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Rokitansky

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[54] **PROCESS AND APPARATUS FOR FILTERING SUSPENSIONS**

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Related U.S. Application Data

[63] Continuation of Ser. No. 113,009, Feb. 5, 1971, abandoned.

[30] **Foreign Application Priority Data**

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Feb. 5, 1971 Austria 227/71

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[51] **Int. Cl.** **B01d 33/06**

[58] **Field of Search** 210/75, 68, 81, 177, 386, 210/385, 396–398, 402, 404, 123, 393

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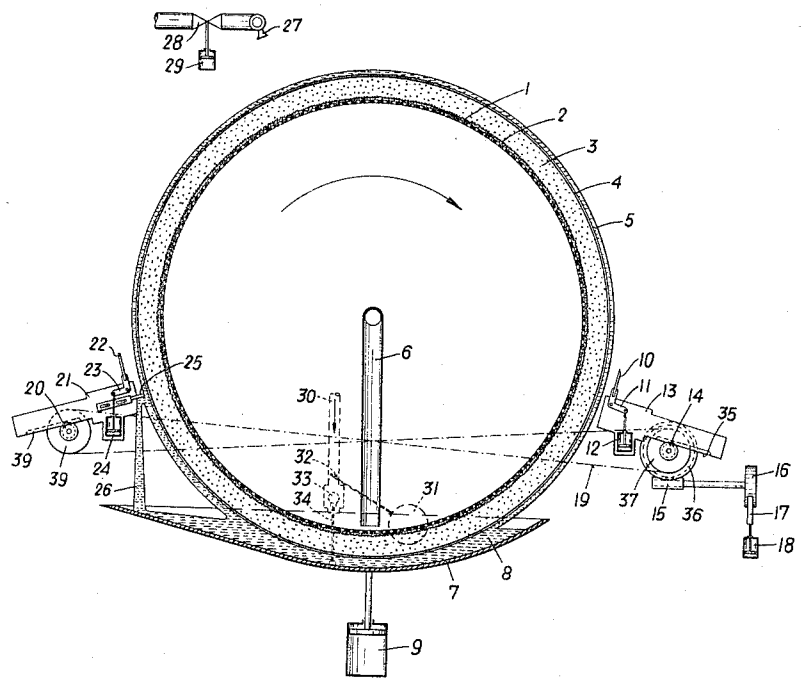
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Primary Examiner—John Adee
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[57] **ABSTRACT**

A rotary filter including a fluid-actuatable motor for supporting and moving a reservoir up and down relative to the filter and having a knife means which has a cutting edge and a scraper means engageable with the knife means as the latter is moved from the operative to the inoperative position to displace from the knife means material removed from the filter and adhered to the knife, the scraper also being engageable with the cutting edge as the knife is moved towards the inoperative position to thereby hone the cutting edge.

