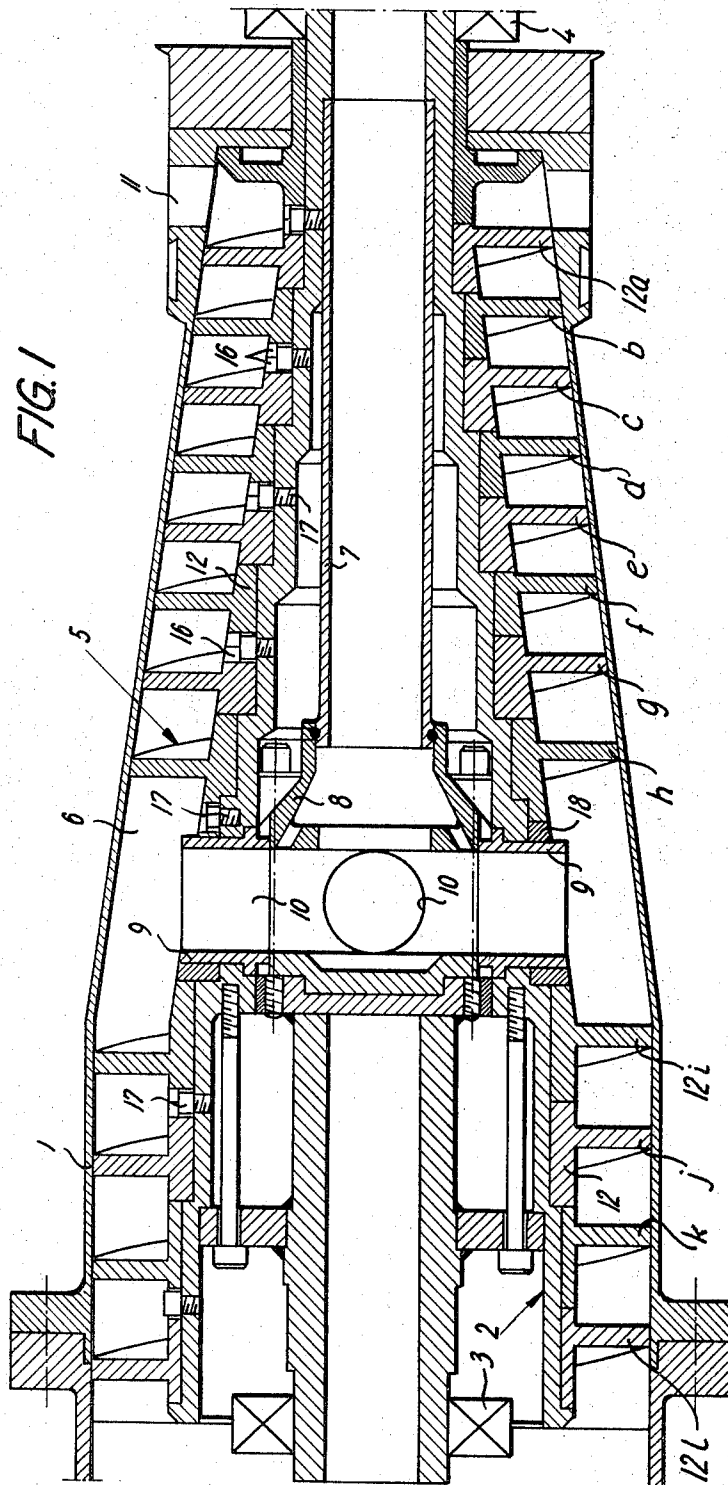


FIG. 1

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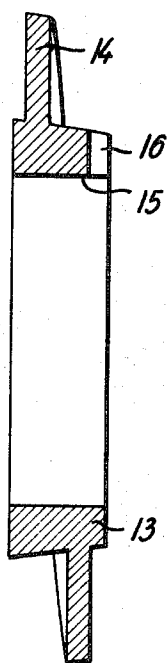


