Aug. 5, 1930.

J. J. NAUGLE

1,772,262

FILTERING METHOD AND MEANS

Original Filed March 31, 1920 2 Sheets-Sheet 1

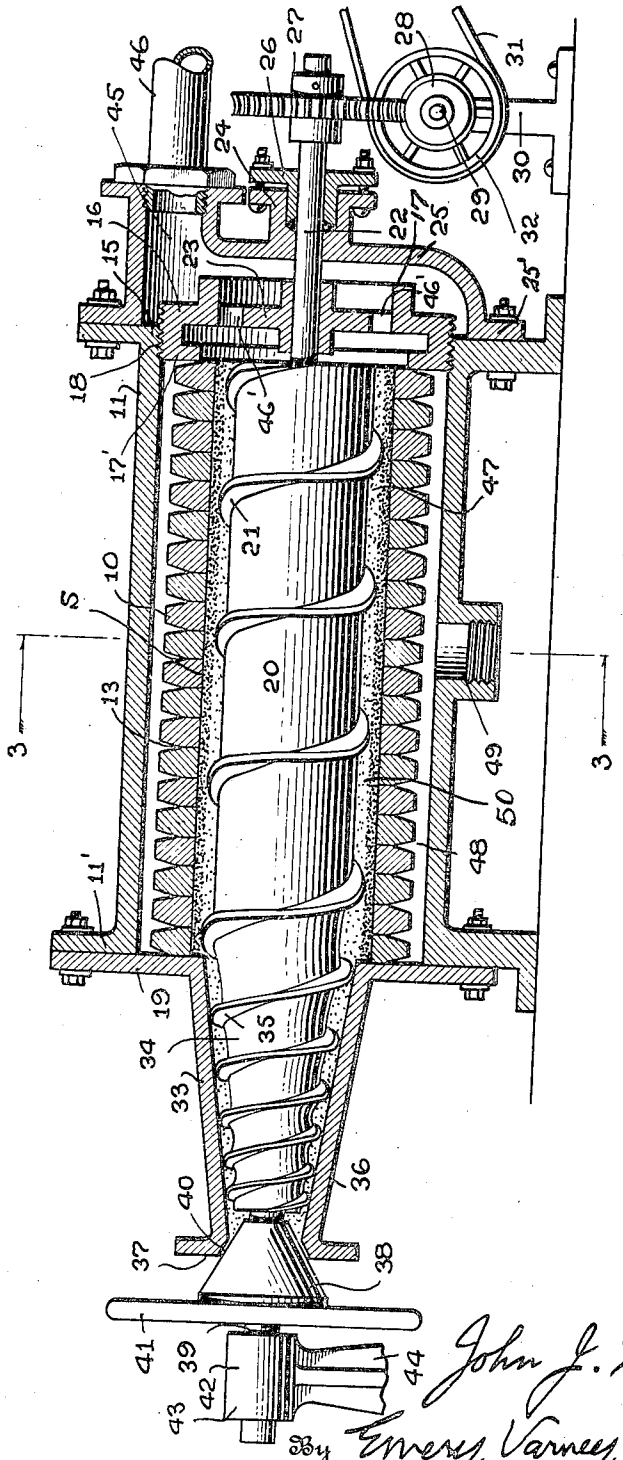

Fig. 1

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Their Attorneys

Aug. 5, 1930. J. J. NAUGLE 1,772,262

FILTERING METHOD AND MEANS

Original Filed March 31, 1920 2 Sheets-Sheet 2

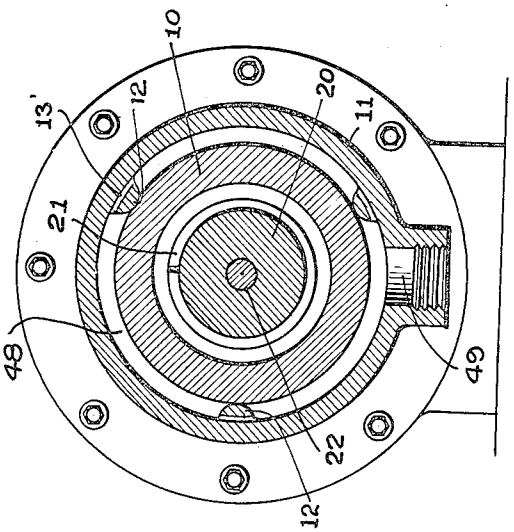

Fig. 3

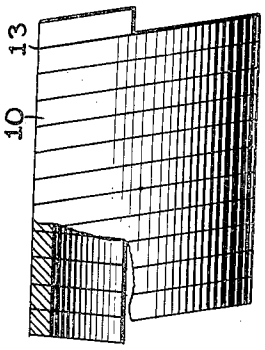

Fig. 7

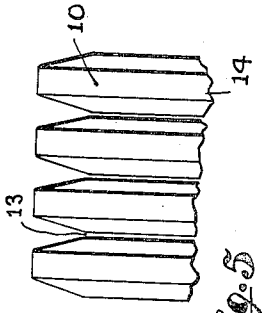

Fig. 4

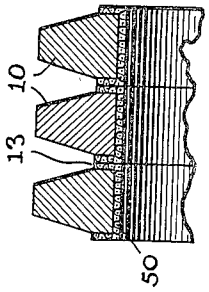

Fig. 5

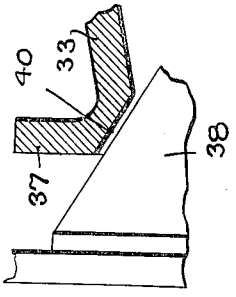

Fig. 8

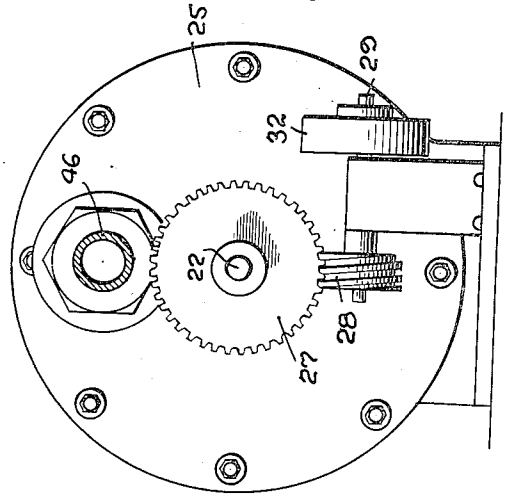

Fig. 2

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Patented Aug. 5, 1930 1,772,262

UNITED STATES PATENT OFFICE

JOHN J. NAUGLE, OF BROOKLYN, NEW YORK

FILTERING METHOD AND MEANS

Application filed March 31, 1920, Serial No. 370,114. Renewed July 23, 1926.

My invention relates to filtering means and aims to provide improved apparatus for, and methods of, filtering whereby the ease, efficiency and rapidity of the filtering operation are much increased, and the operation and construction of the filtering apparatus rendered much more simple, expedient and economical.

By way of example, I have shown in the accompanying drawing an illustrative embodiment of the apparatus of my invention, in which apparatus an illustrative embodiment of the process of my invention may be practiced, it being understood that my invention is not limited to the foregoing embodiments thereof herein shown and described by way of example merely.

Referring to the drawings:

Figure 1 is a longitudinal section, partly in elevation, of said embodiment of the apparatus;

Figure 2 is a rear elevation of the same;

Figure 3 is a cross-section of the same taken along line 3—3 of Figure 1;

Figure 4 is a side elevation, on an enlarged scale, and

Figure 5 is a cross-section, on an enlarged scale, of certain filter-medium supporting means that may be employed in one form of the invention;

Figure 6 is a fragmentary cross-sectional view, on an enlarged scale, of the front or extrusion end of the apparatus shown in Figure 1;

Figure 7 is a side elevation of a modified form of filter-medium supporting means.