15 Claims, 10 Drawing Figures



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SHEET 1 OF 3

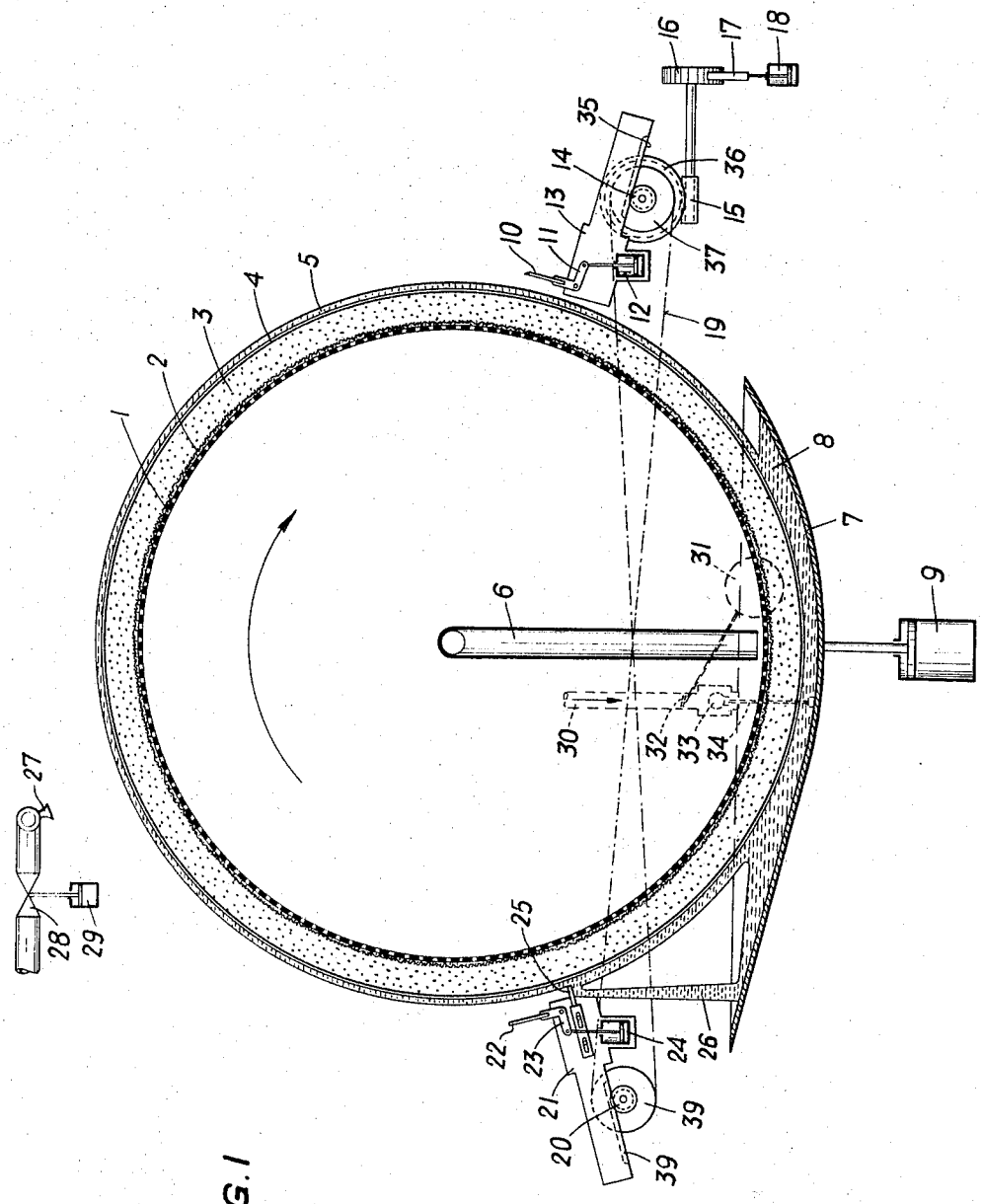


FIG. 1

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FIG.2

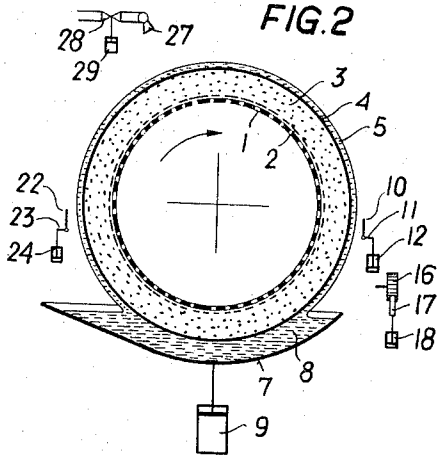


FIG.3

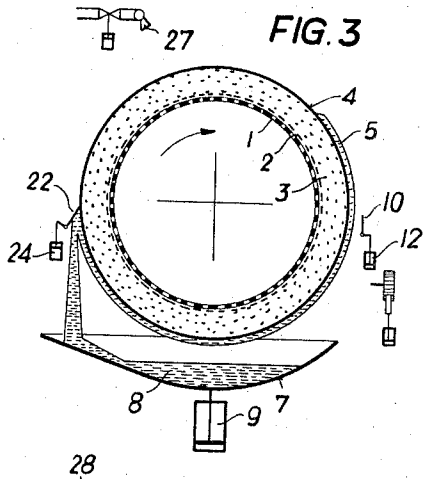


FIG.4

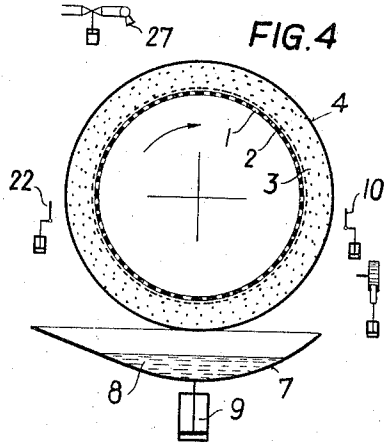


FIG.5

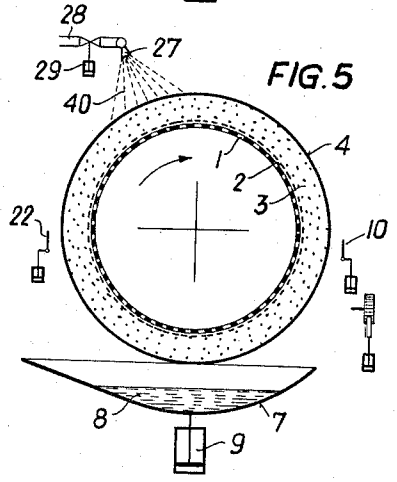


FIG.6

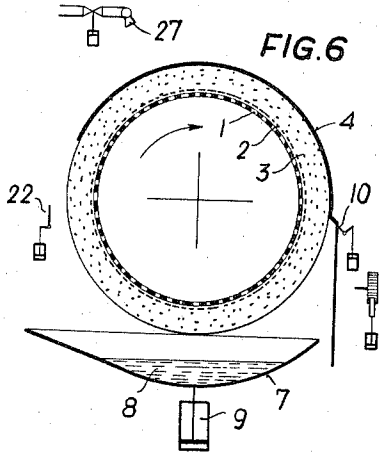
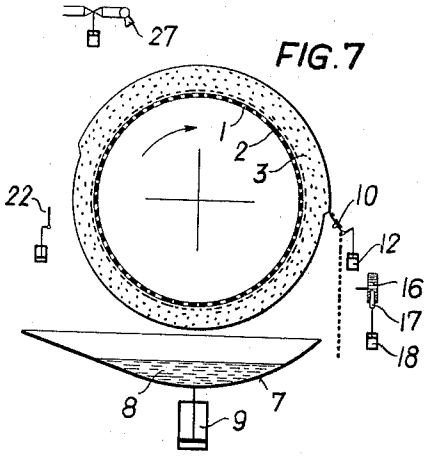