FIG. 2

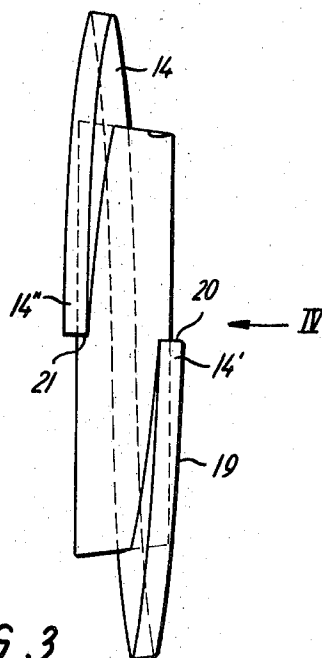


FIG. 3

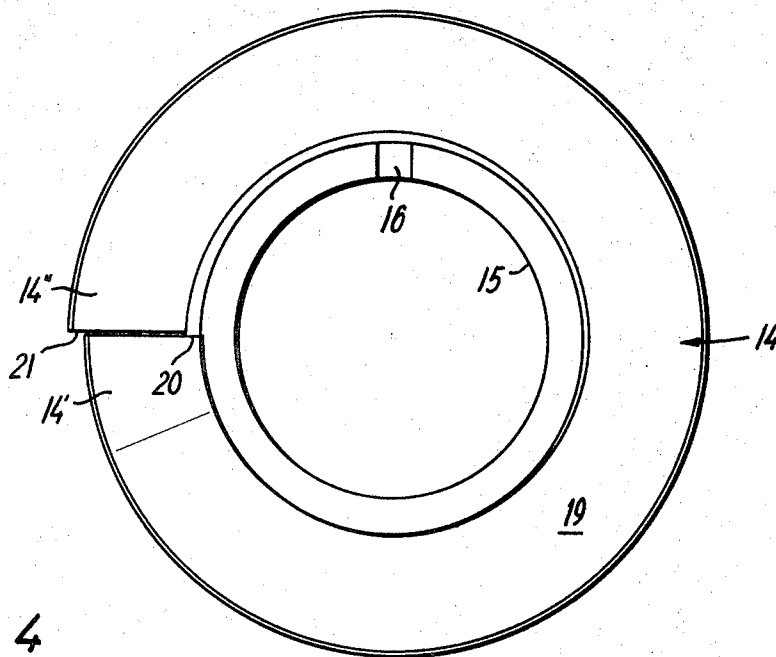


FIG. 4

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SCREW CENTRIFUGE

This invention relates to a screw centrifuge having a separating chamber defined between two rotors rotating at different numbers of revolutions, a conveyor screw located in the separating chamber and secured to the internal rotor and means for supplying a raw material to the separating chamber between the two rotors through one or more apertures in the wall of said internal rotor.

Such centrifuges, which are also called decanters, are employed, inter alia, for a rough or preliminary separation of sludge such as sewer sludge and refuse from destruction plants, into a partially dried phase and a partially cleansed liquid phase, which, if desired, can both be treated further in other kinds of apparatus. The relative rotational movement between the rotors ensures that the screw conveys the solid phase towards one end of the separating chamber which may be conical so that the solid material is also lifted, i.e. moved radially inwards, beyond the inner surface of the rotating liquid phase.

In the use of the centrifuge considerable wear may occur on the conveyor screw, since the solid matter frequently contains highly abrasive constituents, especially sand. This does not apply to sewer sludge only, but also to dead animals, fish, etc. The wear may become so extensive that the leading surface and edge zone of the screw which are effective for conveying the solid phase of the material axially through the separating chamber, are totally worn down after a very short period of operation and consequently necessitate a repair of the screw, even when said surface and edge zone are made of or coated with a highly wear-resistant material such as stellite.

Known conveyor screws are made by winding a strip or band of sheet steel into helix form and welding the helical strip to the rotor body. A repair of such a screw comprises cutting off the strip and welding a new strip onto the rotor. This operation is troublesome and time-consuming, and generally it cannot be carried out in situ by the user of the centrifuge because it is necessary to carry out an accurate balancing of the finished rotor in view of its rather high rotational speed during operation of the centrifuge. The balancing of the rotor often implies that the screw must be locally straightened or that material must be removed locally which, however, may lead to deformation or "wrap" of the screw since localized stresses in the material may be relieved by the machining. The balancing must then be repeated and it may again be necessary to remove material and so on. Not seldom the repair costs may amount to a sum of the same order as the price of a complete screw as delivered by the manufacturer.

It is a primary object of the invention to provide a centrifuge of the kind referred to in which the above-mentioned repair of the internal centrifuge rotor can be carried out more readily than in the previously known centrifuge and without requiring skilled labor and specialized equipment normally not available to the user of the centrifuge.

According to the present invention there is provided a screw centrifuge comprising a hollow internal rotor and an external rotor surrounding said internal rotor and defining therewith a separating chamber, means for rotatably supporting said rotors and means for rotating each of said rotors at mutually different numbers of revolutions per minute, a conveyor screw secured to the outer side of said internal rotor, means for supplying a raw material to be separated into said separating chamber, and means for separately discharging constituents of said raw material from said separating chamber after separation thereof, wherein said conveyor screw comprises a plurality of axially adjoining screw sections, each of said sections being secured individually to said internal rotor, said sections being located angularly with respect to one another.