Referring more particularly to the device shown in Figures 1 to 6, inclusive, of the drawing, the embodiment of filtering apparatus here illustrated comprises suitably arranged filter-medium supporting means consisting, preferably, of a plurality of spaced, separable members defining one or more filtrate passages between them.

I prefer to construct and arrange these filter-medium supporting units or members, designated in the drawing by reference character 10, so that the same shall be readily adjustable for reasons hereinafter set forth.

The members 10, which are referred to in the specification and claims as being "spaced", are, to the eye, apparently in contact throughout their opposed faces, the spacing between these members being due largely to their uneven surfaces, such unevenness generally existing even where the surfaces are to the eye substantially plane or flat, the spaces being of an order corresponding to capillary dimensions.

The members 10 are preferably in the form of flat rings or annuli positioned within the container 11 which is preferably of substantially cylindrical form. The container is provided on its inner face with a series of integral, or otherwise suitably attached, longitudinal ridges or bars 12, so proportioned that the ring-shaped members 10 will fit snugly within the ridges 12, and thereby be retained and properly positioned by the same.

Means are provided for adjusting the position of the members 10 with respect to each other to thereby adjust the size of the filtrate passages, such passages being designated by reference character 13. The purpose of this adjustment is to control the size of the apertures of the filter-medium supporting means, said supporting means comprising the series of members 10 and being generally designated by reference character 14.

For the purpose of so adjusting the size of the filtrate passages 13, I provide one end, preferably the rear end 15, of the container 11, with an adjustable head 16. The head 16 is provided with a flange 17, the outer face of which is screw-threaded to co-operate with the thread 18 on the inner face of the container 11 at the rear end thereof. The flange 17 of head 16 is provided with a transverse or inturned flange 17′ which is so proportioned and designed as to bear against the rearmost of the members 10, the foremost member 10 bearing against the front head 19, which will be described in greater detail hereinafter.

By screwing the rear head 16 a greater or less distance into the container, the series of annular members 10 will be more or less compressed, as the case may be, to thereby decrease or increase the sizes of the filtrate

passages 13. By thus regulating and adjusting the sizes of the filtrate passages, the filtering apparatus comprising the herein-described embodiment of my invention may be regulated and adjusted to filter liquids containing suspended solids of widely varying degrees of fineness. This regulation of the sizes of the filtrate passages serves further to control the speed or rapidity of the filtering operation, and acts further to regulate the degree of fineness of the filtering operation.

It will be noted that by means of the arrangement of members 10 here shown, I have provided a substantially tubular filter-medium supporting unit which contains a plurality of elongated filtrate passages, in the present instance of substantially annular configuration. It is to be noted, however, that members 10 and consequently the filtrate passages 13, may be of varying configuration, such as linear, elliptical, or of other desired form, and of varying number and thickness.

I provide means, preferably continuously-operating means, for removing the solids deposited or separated out during the filtering operation. Preferably such means comprise a continually-rotating screw-shaped cutter 20, provided with a spiral cutting edge 21 carried thereby. The cutter 20 may be rotated at any suitable speed by means of a shaft 22 rigidly attached to the cutter and passing through a journal bearing 23 suitably formed in the rear head 16. The shaft 22 is also supported in a journal bearing 24 suitably formed in the enclosure 25, a gland duct 26 being provided in co-operation with the bearing 24 for the purpose of rendering the shaft connection liquid-tight. At its outer end the shaft 22 carries a worm gear 27 rigidly attached thereto, as by being keyed to the shaft. The worm gear 27 is driven by a worm 28 supported on a shaft 29 carried by a standard 30. The shaft 29 and the worm 28 carried thereby are driven by a belt 31 and a pulley 32 operated from any suitable source of power, not here shown.

I prefer to arrange the cutting thread 21 of the cutter 20 so that the distances between the successive spiral portions of the cutter increase from the rear end 16 to the forward end 19 of the device. Preferably this is done by making the spiral cutter 21 of increasing pitch from the rear to the front end of the apparatus. The purpose of thus increasing the pitch of the spiral cutter 21 from the rear to the front end of the device is to prevent packing or jamming of the deposited solids as they collect and are removed and as they are thus being continually advanced by the spiral member from the rear to the forward end of the device.