FIG.7



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FIG. 8

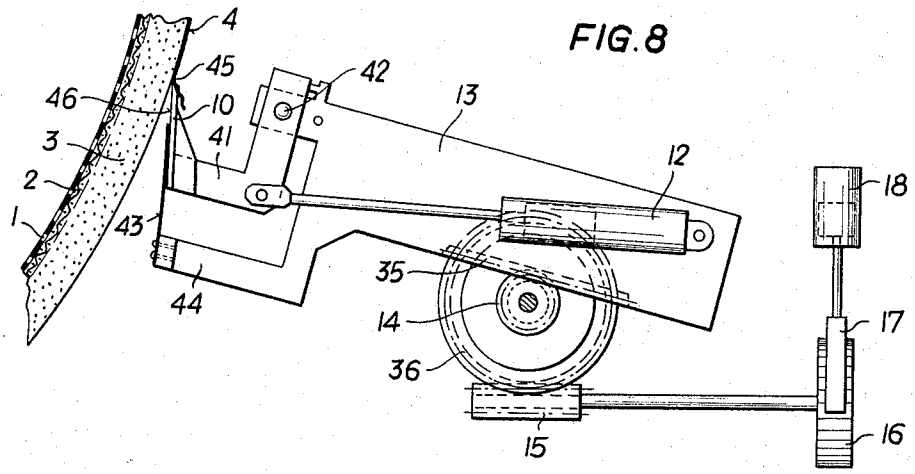


FIG. 9

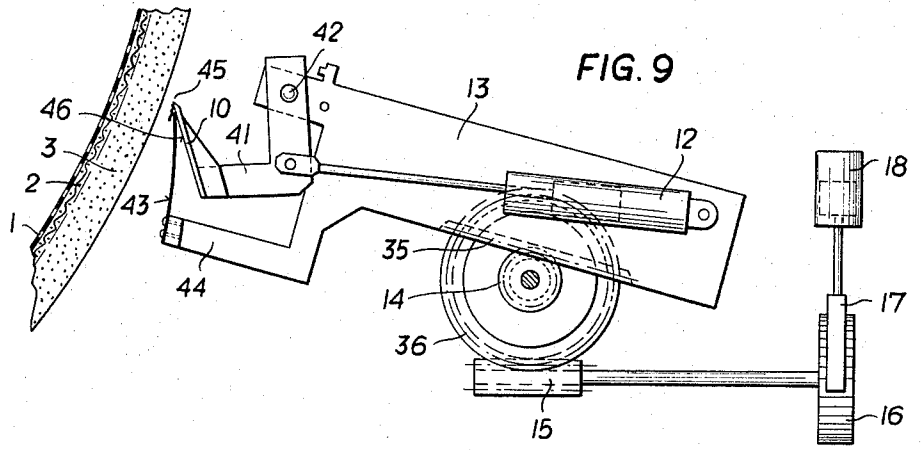
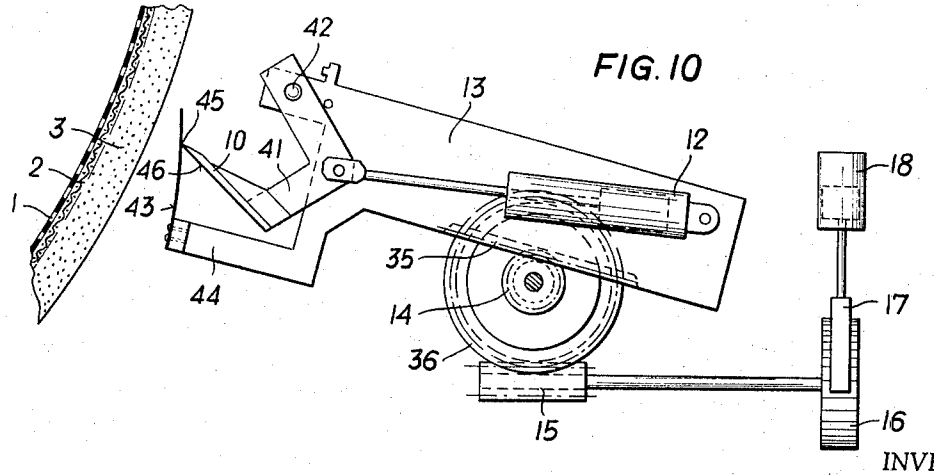


FIG. 10



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PROCESS AND APPARATUS FOR FILTERING SUSPENSIONS

This application is a continuation of application Ser. No. 113,009 filed Feb. 5, 1971, which has now been abandoned.

The invention refers to a process and an apparatus for filtering suspensions on rotating filters, particularly on vacuum operated rotating filters the interior of which is non-subdivided on which the filtrate is centripetally moving under the influence of a pressure difference, in which process and, respectively, apparatus the suspension to be filtered is applied to the filter surface and, respectively, to a precoat of filter aid on said filter surface and is filtered under formation of a filter cake, subsequently the remaining liquid portion retained in the filter cake is, if desired after removal of excessive suspension from the filter, as far as possible filtered off, the liquid retained in the capillaries of the filter cake is, if desired, displaced by another liquid and finally the filter cake together with a layer of the optionally present precoat is removed from the filter. With known rotating filters of the kind described the suspension to be filtered is continuously applied to the filter, f.i. by immersing the filter drum into a trough filled with a suspension to be filtered, the layer of suspension on the rotating filter is, if desired, equallized by a wiper member and subsequently the filter cake is removed from the filter drum at an area in front of the position where the rotating filter drum enters the trough. With known rotating filters of the kind described the filter drum is continuously immersed into the trough so that for sucking the filtrate out of the layer of suspension adhering to the filter surface and out of the filter cake (i.e. for sucking dry the filter cake) only that path of travel is at disposal which each point of the drum surface travels on its way from the point of immersion into the suspension contained in the trough to the point of removal of the filter cake, i.e. only a period is at disposal, which is shorter than the period required for one single revolution of the drum. If prior to removal of the filter cake, the liquid retained in the capillaries of the filter cake is to be displaced by another liquid a still shorter period is at disposal for filtering the suspension and sucking dry the filter cake. In filters of the kind described, frequently a so-called precoat is provided, which consists of a coating of filter aid to be applied to the filter cloth prior to starting the filtration, which filter aid coating is to be passed by the filtrate under the influence of the vacuum applied. With the use of such a precoat it becomes necessary to remove its outermost layer if it has become clogged by the solids contained in the suspension. In known apparatus this is effected simultaneously with removal of the filter cake. The time interval which is at disposal during less than one single revolution of the filter drum is frequently insufficient for satisfactorily sucking dry the filter cake so that removal of the filter cake and, respectively, of the outermost layer of the precoat becomes extremely difficult. This inconvenience is quite remarkable when filtering suspensions of unfavourable filtration characteristics.

The invention now aims at avoiding the abovementioned drawbacks of known rotating filters and essentially consists in that applying of the suspension to be filtered is interrupted during one or more revolutions of the filter, noting that material applied to the filter is filtered off and subsequently the filter cake and, if desired, a layer of the precoating is removed from the

filter. In this connection it is, according to the invention, convenient to apply the suspension to be filtered, to filter the suspension and to remove the filter cake repeatedly in cycles. In view of these inventive features there is no time limit for sucking dry the filter and the time required for sucking dry the filter can, independently on other filtering requirements, be extended at will. These features enable optimal working conditions, and additionally suspensions of unfavourable filtration characteristics can be satisfactorily filtered.