Hereby the repair of a worn rotor is considerably simplified, as it is only necessary to replace the worn screw section or sections with new parts which can be completely finished in advance, including the balancing, and can be supplied as spare parts together with the centrifuge. It is therefore readily possi-

ble to effect repairs in situ, the centrifuge thus being out of operation for a short time only. It is, furthermore, an advantage that the thickness of the screw winding or helix may be greater than with a winding made of sheet material since the screw sections can be cast, e.g. from hardenable steel. When such a relatively thick winding is through-hardened, a considerably longer service life can be obtained as compared to known screws having a wear-resistant surface layer deposited by welding upon a relatively soft ground material, so that the increased wear-resistance is only present in the rather shallow surface layer.

The screw sections may be secured to the rotor with a shrink fit which ensures a simple and easy mounting only requiring a preheating of the sections, e.g. in warm oil.

The screw sections may be secured to stepped portions of the internal rotor and angularly located in pairs, the sections of each pair having complementary recesses, and radial pins secured in the wall of the internal rotor and engaging at their outer end in said pair of recesses. This ensures a relatively simple machining of the fitting or mating surfaces on the inner rotor and safe location of the individual sections with their winding or helix turns contiguous to form a substantially continuous helix.

The leading end of the screw winding of each screw section, as viewed in the conveying direction of the screw, may be thicker than the trailing end of said winding. This ensures the conveying action of the screw upon the solid material also at the transition between the individual sections of the winding at which practical reasons dictate a radial slit between the turns or windings of the adjoining sections and where an undesirable axial back flow of solid matter through the slit is counteracted by the stepped leading surface of the helix provided by the specified differential thickness.

In the following the invention is described in greater detail while referring to the accompanying drawings, in which:

FIG. 1 shows a longitudinal section through a part of a screw centrifuge embodying the present invention;

FIG. 2 is a longitudinal section on a larger scale through one section of the conveyor screw of the centrifuge shown in FIG. 1;

FIG. 3 is an elevation of the screw section shown in FIG. 2; and

FIG. 4 is an end view in the direction of arrow IV in FIG. 2.

The screw centrifuge illustrated in FIG. 1 comprises an outer or external rotor 1 which, in a manner not shown in detail, is journaled rotatably in the centrifuge's frame and is coupled to a driving mechanism. An internal rotor 2 coaxial with rotor 1 is journaled rotatably in relation to the outer rotor 1 which, in FIG. 1 is illustrated by two diagrammatically shown bearings 3 and 4. The driving mechanism, not shown, is arranged to cause rotors 1 and 2 to rotate at slightly differing numbers of revolutions per minute, whereby a screw 5 fixed to the outside of the internal rotor 2 acts as conveyor of solid matter which, in the annular separating chamber 6 delimited between rotors 1 and 2, is separated from a raw material supplied.

The raw material is supplied through a pipe 7 which, at its one end is fixed in the internal rotor 2 coaxial therewith and which opens into an insert 8 fixed in rotor 2, whereby the insert acts as distributor supplying four radially mounted insert bushings 9 that have discharge ducts 10 opening into the separating chamber 6.

As a consequence of the rotation of the rotors 1 and 2, a centrifuging of the supplied raw material takes place in the chamber 6, whereby the material is separated into a solid and a liquid phase. The r.p.m. and the direction of rotation of the two rotors 1 and 2 are chosen in such a manner that screw 5 transports the separated solid matter towards the right-hand side in FIG. 1 to an outlet 11 at the right-hand end of rotor 1. The liquid phase runs off through an overflow, not shown, at the left-hand end of rotor 1.

The screw 5 is composed of a plurality of axially adjoining sections which in FIG. 1 are designated by 12a, b, c etc. As

shown in more detail in FIGS. 2—4, each section 12 comprises one full turn or 360° of the helix and it consists of a hub 13 integral with the winding or helix turn 14. Preferably the sections are cast from a wear and corrosion resistant material. The bore 15 of the hub 13 is machined, preferably by grinding, to provide a tight fit, preferably a shrink fit, between the bore and a mating cylindrical surface on the outer side of the internal rotor 2. One end face of each section 12 is provided with a radially extending semicircular recess 16, and as shown two successive sections 12, the recesses 16 of which face each other, are mounted on the same diameter of the stepped rotor 2. A tapped bore in each cylindrical surface of the rotor 2 receives a cap screw 17 the cap or head of which has a small clearance in the recesses 16 whereby the screw serves to locate the two sections 12 angularly or circumferentially.

In FIG. 1 the screw 5 is shown as being interrupted in the region on either side of the discharge ducts 10. It will be appreciated, however, that normally there will also be one or more screw portions between the individual discharge apertures in the rotor 2 and such screw portions may be shaped as vanes having a larger pitch than the screw 5. The screw portions or vanes may be secured to an annular hub 18 secured to rotor 2 in a similar way as the screw sections 12 and the hub may be located circumferentially by means of a screw 17, e.g. as shown in FIG. 1 in conjunction with the adjoining screw section 12h.

As mentioned above the sections 12 of screw 5 may be cast, and they are preferably made from hardenable steel, such as stainless steel whereby each section after a rough machining may be through-hardened to increase its resistance against wear and abrasion. After being hardened the sections are finished, in particular the bore 15 and the end faces of the hub 13, and each section can then be fully balanced. This means that individual screw sections can be delivered as spare parts which the user of the centrifuge can mount in order to replace a worn section and without affecting the balanced state of the complete rotor 2. The sections 12 are preferably mounted by shrinking them onto the respective mating surfaces of rotor 2, and each section may be heated to about 100° C., e.g. in warm oil, whereupon it can be slid manually onto the mating surface of the stepped rotor 2. When, as shown in FIG. 1, each step of the rotor surface carries two sections 12, the innermost section, e.g. the section 12c, is first mounted against the annular shoulder on the rotor and against the preceding section, such as section 12d, if present. Before the section has been cooled down, its correct angular position is fixed by inserting screw 17 and when the subsequent section, such as section 12b, is pushed onto the cylindrical rotor surface the recess 16 of that section is guided by the head of the screw so that after cooling also the second section is correctly located.

The sections 12 may be dismounted or pulled off successively from one end of rotor 2, in FIG. 1 the right-hand end, by means of a suitable pulling-off tool which can be secured to the section adjoining the section to be pulled off. If desired, the section may be heated, e.g. by means of a welding burner, to effect a slight widening of the hub so as to facilitate the pulling off.

As shown in FIG. 3 the helix turn or winding 14 of each screw section 12 has substantially constant thickness

throughout its circumferential length apart from the front or leading end 14' thereof, which has a gradually increasing thickness. When the sections are mounted on the rotor the rear side of the leading end 14' of a winding 14 is flush with the rear side of the trailing end 14'' of the winding on the next section, whereas the leading face 19—as viewed in the conveying direction of the screw—of the complete helix is stepped at the transitions between two successive sections. This ensures that the winding 14 of each section pushes the conveyed solid material slightly clear of the first part of the surface 19 on the next section and an undesired back flow of solid material through the radial slit present between the end faces 20 and 21 of the respective windings 14, is thereby effectively counteracted.

The invention is not limited to the embodiment shown for illustrative purposes on the drawings. The pitch of the screw 5 may be constant throughout the length of the screw or it may vary in a manner different from that indicated in FIG. 1. Each screw section may comprise a greater or smaller part of the complete screw helix, and to each mounting surface of the internal rotor there may be secured only one screw section rather than two, as shown in FIG. 1. Also in this case the mutual angular location of the sections may be achieved by means of screws or pins secured to the rotor and engaging each with two adjoining sections. The fitting surfaces on the rotor and/or the screw sections may, e.g. in order to prevent seizure when the sections are dismounted, be narrower than the width of the sections, so that they are combined with annular recesses.

I claim:

1. A screw centrifuge comprising a hollow internal rotor and an external rotor surrounding said internal rotor and defining therewith a separating chamber, means for rotatably supporting said rotors and means for rotating each of said rotors at mutually different numbers of revolutions per minute, a conveyor screw secured to the outer side of said internal rotor, means for supplying a raw material to be separated into said separating chamber, and means for separately discharging constituents of said raw material from said separating chamber after separation thereof, wherein said conveyor screw comprises a plurality of axially adjoining screw sections, each of said sections being secured individually to said internal rotor, said sections being located angularly with respect to one another.

2. A centrifuge as claimed in claim 1 wherein said screw sections are secured with a shrink fit.

3. A centrifuge as claimed in claim 1 wherein said screw sections are secured to stepped portions of said internal rotor and angularly located in pairs, the sections of each pair having complementary recesses, and radial pins secured in the wall of said internal rotor and engaging at their outer end in said pair of recesses.

4. A centrifuge as claimed in claim 3, wherein said pins are threadedly secured in said rotor.

5. A centrifuge as claimed in claim 1, wherein the leading end of the screw winding of each screw section, as viewed in the conveying direction of said screw, is thicker than the trailing end of said winding.