I provide suitable liquid extraction or expression means, preferably positioned at the forward end of the device, as by being located in a hollow extension 33 formed on the front end plate 19. Preferably the liquid extraction device comprises a conical member 34 which may be integral with the member 20. The member 34 is provided with a spiral blade 35 which is so constructed and designed as to advance, and at the same time subject to continually increasing pressure, the portions of the removed deposited solids which are fed into the extraction device by the removal means 20. For the purpose of subjecting the solids in the extraction means, generally designated by reference character 36, to a continually increasing compression force, I prefer to space the successive portions of the spiral blade 35 so that the distances between such portions constantly diminish towards the solids-outlet end 37 of the device. Preferably, I do this by arranging the spiral blade 35 so as to be of continually diminishing pitch from its inner to its outer end.

Within the member 36 I arrange a conical closure member 38 somewhat in the nature of a valve. The member 38 is adjustably mounted on a threaded sleeve 39. By means of a hand wheel 41 attached to the conical member 38 the position of the conical member 38 along the sleeve 39 and consequently within the solids outlet passage 40 may be regulated, so as to maintain said passage 40 entirely closed at the beginning of the operation to prevent the liquid from flowing out of the device. After sufficient solids accumulate within the extraction device the member 38 may be moved to slightly open the passage 40 to permit the solids to leave the extraction device 34. At this stage of the operation substantially no liquid will flow out of the device since the spiral passage is full of solids. The threaded sleeve 39 is rigidly supported as at 42 by a journal bearing 43 in the standard 44, the forward end of shaft 22 passing through the bearing 43 and the sleeve 39.

Arranged at the rear end of the device is the closure 25, said closure and also the front end closure 19 being readily attached in a water-tight manner to the container 11 by means of nuts and bolts or other suitable means passing through flanges 11′ provided at the ends of the container 11. For this purpose the rear closure 25 is provided with a flange 25′ co-operating with one of the flanges 11′, already described.

The closure 25 is so arranged as to provide an inlet chamber 45 for the admission of the fluid to be filtered, said fluid passing into said chamber 45 through the fluid inlet pipe 46. The fluid to be filtered passes from the chamber 45 through apertures 46′ in the rear end plate 16 and thus into the space 47 between the removal means 20 and the inner surfaces of the members 10. After passing through the layer of deposited solids, which accumulates and is built up on the inner face of the filter-medium supporting means, the filtered

liquid passes through the filtrate passages 13, thence through the transverse passages 13' provided in the bars 13, into the substantially annular fluid chamber 48 between the inner surface of the container 11 and the outer faces of the members 10, and from there into the fluid outlet passage 49. This passage is preferably provided substantially in the middle and adjacent the bottom of the container 11.

The operation of the apparatus set forth above in the practice of one form of the process of my invention, may be substantially as follows, it being noted, however, that various embodiments of the process may be carried out successfully in the embodiment of the apparatus described above:

With a given liquid to filter, such as saccharine juices, for example juices extracted from sugar cane, it is first desirable to determine what the nature and dimensions of the filter medium to be employed should be for the most successful operation. In filtering such liquids as sugar juices, for example, the filtering medium may and, preferably, does comprise a foreign substance in subdivided or powdered form added to the juices, such as a bleach, as for example, bone charcoal. In certain other cases the solids present in the liquid to be filtered may, by themselves, furnish suitable filter media. This is the case with such liquids as suspensions of precipitated chalk and the like. In still other cases, while the solids suspended in the liquids to be filtered may comprise more or less suitable filter media, such media may be considerably improved by the addition of foreign substances in subdivided or powdered form, such as kieselguhr, fuller's earth, and the like.