The filter cake formed on the filter and, respectively, a precoat optionally present contributes to the filtering action. As long as the thickness of the filter cake is low the filter and, respectively, the precoat is subjected to more severe load. Particularly when filtering suspensions which give rise for clogging the filter pores, the filter cake produced protects the pores of the filter surface and, respectively, or the precoat from becoming clogged, because such pores are protected by the filter cake. Because, in view of the inventive features, a filter cake of greater thickness can be sucked dry, the effective life time of the filter and of the precoat is increased. However, if the filter cake becomes too thick the filtering speed is decreased and also the filter efficiency is decreased. For this reason it is advantageous to apply, according to the invention, the suspension to be filtered onto the filter until a filter cake of predetermined thickness has been formed, what provides the possibility to control the endpoint of applying the suspension to the filter in dependence on the thickness of the filter cake. Removal of the filter cake can, according to the invention, be effected after completing at least one revolution of the filter, conveniently after completing several revolutions of the filter, subsequently to terminating supply of the suspension to be filtered onto the filter, what, after terminating the supply of the suspension to be filtered, provides an adequate period for sucking dry the filter cake, noting that also said period is not in the least subjected to those restricting conditions existing up till now, according to which the complete filtering cycle has to be completed during the time necessary for one single revolution of the filter drum. During said period, sucking off of the liquid portion remaining in the filter cake can, according to the invention, be effected after terminating supply of the suspension to be filtered onto the filter and said period can be long enough for attaining the desired and predetermined humidity content of the filter cake. In this case, starting of removal of the filter cake is controlled in dependence on the humidity content of the filter cake. Optimal thickness of the filter cake is in turn dependent on the quality of the suspension to be filtered so that said optional thickness must be preselected if termination of supply of the suspension to be filtered onto the filter is to be controlled in dependence on the thickness of the filter cake. Control of termination of supply of the suspension can, therefore simply be effected according to a preselected program, and such a control according to a preselected program is, as a rule, sufficient for defining the duration of each of the single filtering stages.

For obtaining a uniform filter cake and also a uniform filter efficiency at all areas of the circumferential surface of the filter drum it is convenient to equalize, according to the invention, the thickness of the layer of the suspension to be filtered and being present on the filter at least near the end of the period of supplying the

suspension onto the filter, preferably during the total period of supplying said suspension, because thickness of said layer of suspension present on the filter cake is again influencing the thickness of the filter cake formed. Supply of the suspension can be effected continuously. However, it is also possible to interrupt the supply of fresh suspension to be filtered onto the filter when the filter cake formed has assumed a predetermined thickness. After interrupting supply of the suspension, excessive suspension can be removed from the filter.

According to the invention, removal of the liquid retained in the filter cake after interrupting supply of the suspension to be filtered can be effected until a predetermined degree of humidity is attained, and it is further possible to displace, prior to removal of the filter cake from the filter, the liquid contained in the capillaries of the filter cake at least partially by another liquid. In view of the inventive feature, i.e. to interrupt supply of the suspension to the filter prior to removal of the filter cake, no time limitation is to be considered for these operations and optimal working conditions are provided.

Further, also the circumferential velocity is no more limited by the condition saying that sucking dry of the filter cake must be completed within less than one single revolution of the filter drum. If the revolution speed of the filter drum is too low there exists the possibility that the suspension to be filtered is flowing off the filter surface in too great a percentage, whereas with high revolution speeds the suspension may be removed from the filter surface by centrifugal forces. By excessively high relative velocities between suspension and filter surface, formation of the filter cake can be disturbed, and under certain circumstances even precoat material may be rinsed off the filter. The filter surface should be enclosed by a layer of suspension to be filtered while applying said suspension to the filter surface. Proper selection of the circumferential velocity of the filter drum is no more restricted in a process according to the invention in which a circumferential velocity of 0.5 to 2 m/sec has proved as advantageous with vacuum actuated rotating filter drums. Such circumferential velocities are favourable when removing the filter cake by means of a peeling knife, which, when working with higher velocities, gives a smoother cut. Obviously, it would be possible to increase the circumferential velocity during removal of the filter cake, however, the circumferential velocity is, according to the invention, kept constant, because the above mentioned circumferential velocities are sufficient for producing a smooth cut by means of a peeling knive or an equivalent tool.

The sucking pressure (a sub-atmospheric pressure) within the filter drum could be reduced (resulting in a higher absolute pressure) during removal of the filter cake so that it is avoided that an excessive amount of air enters the filter drum, what otherwise could deteriorate the filtrate and could give rise to foam formation, however, in practice it has been found that it is convenient to keep constant the sucking pressure within the filter drum during the complete filtering cycle.

An apparatus for performing the process according to the invention comprises, in a manner known per se, means for supplying the suspension to be filtered onto the filter, means for removing the filter cake formed from the filter, optionally means for removing excessive suspension from the filter and, also optionally, means for supplying a displacing liquid for displacing the liquid retained in the capillaries of the filter cake. Control means may be provided for making said means operative and inoperative, and said control means may be actuated arbitrarily or automatically, either in dependence on an operating condition or in dependence on a predetermined program. Known rotating filters usually are provided with a trough to be filled with suspension to be filtered, whereby the filter drum is continuously immersed into said trough. However, according to the invention, in an apparatus of the kind described the arrangement is such that the distance between the axis of the filter drum and the liquid level within the trough can be varied between an amount being smaller than the radius of the filter drum and an amount being greater than the radius of the filter drum. In this connection, the trough and the filter drum may be supported for relative lifting and lowering movement, but it is also possible to adjust the liquid level with the trough, f.i. by means of an immersing body. Usually the liquid level within the trough containing the suspension is controlled by a swimming or floating body. For avoiding excessive lifting of the liquid level within the trough on immersion of the trough or of the immersing body into the trough, the arrangement can be such that into the supply conduit leading into the trough, a valve is interconnected, which clears said supply conduit only with the filter drum immersed into the trough or with the immersing body immersed into the trough.

However, it is also possible to provide at least one distributing tube for applying the suspension to be filtered onto the filter drum, noting that in this case it is, according to the invention, convenient to provide a closure member upstream of the mouth of the distributing tube. By means of such a distributing tube, the suspension to be filtered may be poured or sprayed onto the filter drum, and in this case it is obviously also possible to collect excessive amounts of suspension in a trough arranged below the drum. In this manner it is possible to arbitrarily select the mode of supply of the suspension onto the filter drum.

For removal of the filter cake and optionally for removal of a surface layer of the precoat, generally a peeling knife is provided. According to the invention such a peeling knife can be pivotably mounted and can be, conveniently by means of pneumatic cylinders, pivotable into the operating position and pivotable out of the operating position. The peeling knife, and conveniently also a wiper optionally provided for removing excessive suspension from the filter drum, can, according to the invention, be supported on a slide arranged for sliding movement in direction to the filter drum. If a wiper is provided, the slide for the wiper and the slide for the peeling knife can be positively coupled for simultaneous movement in direction to the filter drum, because the decrease of the effective diameter of the filter surface when peeling the precoat has to be considered for both the wiper and the peeling knife.

It is a premise for a smooth cut and a long effective life time of the precoat coating that the peeling knife be maintained in an unobjectional condition. If the peeling knife is not in an unobjectional condition parts of the precoat material can be torn out of the precoat even when only peeling the filter cake. Damaged areas of the precoat can only be removed by peeling the pre-

coat for a depth corresponding to the depth of the damaged areas, what results in a heavy consumption of precoat material. If, on the other hand the precoat has only to be freed of the clogged pores it is sufficient to only peel off a surface layer of the precoat, however, for removing such a thin surface layer it is also necessary that the peeling knife be sharp enough. In known apparatus of the kind described the peeling knife had to be frequently manually cleaned or frequently interchanged by a new one, what had a result frequent stand still. According to a prefered embodiment of the invention a scraper is provided with which the peeling knife is, with its face facing the drum, in sliding engagement during the movement into the inoperative position, the scraper preferably also engaging the cutting edge of the peeling knife in the later stages of the movement of said knife into the inoperative position. During sliding engagement of the plane surface of the peeling knife with the scraper this plane surface is freed of adhering filter cake material when the knife is moved from its operative position in its inoperative position. Therefore, it is just the surface of the peeling knife being in contact with the precoat behind the cutting area, which is continuously kept smooth and which otherwise would damage the precoat. Said arrangement is particularly advantageous. If additionally, the peeling knife is moved into a position in which the scraper also slides over the cutting edge of the knife, the abrasive action effected results in sharpening the cutting edge of the knife, which remains sharp because such movement is frequently repeated. Such an arrangement provides a smooth cut produced by the peeling knife. Such an arrangement is also advantageous if only the filter cake is to be removed and this filter cake is inclined to tear precoat material out of the precoat. Further, clogged pores of the precoat can be reliably removed with a sharp peeling knife which also provides the possibility to keep the surface layer of the precoat as thin as possible, so that also the effective life time of the precoat is maximally increased. The arrangement described proves exceptionally reliable if the precoat material contains hard particles as is the case with infusorial earth (essentially consisting of pure SiO_2) or with perlites (vulcanic gas).

According to the invention, the scraper consist of a resilient steel sheet resiliently engaging the peeling knife. Such a prestressed resilient steel sheet acts with its edge on the surface of the peeling knife facing the drum and keeps clean said surface. The abrasive effect of such as essentially smooth steel sheet is comparatively low, what, however, is quite desired, because the cutting edge of the peeling knife is sliding on said sheet on each movement into the inoperative position and a heavy abrasive effect would reduce the effective life time of the peeling knife. The mentioned low abrasive effect is, however, sufficient for keeping sharp the cutting edge of the peeling knife.

The invention is further illustrated with reference to the drawing in which several embodiments of an apparatus according to the invention are shown.

FIG. 1 shows a cross-section of a filter drum in its operating position,

FIGS. 2 to 7 illustrate various working stages of one operation cycle,

FIGS. 8, 9 and 10 show, in an enlarged scale, a peeling knife together with a device for cleaning and sharpening said knife, FIG. 8 showing the peeling knife in the working position with respect to the filter drum and FIGS. 9 and 10 illustrating inoperative positions of said peeling knife, noting that FIG. 9 illustrates that inoperative position in which a scraper is cleaning the peeling knife and FIG. 10 is showing that inoperative position, i.e. the end position, which is reached by the peeling knife after the cutting edge of the peeling knife has been slidingly moved along the scraper.

On the perforated mantle of a filter drum 1 a filter cloth 2, f.i. a filter cloth of stainless steel, is put under tension. A coating 3 of filter aid, a so-called precoat, f.i. consisting of powdered starch, is maintained in engagement with the filter cloth 2 by the vacuum prevailing in the interior of the filter drum.

When applying the suspension to be filtered to the thus prepared surface of the filter drum a filter cake 3 is formed by the solids of the suspension, and on the surface of said filter cake of layer 5 of the suspension to be filtered is present. In operation, the filter drum 1 is rotated in direction of the arrow shown in FIG. 1 and a vacuum is produced within the filter drum 1 by a vacuum source (not shown) via the sucking conduit 6, through which the filtrate is sucked out of the filter drum 1. A trough 7 is filled with the suspension 8 to be filtered and can be pneumatically lifted or lowered by means of the pneumatic cylinder 9, so that, with the drum rotating, it is possible to intermittently immerse the filter coat into the suspension and the filter coat is covered by a layer 5 of the suspension to be filtered.

A peeling knife 10 is shown in FIG. 1 in its rest position. This peeling knife 10 can, by means of a pneumatic cylinder 12 and a crank lever 11 be swung in direction to the filter drum 1 to such an extent that it is peeling off the filter cake 5 and, if desired, the uppermost layer of the coating 3 consisting of filter aid. The peeling knife 10, the crank lever 11 and the pneumatic cylinder 12 are arranged on a slide 13, which in its turn is provided with a toothrack 35 engaged by a toothed gear 14. The toothed gear 14 is intermittently driven via a worm 14 and a worm gear 36 by means of a latch wheel 16 coupled to the shaft of the worm 15 and being engaged by a latch 17 which in turn is arranged for reciprocating movement by means of a penumatic cylinder 18. In operation, the slide 13 is gradually moved in direction to the filter drum 1 so that the peeling knife 10 gradually peels off the uppermost layer of the filter aid coating 3. Supply of the actuating fluid for the pneumatic cylinder is controlled by electric pulses which are produced in dependence on the necessary change of the working position of the peeling knife 10, f.i. according to a preselected program. To the axis of the toothed gear 14 and the worm gear 36*a* sprocket wheel 37 is coupled, so that this sprocket wheel 37 is, via a crossed sprocket chain 19, in driving connection with a further sprocket wheel 38 mounted with a further toothed gear 20 on a common shaft. This further toothed gear 20 is in driving engagement with a tooth rack 39 of a slide 21 so that the slides 33 and 21 are driven in direction to the filter drum 1 for equal increments. A wiper blade 22 consisting of elastic plastics is fixed to a crank lever 23 in a manner similar to the mounting of the peeling knife 10 to the crank lever 11. Said crank lever 23 can be pivoted by means of a pneumatic cylinder 24. The slide 21 is further provided with a wiper element in the form of a limiter blade 25 serving the purpose of defining the thickness of the layer 5

of the suspension to be filtered and further serving the purpose of equalizing the thickness of said layer **5**.

FIG. **1** is illustrating how a portion **26** of the suspension to be filtered is wiped off by the limiter blade **25** and then flowing back to the trough **7**.