In the embodiment of the process of my invention here described for purposes of illustration only, I aim to build up a filter medium of predetermined thickness and porosity out of the solids, whether originally present or subsequently added, suspended in the liquid to be filtered. For this purpose the members 10 and the cutter 21 are so proportioned as to leave a space, designated by reference character S, between the inner faces of the members 10 and the outer edge of the cutting member 21. It is the size of this space which will, in a given case, determine the thickness and porosity of the layer of filter medium built up out of the solids suspended in the liquid being filtered.

Having chosen a space S of suitable size by selecting members 10 or the cutter 20, or both, of proper dimensions, the degree of compression to which the members 10 are to be subjected is now determined and the rear closure 16 adjusted for this purpose. As already stated, while the members 10 appear to be in contact, even in close contact, with each other as viewed by the naked eye, they are, however, in a certain sense, "spaced" from each other by reason of the inherent unevenness of their meeting or opposed surfaces. The "spaces" between the members 10 providing the filtrate passages 13 are of capillary size. The dimensions of these passages 13 are regulated and controlled by the adjustment of the position of the rear end plate 16 within the container 11.

This adjustment of the size of the filtrate passages 13, which is of great practical importance, serves to regulate and control the rate of filtration, this rate being further controlled by controlling the pressure under which the fluid to be filtered is admitted to the filtering apparatus. The regulation of the size of the filtrate passages serves further to control the fineness of the particles which are removed from the fluid to be filtered, and controls also the density and, consequently, the porosity of the layer of filter medium formed within the members 10 from the solids suspended in the fluid. The adjustment of the size of the filtrate passages 13 also controls the pressure under which the fluid passes through the filtering apparatus, and this adjustment may also be made to serve to adapt the apparatus for the more successful filtering of liquids of peculiar character, such as liquids containing slimes, clays, chalks, gelatinous and albuminous materials, etc.

In starting the filtering operation, the cutting and extraction devices are put into rotation by means of the worm and worm gear mechanism, and a suitable valve, not here shown, is opened to admit the fluid to be filtered through the fluid inlet pipe 46. This fluid passes into the chamber 45 and from there through the passages 46' into the space between the removal means 20 and the inner faces of the members 10.

During this initial filtering operation, a layer of filter medium is built up out of the solids suspended in the fluid being filtered, although it is to be understood that, if so desired, the filter medium may be derived and prepared from a great variety of sources and may be applied to the inner face of the members 10 before any fluid is passed into the filtering apparatus. For example, I may provide strips of a filtering medium, such as cotton or other suitable cloth, designated by reference character 50', arranged, as shown more clearly in Figure 5 of the drawing, aobut the inner faces of the members 10 and between the opposed faces of said members in the filtrate passages 13. The cloth or other filter medium 50' will be securely positioned by being retained between the opposed faces of members 10.

In other cases, I may provide a composite filter medium of cloth, or of a layer of another solid deposited from its suspension in another liquid than the particular liquid to be filtered, or of any combination of such filter media, and a layer of the solids de-

posited from the particular liquid to be filtered. Where a filter medium consisting of a layer of solids deposited from their suspensions in a liquid other than the liquid to be filtered is employed, I pass such other liquid initially through the apparatus to build up the layer of filtering medium before the particular liquid to be filtered is passed through the device.

As the filtering medium continues to be built up, it ultimately fills the space S until it comes into contact with the rotating cutting edge of the cutter 21. After this all of the deposited solids in excess of that filling the space S will be removed by the removal means 20, and will pass into the extraction device 33. Since, during the building up of the filter medium, the filtering operation will not be completely performed, I prefer to return the fluid initially passing out of the device through the outlet 49 back to the original supply of liquid for refiltering the same, after the layer of filter medium has been built up.

After the layer of filter medium has been built up, as above set forth, the liquid to be filtered will pass through said layer before reaching the filtrate passages 13. After the layer of filter medium has been built up the filter-medium supporting members may be more widely separated to enable the filtrate to pass more readily out of the device after having traversed the filtering medium. It will be noted that, as already indicated, the layer of filter medium will be maintained at a substantially constant thickness and porosity by means of the removal means 20, so that the filtering operation is, in this way, rendered accurate, uniform and continuous. The thickness of the layer of filter medium will be predetermined by the size of the space S, and the filter medium, when built up, will be in the form of a substantially cylindrical, porous member of predetermined porosity and thickness.