With a certain distance from the surface of the filter drum **1**, a plurality of spray nozzles **27** is arranged. Washing liquid may be supplied to the surface of the filter drum via said spray nozzles **27**, however, in the operating stage illustrated by FIG. **1** supply of washing liquid is interrupted by valve **28**, which can be actuated by a pneumatic cylinder **29**.

The suspension to be filtered is fed to the trough **7** via a conduit **30**, the end of which is closed either by a ball valve **33** or a valve **32** actuated by a swimmer **31**. In the uppermost position of the trough **7**, the ball valve **33** is opened by an actuating stem **34**, fixed to the trough **7**. With this arrangement the proper filling level of the suspension within the trough **7** is maintained, so that on immersion of the filter drum into the trough **7**, suspension will not flow over the rim of the trough.

If desired, provision can be made for cleaning the peeling knife, while being inoperative, of adhering residues of the filter cake or filter aid so that the filter aid coating cannot be damaged by said residues when the peeling knife again comes into engagement with the coating on the filter drum.

A vacuum-operated rotating filter drum according to the invention, which is not provided with cells in the interior of the filter drum (non-subdivided) and is operated without a filter aid coating, would differ from the rotating filter illustrated in FIG. **1** by the filter aid coating **3** ommitted and substituted by a thinner filter cake, noting that also the parts for the engaging movement of the peeling knife **10** and of the wiper blade **22** are ommitted.

Now, FIGS. **2** to **7** illustrate the various operating stages during one cycle when operating a precoated filter drum.

During the first operating stage (FIG. **2**) the filter drum **1** provided with filter aid coating **3** (precoat) is immersed into the suspension **8** contained within the trough **7**, because the trough **7** is lifted in its uppermost operating position by the pneumatic cylinder **9**. In view of the rotating filter drum a suspension layer **5** is formed on the filter surface and completely enclosing the filter surface. In the area between the suspension layer **5** and the filter aid coating **3** the filter cake **4** is formed while the filtrate enters the interior of the filter drum and is sucked off via the sucking conduit **6** (FIG. **1**). In this operating stage the peeling knife **10** and the wiper blade **22** are in retracted position with respect to the filter drum **1** and the spray nozzles **27** are shut off. If it is intended to avoid excessive agitation and foaming of the suspension within the trough **7**, it is possible to lower and lift the trough **7** several times during said operating stage.

If application of the suspension to the filter drum has been finished the second operating stage (FIG. **3**) is started. For this purpose the wiper blade **22** is swung in direction to the filter drum **1** under the influence of the actuated pneumatic cylinder **24** and thus is wiping off excessive suspension **5** adhering on the filter cake **4**. The excess of the suspension **5** is flowing back into the trough **7**, which in the meantime has been lowered. After passing the wiper blade **22** only a little amount of liquid suspension or no suspension at all remains on the filter cake **4**. The peeling kinife **10** and the spray nozzles **27** are still inoperative in this operating stage.

Subsequently the third operating stage (FIG. **4**), i.e. drying of the filter cake, is started. In this operating condition the trough **7** is maintained in its lowered position and peeling knife **10**, wiper blade **22** and spray nozzles **27** remain still inoperative. This operating stage is maintained for a time interval sufficient to achieve the desired dehydration of the filter cake, i.e. until a moment at which the filtrate is essentially completely sucked out of the filter cake.

During the fourth operating stage (FIG. **5**) the liquid still contained in the cake **4** by capillary action is displaced. For this purpose, the valve **28** for the spray nozzles **27** is actuated by means of the pneumatic cylinder **29** for spraying a displacing liquid **40**, f.i. pure water, onto the surface of the filter cake **4**. Spraying of the displacing liquid onto the surface of the filter cake may be effected several times. At the right moment prior to the end of the fourth operating condition, the valve **28** is closed again so that the filter cake **4** becomes dry again before removal thereof. The trough **7** is in its lowered condition and the peeling knife **10** and the wiper blade **22** are inoperative.

During the subsequent fifth operating stage (FIG **6**), the peeling knife **10** is swung in direction to the filter trough **1** and thus peels the finished filter cake **4** off the underlying filter aid coating **3**. The removed filter cake **4** is sliding down along the inclined surface of the peeling knife **10** and can be collected by a suitable means and subjected to further treatment. During this fifth operating stage the trough **7** is maintained in its lowered position and the wiper blade **22** as well as the spray nozzles **27** are inoperative.

FIG. **7** is illustrating the filter during the sixth operating stage. In this operating stage neither suspension to be filtered nor filter cake are present on the filter surface in substantial amounts. Now, by means of the pneumatic cylinder **18** and the latch **17** connected thereto, the latch wheel **16** is rotated by one latch step so that the peeling knife **10** is shifted in direction to the filter drum **1** for a minute amount. In the now assumed position, the peeling knife **10** is removing a thin layer from the filter aid coating **3** and is thus cleaning the surface of said filter aid coating so that a well permeable filter aid coating is provided for the next operating cycle, i.e. the first operating stage thereof. If desired, the filter aid removed can be separately collected from the filter cake peeled off. Simultaneously with the peeling knife **10** also the wiper blade **22** is moved nearer to the filter drum **1** and therefore follows the evading surface of the filter aid coating **3** such tht said wiper blade **22** is in the correct position for the beginning of the next operating cycle (FIG. **2**).

Obviously, it is possible to peel the filter aid coating (FIG. **7**) at the end of each operating cycle or only after several operating cycles or only sometimes, as required. Under certain conditions the operating stage according to FIG. **7** can be ommitted and substituted by applying a surface layer of filter aid simultaneously with producing a filter cake during the fifth operating stage according to FIG. **6**. The latter mode of operation can be performed if the time interval between removal of the filter cake (FIG. **6**) and application of further amounts of suspension (FIG. **2**) shall be kept as short as possible for counteracting entering of air into the filter drum.

During the first operating stage (FIG. 2), application of suspension to be filtered can be effected as long as desired what results in a continuous increase in thickness of the filter cake. When filtering suspensions of low content in solids and giving a well permeable filter cake this operating stage can be performed for a comparatively long time. With well permeable filter cakes, the drying time (FIG. 4) as well as the displacing time (FIG. 5) may be selected short. When filtering suspensions of high content in solids and giving badly permeable filter cakes, a comparatively long time of application of suspension to be filtered (FIG. 2) must be selected and also longer drying periods (FIG. 4) and longer displacing periods (FIG. 5) must probably be selected for removing the filtrate from the filter cake as far as possible. When filtering suspensions the liquid phase of which is of high viscosity, long immersion periods (FIG. 2), long drying periods (FIG. 4) and long displacing periods (FIG. 5) are required. By selecting the time interval and, respectively, the number of revolutions for each of the operating stages according to FIGS. 2, 4 and 5, also the efficiency of the filter can be influenced. If it is desired to keep high the efficiency of the filter per surface unit, said time intervals are to shorten as far as possible. On the other hand said time intervalls will be extended if filter aid material is to be saved. The optimal duration of the operating stages and the optimal number of revolutions of the filter drum during the single operating stages may be determined by trial and error.

FIGS. 8, 9 and 10 illustrate details of the peeling knife and the cooperating device for cleaning and sharpening the peeling knife. The support 41 carrying the peeling knife 10 is pivotally connected to an axis 42 and actuated by a pneumatic cylinder 12. The scraper 43 is formed of a resilient steel sheet and fixed to an arm extending from the slide 30. The scraper 43 is thus stationarily fixed relative to the pivotal axis 42 of the support 41 for the peeling knife 10, the cutting edge of which is designated 45.

In FIG. 8 the peeling knife 10 is shown in operating position in which said knife is peeling the filter cake off the filter aid coating 4. Particularly when peeling off sticky filter cakes, it cannot be avoided that some of the filter cake material is reaching and adhering on the back surface 46 of the peeling knife 10. Such filter cake material detracts from a proper cut and deteriorates the surface of the filter aid coating.

When retracting the peeling knife 10 from the operating position shown in FIG. 8, the scraper 43, resiliently engaging the back surface 46 of the peeling knife 10, slides along said back surface 46 and removes the material adhering thereon, as is illustrated in FIG. 9.

The peeling knife 10 is then further moved in the end position of its inoperative range as shown in FIG. 10 whereby the cutting edge 45 of the peeling knife 10 is sliding over the scraper 43 consisting of a resilient steel sheet and is thus subjected to an abrasive action, which results in sharpening the cutting edge 45 of the peeling knife.

Obviously, in place of the pneumatic cylinders shown in the drawing hydraulic cylinders may be used.

Examples of suitable materials for producing the filter aid coating are potatoe starch, corn starch, infusorial earth or the like.

The invention provides the advantage that also those suspensions can be satisfactorily filtered which, up till now, could, in view of unfavourable filtration characteristics, not be or practically not be economically filtered on known rotating filters. Examples for suspensions with such unfavourable filtration characteristics are the following.

Dregs or sediments occuring in the storage cellars of breweries. Such dregs are suspensions of relatively low content in partially denaturated yeast cells, clowding particles and so on in beer. Filtration of such suspension is quite more difficult than filtration of beer yeast.

Wine dregs, i.e. the sediment in wine fermenting vessels. Such suspensions contain partially denaturated yeast cells, cream of tartar, clowding substances and the like in wine.

Autolysated cream of yeast, i.e. a suspension of partially emptied cell walls of yeast in a solution of partially chemically decomposed yeast substances. Such suspensions are obtained when producing yeast extracts and are extremely difficult to filtrate.

When filtering such suspensions the filter cake as well as the filtrate is to be collected because both are valuable.

What I claim is:

1. The method of filtering a suspension of solids in a liquid carrier with a hollow, cylindrical, rotary vacuum type filter which comprises the carrying out of a cycle including the steps of: effecting continuous rotation of said filter about a horizontal axis; while said filter is rotating, maintaining the pressure within said filter at a level below the pressure exteriorly of the filter to thereby create a force capable of effecting the flow of liquids from the exterior of the filter through said filter to the interior thereof; applying the suspension to be filtered to the exterior of the filter until a layer of at least a selected minimum depth has been formed thereon; then terminating the application of the suspension to the filter; thereafter and without applying additional suspension to said filter or removing any of the solids in said layer, continuing the rotating of the filter and keeping the pressure within the filter at the level below the pressure exteriorly thereof for at least one complete revolution and until the liquid content of the material applied to the exterior of the filter has been reduced to a selected level by the passage of liquid from said layer through the filter to the interior thereof; and subsequently removing material of reduced liquid content from the exterior of the filter, the removal of said material being carried out entirely after the formation of the layer on the filter is completed and the liquid content of the material reduced to the selected level and while the application of the suspension to the filter is interrupted, whereby the removal of liquid from the layer on the filter can be made independent in length of time from the formation of said layer thereon.

2. The method of claim 1, wherein the cycle of applying the suspension to the exterior of the filter, interrupting the application of suspension, continuing the rotation of the filter with the pressure in the interior thereof maintained below the pressure exteriorly of the filter, and removing from the filter the material of reduced liquid content is repeated.

3. The method of claim 2, wherein the peripheral velocity of said filter and the differential between the pressures in and exteriorly of the filter are maintained constant throughout the plurality of filtering cycles.

4. The method of claim 1, wherein the filter is rotated at a speed such that the peripheral velocity of said filter is in the range of from 0.5 to 2 meters per second.

5. The method of filtering a suspension of solids in a liquid carrier with equipment which includes a hollow, cylindrical, rotary vacuum type filter and a reservoir for said suspension, said method comprising the steps of: effecting continuous rotation of said filter about a horizontal axis; while said filter is rotating, maintaining the pressure within said filter at a level below the pressure exteriorly of the filter to thereby create a force capable of effecting the flow of liquids from the exterior of the filter through said filter to the interior thereof; effecting a relative displacement between said filter and said reservoir which is effective to bring said filter into contact with the suspension in the reservoir whereby, as said filter rotates, a layer of material will form on said filter; after said layer has reached a selected minimum depth, terminating the application of material to the filter by effecting a relative displacement between the reservoir and filter which is effective to interrupt the contact between the filter and the suspension in the reservoir; thereafter and while the filter is out of contact with the suspension, continuing the rotation of the filter and keeping the pressure within the filter at the level below the pressure exteriorly thereof for at least one complete revolution and until the liquid content of the material applied to the exterior of the filter has been reduced to a selected level by the passage of liquid from said layer through the filter to the interior thereof; and subsequently removing material of reduced liquid content from the exterior of the filter, the removal of said material being carried out entirely after the formation of the layer on the filter is completed and the liquid content of the material is reduced to the selected level and while the application of the suspension to the filter is interrupted, whereby the removal of liquid from the layer on the filter can be made independent in length of time from the formation of said layer thereon.