As already stated, the cutting blade 21 is so arranged and proportioned in its supporting member 20, that there will be little or no danger of packing or jamming the portions of solids as they are successively removed. These portions comprise the solids last deposited and will, therefore, be in a condition which renders them readily removable.

The removal means 20 serves also to feed the successive portions of removed solids into the extraction device 36. The blade 35 of the extraction device is preferably not a cutting blade, and fits rather snugly within the conical container 33. As already stated, the compression blade 35 is so proportioned and arranged as to submit the solids passing into the extraction device 33 to a continually increasing extraction pressure. The liquid thus extracted flows backwards between the successive portions of the blade of the spiral 35 and ultimately through the filter medium here designated by reference character 50, through the filtrate passages 13, into space 48, and out through the fluid outlet 49. The solid material, now substantially free from liquid, passes out through the forward end of the extraction device 33 in the form of a spiral thread or worm over the conical member 30, up against the guard plate 41, and may be collected and stored in any suitable manner.

Once the filter medium has been built up, the liquid being filtered passes, after being freed from its suspended solids, through the filter medium 50 into the filtrate passages 13, space 48, and out by the fluid outlet 49, from which it can be led to any suitable reservoir, or discharged as waste.

As specific examples of fluids which may be filtered with great success according to the method and in the apparatus described above, I may, among others, refer to sugar juices, to which a bleach such as bone charcoal has been added, to serve not only to bleach the juices, but also as a filter medium in accordance with my invention; various vegetable and animal oils to which kieselguhr or fuller's earth has been added to serve not merely as a clarifying and deodorizing agent, but also as a filter aid or medium in accordance with my invention; suspensions of clays, chalks, and similar insoluble or precipated materials, in which case the material itself forms a filter medium according to my invention, and in which case, also, the device acts rather as a de-hydrator than as a filter, since it is in this case a solid, rather than a liquid, component which is sought to be recovered. I may also, in certain cases, pass a reagent through the device to act upon the deposit, since I have found that in my device such an interaction will be unusually complete and efficient.

The advantages of the method and apparatus of my invention, as set forth in connection with the description of the embodiments of the same herein shown and described by way of illustration only, are numerous and of great practical importance. By reason of this construction, the device is very strong and can be operated under very great pressures, with a consequent material gain in rapidity of the filtering operation. By reason, also, of its construction, the device may be very simply and economically manufactured, and will be rugged and lasting to a very high degree.

Since the sizes of the filtrate passages can be regulated, a single filtering apparatus may, in accordance with my invention, be employed for filtering a wide variety of liquids and for the recovery of a wide variety of suspended solids. Since the filter medium may be built up out of the solids suspended

in the liquid being filtered, and since a large variety of solids may be initially added to the liquid for various purposes, I may, under certain conditions, carry out one or more operations simultaneously with, and in addition to, the filtering operation, as by adding a bleach, clarifier, or deodorizer, to the liquid to be filtered, said addition agents serving either by themselves or in cooperation with the solids originally present in the liquid as the filter media in accordance with my invention.

By reason of the construction of the foregoing embodiment of the apparatus of my invention, such apparatus may be readily assembled and may be as readily disassembled, for cleaning, or for repairs.

By means of the extraction means shown in connection with the foregoing embodiment of the apparatus of my invention, I am enabled to recover the separated solids in a substantially liquid-free condition, all in a single, continuous operation.

In order to clean the apparatus, I may loosen the members 10, by unscrewing the end plate 16, and thereafter pass a cleaning fluid in a reverse direction through the device, admitting such fluid through the outlet pipe 49 and permitting it to flow out of the device through the inlet pipe 46.

In Figure 7 I have shown a series of filter members which are integral or continuous in the form of a spring spiral. The cross section of each member 10 is rectangular, as shown in the drawing, and the space between successive members, such space forming a continuous spiral space, is indicated by reference character 13. The area of the opening 13 may be regulated as for the filter members previously described.

It is of course to be understood that my invention is not limited to the particular uses and embodiments thereof herein shown and described for purpose of illustration only.

What I claim is:

1. In a filtering apparatus, a plurality of annular filter-medium supporting units, a container, ridges within the container adapted to support each unit parallel with the other units and spaced from the wall of the container.

2. In a filtering apparatus, a plurality of annular filter-medium supporting units, a container, ridges within the container to independently support each individual unit parallel with the other units and spaced from the wall of the container, and means to adjust the position of the units relative to each other.

3. In a filtering apparatus, a plurality of annular filter-medium supporting units, and means engaging the circumferential wall of each unit to support said unit independently of but parallel with the other units.

4. In a filtering apparatus, a plurality of annular filter-medium supporting units, means engaging the circumferential wall of each unit to support said unit independently of but parallel with the other units, and means to adjust the position of the units relative to each other.

5. In a filtering apparatus, a plurality of annular filter-medium supporting units, and means engaging the circumferential wall of each unit within but spaced from the wall of the container.

6. In a filtering apparatus, a plurality of annular filter-medium supporting units, a container and ridges within the container adapted to engage the circumferential wall of each unit for supporting said unit within but spaced from the wall of the container.

7. In a filtering apparatus, a plurality of annular filter-medium supporting units, a container, means engaging the circumferential wall of each unit to support said unit spaced from the wall of the container and independently of but parallel with the other units.

8. In a filtering apparatus, filter-medium supporting means provided with a plurality of adjustable filtrate passages, and means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness.

9. In a filtering apparatus, filter-medium supporting means provided with a plurality of adjustable, substantially annular filtrate passages, and means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness.

10. In a filtering apparatus, solids-supporting means comprising a substantially tubular member provided with a plurality of adjustable filtrate passages, and means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness.

11. In a filtering apparatus, solids-supporting means comprising a substantially tubular member provided with a plurality of adjustable, substantially annular filtrate passages, and means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness.

12. In a filtering apparatus, a substantially tubular member provided with a plurality of substantially annular filtrate passages, and means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness.

13. In a filtering apparatus, a substantially tubular member provided with a plurality of substantially annular filtrate passages, means for adjustably compressing said member to thereby vary the effective size of said pas-

sages and means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness.

14. In a filtering apparatus, a substantially tubular member provided with a plurality of substantially annular filtrate passages, means for varying the effective sizes of said passages, and means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness.

15. A filtering apparatus comprising a plurality of spaced members defining a filtrate passage between them, in combination with means associated with said members for adjusting the position of the same with respect to each other to thereby adjust the size of said passage, means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness, and means for treating the removed portions of the deposited solids to extract a part at least of the liquid content of the same.

16. A filtering apparatus comprising a plurality of spaced, separable members defining a filtrate passage between them, in combination with means associated with said members for adjusting the position of the same with respect to each other to thereby adjust the size of said passage, means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness, and means for extracting from the removed portions of the deposited solids a part at least of the liquid content of the same.

17. A filtering apparatus comprising a plurality of opposed, substantially annular members providing a substantially annular filtrate passage between them, in combination with means associated with said members for adjusting the position of the same with respect to each other to thereby adjust the size of the said passage, means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness, and means for treating the removed portions of the deposited solids to extract a part at least of the liquid content of the same.

18. A filtering apparatus comprising a plurality of opposed, substantially annular, separable members providing a substantially annular filtrate passage between them, in combination with means associated with said members for adjusting the position of the same with respect to each other to thereby adjust the size of said passage, means for removing successive portions of the layer of deposited solids to thereby maintain said layer at a substantially constant thickness, and means for extracting from the removed portions of the deposited solids a part at least of the liquid content of the same.

In testimony whereof, I have signed my name to this specification this 24th day of March, 1920.

JOHN J. NAUGLE.