6. The method of claim 5, wherein the cycle of applying the suspension to the exterior of the filter, interrupting the application of suspension, continuing the rotation of the filter with the pressure in the interior thereof maintained below the pressure exteriorly of the filter, and removing from the filter the material of reduced liquid content is repeated.

7. Apparatus for filtering suspensions which comprises: a hollow, cylindrical, rotary filter; means for effecting continuous rotation of said filter about a horizontal axis; means operable while said filter is rotating to maintain the pressure within said filter at a level below the pressure exteriorly of the filter and thereby create a force capable of effecting the eduction of liquid from the exterior of the filter through said filter to the interior thereof; means for applying the suspension to be filtered to the exterior of the filter and for terminating the application of the suspension to the filter when a layer of at least a selected minimum depth has been formed thereon which includes a reservoir subjacent said filter and means capable of effecting relative vertical movement between said rotary filter and said reservoir for first so adjusting the distance between the suspension contained in said reservoir and said filter that said filter will contact said suspension as the filter rotates and then so adjusting said distance as to prevent contact between said filter and the suspension thereon with the suspension in the reservoir; means operable after the application of the suspension to the filter has been terminated and while the application of suspension to said filter is interrupted to continue the rotation of the filter through at least one revolution while maintaining the pressure within the filter at a level below the pressure exteriorly thereof so that the liquid content of the material applied to the exterior of the filter can be reduced to a selected level by the eduction of liquid from said layer through the filter to the interior thereof; and means operable entirely after the formation of the layer on the filter has been completed and the liquid content of the material has been reduced to the selected level and while the application of the suspension to the filter is interrupted for removing material of reduced liquid content from the exterior of the filter, whereby the removal of liquid from the layer of material on the filter can be made independent in length of time from the formation of said layer thereon.

8. The apparatus of claim 7, wherein the filter is vertically immovable and including a fluid-actuatable motor for supporting and moving said reservoir up and down relative to said filter to effect the relative vertical movement therebetween.

9. The apparatus of claim 7, together with means for limiting the level of the suspension in the reservoir which includes a conduit through which the suspension to be filtered can flow into said reservoir, valve means in said conduit, and means including a float in said reservoir for so controlling the opening anc closing of said valve that said valve will be and and the flow of the suspension into said reservoir interrupted when said filter is out of contact with the suspension in the reservoir.

10. The apparatus of claim 7, wherein the means for removing material of reduced liquid content from the exterior of the filter comprises a slide, a knife means pivotally mounted on said slide, means operable when the liquid content of the layer of material on the filter has been reduced to the selected level for pivoting said knife means relative to said slide to an operative position in which said knife means is engageable with the layer of material on the exterior of the filter to remove material therefrom and for thereafter pivoting said knife means to an inoperative position in which the knife means is isolated from said layer of material, and means for moving said slide and said knife means toward and away from said filter to thereby control the depth to which the material is removed from said layer by said knife means.

11. The apparatus of claim 7, wherein the means for removing material of reduced liquid content from the exterior of the filter comprises a knife means, a base means, means supporting said knife means from said base means, motor means mounted on said base means for moving said knife means between an operative position in which said knife means is engageable with the layer of material on the exterior of the filter to remove material therefrom and an inoperative position in which said knife means is isolated from said layer of material.

12. Apparatus for filtering suspensions which comprises: a hollow, cylindrical, rotary filter; means for effecting continuous rotation of said filter about a horizontal axis; means operable while said filter is rotating to maintain the pressure within said filter at a level below the pressure exteriorly of the filter and thereby create a force capable of effecting the eduction of liq-

uid from the exterior of the filter through said filter to the interior thereof; means for applying the suspension to be filtered to the exterior of the filter; means for interrupting the application of the suspension to the filter when a layer of at least a selected minimum depth has been formed thereon; means for thereafter and without the application of additional suspension to said filter, continuing the rotation of the filter while maintaining the pressure within the filter at a level below the pressure exteriorly thereof, whereby the liquid content of the material applied to the exterior of the filter can be reduced to a selected level by the eduction of liquid from said layer through the filter to the interior thereof; and means for removing material of reduced liquid content from the exterior of the filter which comprises knife means which has a cutting edge and which is movable between an operative position in which the knife means is engageable with the layer of material on the filter and an inoperative position in which the knife means is isolated from said layer and a scraper means engageable with said knife means as the latter is moved from the operative to the inoperative position thereof to displace from said knife means material removed from the rotary filter and adhered to said knife means, said scraper means also being engageable with said cutting edge as said knife means is moved towards said inoperative position to thereby hone said cutting edge and keep it sharp.

13. The apparatus of claim **12,** wherein said scraper means is a thin, sheetlike member of resilient metal.

14. The apparatus of claim **12,** together with a support means, means supporting said knife means for pivotal movement relative to said support means, and means so supporting said scaper means from said support means that the scraper means is stationary with respect to the axis about which the knife means pivots.

15. Apparatus for filtering suspensions comprising a hollow, cylindrical, rotary filter continuously rotatable about a horizontal axis while the pressure within said filter is maintained at a level below the pressure exteriorly of the filter; means for effecting the application of the suspension to be filtered to the exterior of said filter and for interrupting the application of the suspension thereto; and means for removing material of reduced liquid content from the exterior of the filter which comprises knife means which has a cutting edge and which is movable between an operative position in which the knife means is engageable with the material of the filter and an inoperative position in which the knife means is isolated from said layer and a scraper means engageable with said knife means as the latter is moved from the operative to the inoperative position thereof to displace from said knife means material removed from the rotary filter and adhered to said knife means, said scraper means also being engageable with the cutting edge of said knife means as said knife means is moved towards said inoperative position to thereby hone said cutting edge and keep it sharp.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,869,389

DATED : March 4, 1975

INVENTOR(S) : Karl Rokitansky

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the title page, item [73], after "Assignee:" change "Vogelsbusch" to --Vogelbusch--.

On the title page, item [30], third line, change "Feb. 5, 1971" to --Jan. 13, 1971--.

Column 4, line 21, change "with" to --within--.

Column 5, line 50, change "as" to --an--.

Column 8, line 52, change "tht" to --that--.

Claim 9, line 30, change "anc" to --and--.

Claim 9, line 31, after "be" add --closed--; delete "and" (first occurrence.

Claim 15, line 18, change "of" to --on--.

Signed and sealed this 10th day of June 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks