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METHOD OF EXTRACTING OILS AND THE LIKE.

APPLICATION FILED OCT. 9, 1912.

Patented Jan. 19, 1915.

1,125,920.

3 SHEETS—SHEET 1.

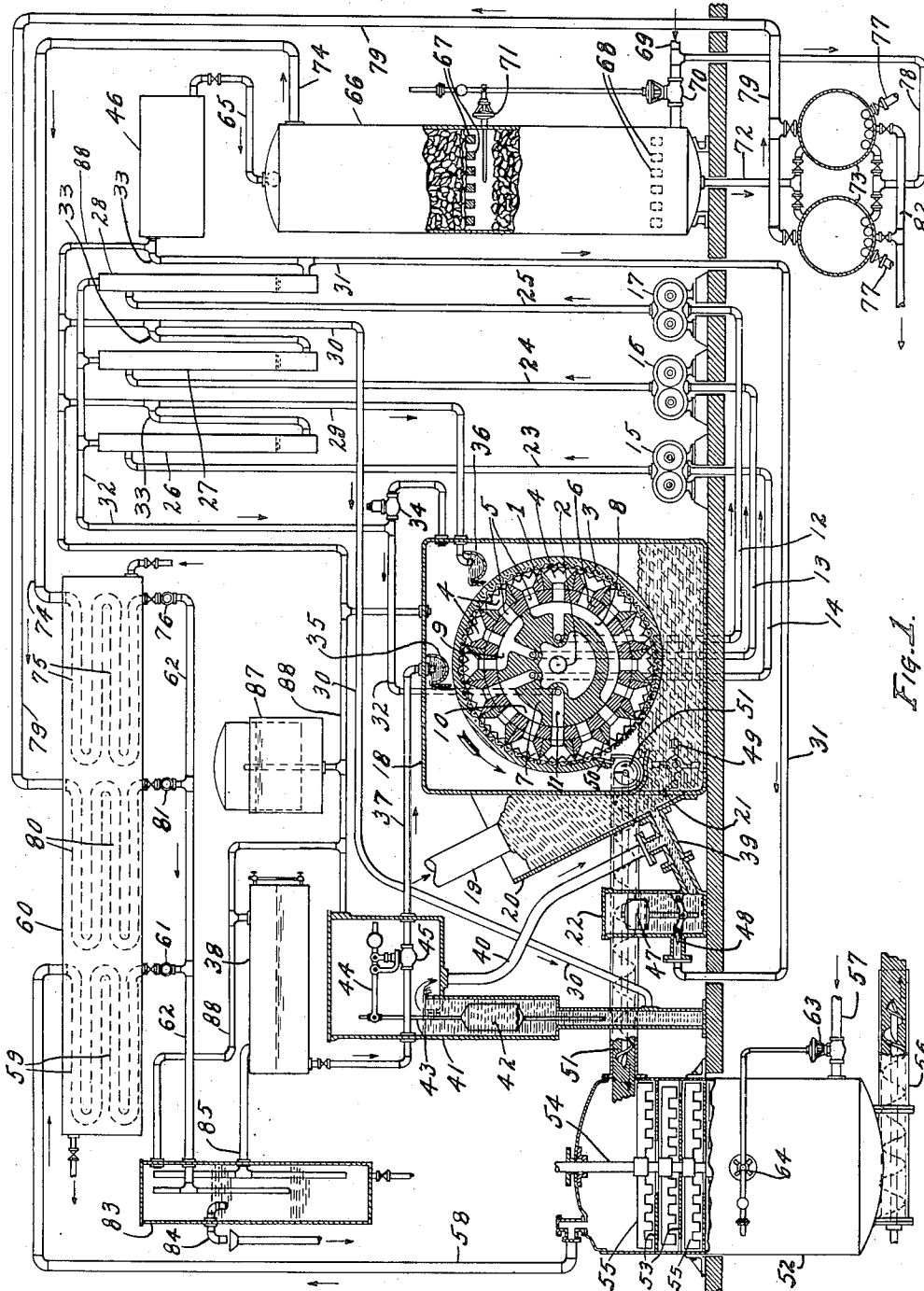


Fig. 1.

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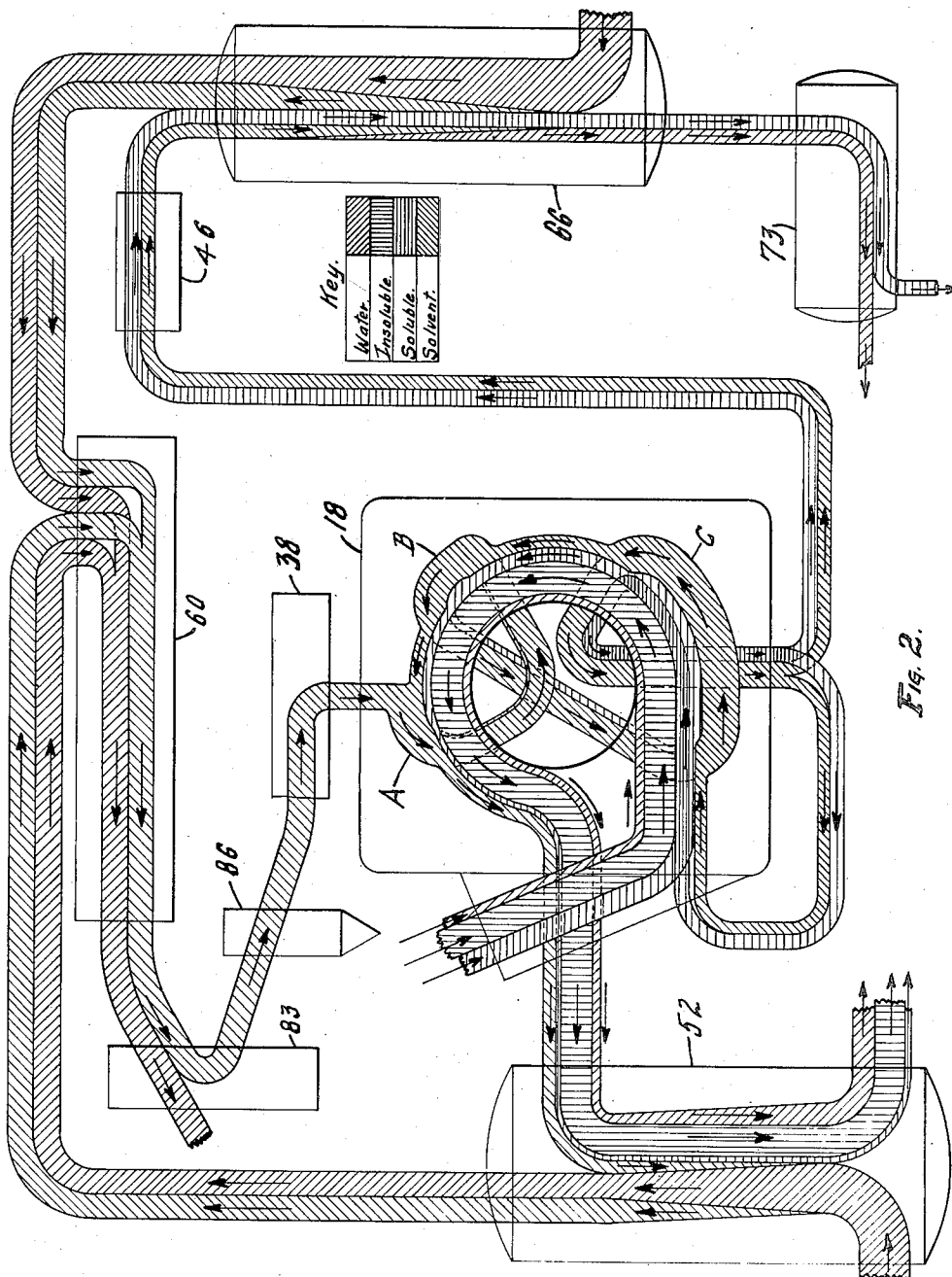
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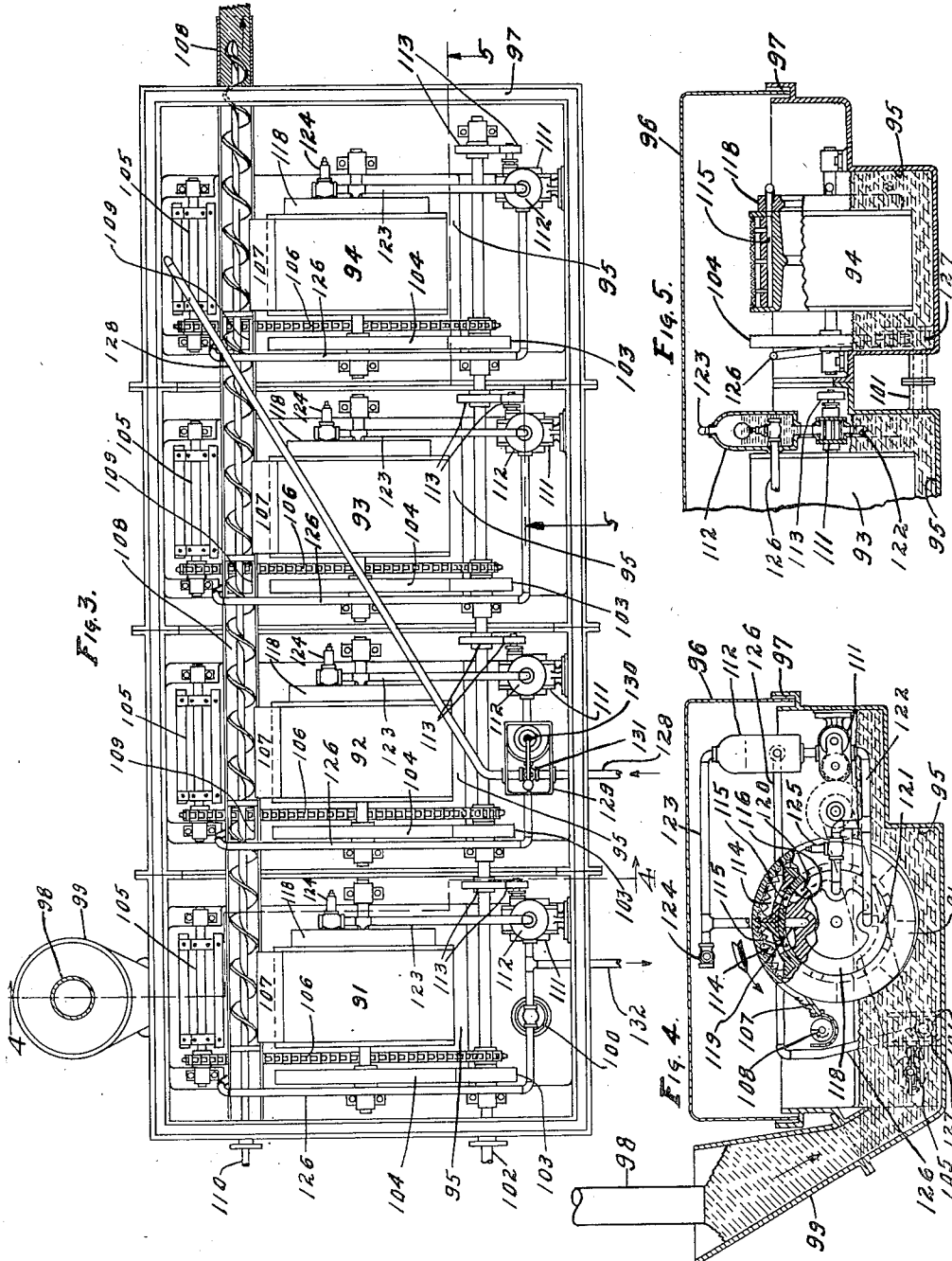
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3 SHEETS—SHEET 3.

1,125,920.



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METHOD OF EXTRACTING OILS AND THE LIKE.

1,125,920.

Specification of Letters Patent.

Patented Jan. 19, 1915.

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To all whom it may concern:

Be it known that we, EDWIN O. BARSTOW and THOMAS GRISWOLD, Jr., citizens of the United States, and residents of Midland, county of Midland, State of Michigan, have jointly invented a new and useful Improvement in Methods of Extracting Oils and the like, of which the following is a specification, the principle of the invention being herein explained and the best mode in which we have contemplated applying that principle, so as to distinguish it from other inventions.

The present improved method relates in general to the art of separating the more readily soluble constituents of materials from their less readily soluble, or insoluble constituents by the process of washing, and in certain of its aspects such present method may be regarded as an improvement on the method of washing, which forms the subject matter of U. S. Letters Patent No. 863,062, issued to Thomas Griswold, Jr., August 13, 1907. Such present method and apparatus relates more particularly, although in no sense exclusively, to the extraction of oils and the like from the material in which they are found, by treating such material with a suitable solvent in such fashion as to take up therefrom the oil or the like, the latter being then subsequently separated from the solvent which may be utilized over and over again.

The object of the invention is to provide for the economic extraction of such materials.

The advantages over other processes now known to the inventors as being in use, are many. The working capacity or output is relatively very large compared to the investment. The process is continuous and largely automatic, thus reducing labor and cost of attendance to a minimum. A solution or an extract (mixture of solvent and extracted matter) high in extracted matter is obtained and the amount of solvent left adhering to the material after extraction is relatively small, resulting in a relatively low fuel cost for solvent recovery. A relatively very small quantity of solvent "in process" is required, thus reducing investment therein. The solvent "in process" is maintained in constant flow either as liquid or vapor, and owing to the manner of its use and recovery, the actual quantity present in the various portions of the apparatus with the exception

of the solvent storage tank is substantially constant, hence any loss of solvent will be at once manifest by change in its surface level or depth in said tank, a most important feature, enabling the operator to know at all times, and for any lapse of time, the solvent consumption and the efficiency of recovery, and a sudden change in such level or depth gives prompt warning of accidental loss by leakage or otherwise before such loss shall have grown to a material amount. The application of heat in the solvent recovery steps is direct, effective and efficient, insuring a substantially complete and economical recovery, an important point in practical working.

The process is especially well adapted for the use of carbon tetrachlorid as solvent, on account of the small quantity required, the high efficiency of recovery and the promptness with which any loss is made evident, which features are particularly important because of the higher relative cost per gallon of this solvent.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the steps hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain means for and modes of carrying out the invention, such disclosed means and modes illustrating, however, but several of the various ways in which the principle of the invention may be used.

In said annexed drawings:—Figure 1 shows, in more or less diagrammatic form, an arrangement of apparatus for the carrying out of our improved process; Fig. 2 is a diagrammatic representation of the flow of the different materials involved in the carrying on of our improved process; Fig. 3 is a plan view showing a modified form of extractor from that included in the apparatus of Fig. 1; Fig. 4 is a transverse section of such modified apparatus on line 4—4; and Fig. 5 is a broken longitudinal vertical section of the same taken on the line 5—5, Fig. 3.

The general arrangement of apparatus illustrated in Fig. 1 is suitable for the treatment of any material which can be delivered to it in the form of meal, either fine or coarse, and is furthermore adapted to the use of a volatile solvent heavier than water, such as carbon-tetrachlorid, tri-chlor-ethyl-

ene or the like; and, with slight modifications, for a solvent lighter than water, such as naphtha. The central piece of apparatus around which the others are grouped, is the
5 extractor proper, a modified construction of which is illustrated in Figs. 3, 4 and 5. Whatever its form of construction, such extractor is designed to operate on the order of a continuous filter whereon the material
10 to be treated is caused to pass in a layer of greater or less thickness, while it is periodically treated with, and separated from, the solvent; in other words, the material and solvent may be regarded as moving in
15 currents whose general directions of flow are opposite, but which currents are caused to encounter each other intermittently.

Confining our attention for the present to the form of extractor shown in Fig. 1, it
20 will be seen to consist of a cylindrical drum 1 which, in said figure, is diagrammatically shown in cross section at right angles to its axis. This drum is rotatable on a shaft 2, suitable means (not shown) being provided
25 for the purpose of rotating the same. The cylindrical periphery of the drum is corrugated and covered with a pervious filter 3 of suitable material, that forms a continuous band around the drum over the corruga-
30 tions. The surface of the drum is further divided off into a plurality of similar transverse sections 4, sixteen being shown for the purpose of illustration. Each of these sections is provided with a port 5,
35 such ports 5 opening in the surface of a commutating valve 6 against which is slidably held a stationary take-off valve 7 provided in the present instance with four ports 8, 9, 10 and 11, the first three of which
40 are respectively connected by means of pipes 12, 13 and 14 with pumps 17, 16 and 15. These pumps are adapted to create a suction through the corresponding pipes and ports and thus through the several sections of the filter cover that happen to be
45 in communication with the respective ports. The filter drum 1 is inclosed within a tight casing or chamber 18, the lower portion of which constitutes a receptacle for the reception of a mixture of the material to be
50 treated and the solvent used in the extraction process. The material to be treated is fed into the chamber near its bottom by way of a spout 19 and a hopper 20, the
55 latter being attached to the side wall of the chamber, with which it communicates through an opening 21 that preferably lies below the level of the liquid mixture within the chamber. Such level is determined by
60 means of an automatic regulator 22, by which the supply of the solvent to the chamber is controlled, the construction and operation of such regulator being reserved for future description. The level of the mixture,
65 within the chamber however, is such

as to cause the drum 1 to be partially submerged therein, as clearly shown in Fig. 1. The respective discharge lines 23, 24 and 25 from the pumps 15, 16 and 17 lead to separators 26, 27 and 28 which are adapted to
70 receive the mixed air and solvent (such air and solvent being drawn through the pumps, as will be presently described), and separate the same by gravity, the solvent passing off by way of separate pipes 29, 30
75 and 31 and the air by way of a common branched pipe 32. The air in such pipe 32 will be under pressure, due to the hydrostatic head measured from the level of the liquid in the several separators (such level
80 being indicated by dotted lines) to the outlet level of said reservoirs which is the same in each being indicated by numeral 33 in each case. Such hydrostatic head is controlled at will by means of an adjustable
85 relief valve 34 connected to pipe 32 and venting into the housing 18. Located above and parallel with the axis of the extractor drum within the casing 18 that houses the same, are two troughs, or feed boxes 35 and
90 36, the first of which is supplied with fresh solvent by way of pipe 37 from a storage tank 38; the second of which is supplied by the pipe 29 leading from the overflow of separator 26. The overflow of separator 27
95 is carried to a liquid inlet pipe 39 at the base of the chamber 18 by way of pipes 30 and 40, a hydrostatic device, which controls the supply of fresh solvent through pipe 37, being interposed between said two
100 pipes 30 and 40. This hydrostatic device comprises a vertical stand pipe 41 enlarged at its upper portion to form a chamber, the latter overflowing into the pipe 40 that leads to the liquid inlet pipe 39 at the bottom
105 of the extractor chamber. In the chamber of the device is located a float 42 connected by means of a rod 43 to the lever 44 of a valve 45 in the feed pipe 37 for the fresh solvent. This float, being immersed
110 in the extract in the chamber will obviously rise and fall as the latter varies in density. Assuming the hydrostatic device to be arranged for dealing with carbon tetrachlorid in extracting an oil lighter than such tetra-
115 chlorid, should the extract become poorer in oil and hence heavier, the float will rise, thereby actuating the valve 45 to decrease the flow of fresh solvent into the extractor; should, on the contrary, the extract become
120 richer in oil and hence lighter, the float will sink and actuate the valve to increase the flow of fresh solvent to the extractor. The connection between the rod 43 and the lever 44 is adjustable so that the float can be set
125 to respond to any desired density or strength of extract in chamber 41, and when so set it will automatically regulate the flow of fresh solvent to the extractor, such regulation being based on the strength of the
130

extract obtained. The separator 28 into which pump 17 discharges, is designed normally to overflow into a stationary filter 46, but the overflow from said separator is also connected by means of the pipe 31 with the regulator 22, previously referred to, and thence with the extractor chamber by way of inlet pipe 39. The action of this regulator is normally to close the connection of the pipe 31 therewith, so long as the mixture in said chamber is maintained at a predetermined level. Should, however, this level fall, a float 47 in the regulator will drop correspondingly and thereby open a valve 48 and permit a portion, or all, of the extract overflowing from the separator 28 to be diverted from filter 46 through pipe 31 to the extractor chamber 18. Such lowering of the level obviously will occur only when the supply of extract overflowing from separator 27 and passing thence through pipe 30, hydrostatic device 41, and pipe 40 to the extractor chamber, is insufficient to maintain the predetermined level in said chamber. The normal course of flow of the solvent may be, for the purposes of the description, taken to be from the last extraction to the filter 46, although in actual operation the volume of this flow is less than that returned to the extractor, in order to maintain a uniform and constant level in same. Under ordinary operating conditions, the valve 48 is always open and a continuous flow of extract is coming in through it and also a continuous flow is passing forward to the filter 46, the valve serving merely to automatically divide the total flow into two portions, one to the filter, the other to the extractor. The extract as it enters the chamber, whether supplied through pipe 40 or pipe 31, is mixed with the untreated material as the latter is drawn away from hopper 20 into the base of the extractor by the action of paddles 49 suitably rotated, as need not be explained. The opening from the hopper 20 into the extractor chamber, being below the liquor level therein, such liquor traps the opening and prevents escape of air and solvent vapor from the chamber 18, and the downwardly moving mass of material within the hopper forms a stopper which further retards or prevents the vaporization of the solvent which wets the material in the base of the hopper.

Before proceeding with the description of the other associated parts of the general apparatus, the operation of the extractor proper may be advantageously reviewed. It will be noted, then, that the material, as it is fed through the hopper into the extractor chamber 18 by the action of the paddles 49, is mixed with the extract flowing in through the pipe 39, such extract being in the main supplied through pipe 31 and valve 48, there being a larger flow of extract returned through such pipe 31 and valve 48 than through pipe 40, since there is a considerably larger volume drawn in through the filter in producing a layer thereon than there is drawn through the same in washing such layer, and the portion divided out and sent forward to the stationary filter 46 is relatively small. It will be understood that whenever the level of the mixture in the chamber falls below a predetermined point, the deficiency is made up by diverting a larger portion of the overflow from separator 28, through pipe 31. The mixture of extract and material, thus produced in the bottom of the extractor chamber, being in contact with the submerged portion of the filter drum 1, a quantity of the fluid extract is drawn from such mixture in the base of the chamber through the submerged sections 4 of the drum's cylindrical surface by pump 17 acting through pipe 12 and port 8. A layer of the material is thus caused to deposit on the surface of the drum, such layer forming continuously to approximately uniform thickness as the drum rotates. The material thus deposited on the drum's surface as it rises above the level of the mixture is, of course, wet, that is, it includes a considerable content of the extract; however, the suction of the pump 17 continues to be exerted upon said layer after it has thus passed out of the body of mixture in the bottom of the extractor chamber until the upper limit of the port 8 has been passed by the ports 5 in the commutating valve member 6 that rotates with the drum. Immediately following the breaking of connection with port 8 and pump 17 just described, the sections 4 are successively brought into communication with the port 9 that is connected with pump 16, such port being normally in register with but three of the sections of the drum's surface at a time, whereas the first port was more extensive, as shown in Fig. 1. The trough or feed box 36 which receives the overflow from separator 26 is disposed to discharge the weaker extract received from said separator on the surface of the drum along a line just safely above that which the sections of said drum's surface must reach in order to be in communication with said port 9. The additional flow of solvent thus run onto the material from the feed box is drawn through the material by the pump 16 and by it conveyed to the next separator in the series, viz. separator 27. The sections 4 of the drum's surface are next brought into communication in succession with port 10 connected with pump 15, the second trough or feed box 35 being disposed so as to discharge the fresh solvent received from the reservoir 38 onto the layer of material covering the drum's surface along a line just beyond that which

the sections must reach in order to first come into such communication with such port 10. Finally the sections, one by one in the illustrated construction, come into register with the port 11. This port is connected with the air line 32 through which the air that is drawn by the several pumps and then separated from the solvent in the separators is returned to the extractor chamber. This air blows through the filter membrane that forms the outer surface of the drum and thus assists in loosening the layer of material thereon so that the latter may be easily removed by means of a scraper 50 which delivers the extracted material onto a conveyer 51 that serves to continually convey the same outside of the housing as fast as it is received from the revolving extractor drum. It should be noted at this point that the rate of rotation and degree of suction are intended to be such that not only will the extract or solvent be sucked through the layer of material, but air from within the housing will also be drawn through the layer, thus mechanically displacing in a measure the residual solvent or extract between the particles of material in such layer. Both air and extract or solvent, of course, are drawn into the several pumps and are then delivered into their corresponding separators. This same air, after separation, is available for loosening the layer of exhausted material, no outside air being required to be introduced at any stage of the operation. It will be further noted that after the extract is separated from the material picked up by the rotating extractor, the solid material remaining on the drum's surface is washed one or more times by weaker extract, and finally by entirely fresh solvent, as the extractor drum rotates; also that the extract from each extraction, as such drum rotates, is kept separate from the extract of all the other extractions and the fresh solvent fed into the box or trough 35 is next fed into the box or trough 36 and is later mixed with the fresh, incoming material at the base of the extractor chamber. Such incoming material, it will accordingly be seen, moves in a general direction substantially opposite to that in which the current of solvent, freshly received at the feed box 35, is caused to move as it is brought intermittently into contact with the material as the latter is picked up and carried around the drum. Counting the extractions as Nos. 1, 2, 3, etc., beginning with the fresh solvent wash, and the last extraction, viz., that obtained through the submerged portion of the drum, it will be noted that we have placed the regulator 42, so that it will regulate according to the density of extract from the next to the last extraction. It should be understood, however, that this regulator can be placed in any por-

tion of the circulation so as to regulate according to the density of extract at the preceding extraction; preferably, however, we place it as shown near the final extraction, at which point the extract is nearly full strength.

Passing now from the extractor proper, the treatment of the discharged extracted material delivered by the drum 1 to conveyer 51 will next be traced. Such conveyer, comprising a closed tube within which revolves a screw of usual form, extends to the upper end of a vertically disposed cylindrical chamber 52 that forms a heater where the solvent remaining in the material is removed by contact with a counter-current of steam. The screw of conveyer 51 stops short of the opening in the steamer chamber, so that such opening is closed by a plug of the moist material which serves to prevent the escape of steam or vaporized solvent from the steamer into the extractor. Within the steamer chamber are arranged a plurality of shelves 53 which open alternately at the center and periphery of the chamber. A central rotatable shaft 54 extends longitudinally of the chamber and carries rakes 55, or like devices, which move over and just above the several shelves, being adapted to turn over the material on said shelves and to gradually move the same in a spirally inward or outward direction, as the case may be, depending upon whether the shelf opens centrally or at its periphery. The entering material is thus spread out and broken up on the upper shelf, fed gradually across it, dropped onto the next lower shelf and so on from shelf to shelf until such material reaches the bottom of the chamber where it is received by the inner end of another screw conveyer 56 that delivers it without the apparatus. The screw in this conveyer, as in conveyer 51, stops short of the opening in the conveyer pipe so that a portion of the steamed material fills such opening and practically seals the steamer against the entrance of air or the escape of vapor. At the same time that the material is being turned over and raked on the several shelves and gradually fed down through the steamer chamber 52, steam is admitted near the base of the latter by way of pipe 57, such steam rising in a zigzag path in contact with the constantly changing surfaces of the body of material that passes downwardly through the steamer as just described. Any excess of such steam, together with the vaporized solvent, escapes finally through a vapor pipe 58 which carries it to a condenser coil 59 in the tank 60. The action of this opposing current of steam on the material is to thoroughly vaporize the solvent mixed with such material, so that substantially all such solvent is driven off by the steam to this condenser coil. From the latter the condensed

steam and solvent flow by way of a sight box 61 into a condensation main 62, whereby they are conducted to a separator, which will be described later. In mentioning the excess of steam accompanying the solvent vapors, we wish to point out the fact that the solvent vapor will be greatly in excess and that the steam is present only in small amount. The amount of steam present will actually be dependent upon whether the apparatus is being forced or not. If it is being forced, the excess of steam will be great. If it is being worked at a rate suitable to its capacity, the excess of steam will be quite small. The supply of steam to the steamer chamber by way of pipe 57 is controlled by a valve 63, which is in turn operated by means of a thermostat 64 mounted at a suitable point in the wall of the chamber 52, so as to be in contact with the vapor within the latter. Inasmuch as the temperature of such vapor, consisting, as it does, of a mixture of steam and solvent, will vary, depending upon the relative proportions of the two ingredients, it follows that there will be a gradual change of temperature within the steamer varying from bottom to top with the different proportions of steam and solvent vapor, and that there will be some certain temperature which, if maintained at the selected point in the vapor space within the steamer chamber, will insure the practically complete absence of solvent or solvent vapor at the base of the steamer. Accordingly, by properly locating the thermostat and adjusting its action, such thermostat may be adapted to automatically control the steam entering pipe 57, so as to effect a practically complete recovery of the solvent in the material without the waste of steam.

The course of the final extract overflowing from separator 28 will now be followed, such extract first passing, as previously indicated, into a filter 46, the function of which is to remove any particles of insoluble material which may have passed through the filter membrane on the drum. From this filter the liquid extract is then led by way of pipe 65 into the top of a distillation column 66 which may be of any suitable construction, although preferably made cylindrical, as shown, with its upper portion filled with broken coke or similar packing, resting upon a grating 67, while its lower portion is filled with a similar material resting upon a second grating 68. Steam is admitted into the base of the column by a pipe 69 in which is a valve 70, which is controlled by means of a thermostat 71, much as in the case of the thermostatically controlled supply valve 63 of the steamer chamber 52. Such thermostat 71 is conveniently located so as to extend into the space between the two bodies of filling material within the column. The extract flows

down from the filter 46 through the material filling this column and meets therein the upward current of steam which serves to vaporize the solvent, but leaves the oil and any water that may have been included in the extract. Such oil and water together with the added water of condensation of the steam condensed in the distillation leave the column by way of a pipe 72 connected with two tanks 73, while the solvent vapor and any excess steam pass out by way of pipe 74 and are led to a condenser coil 75 in the tank 60 from which the condensate passes through a sight box 76 into the same main 62 that receives the condensate from coil 59. The oil that flows from the bottom of the column 66 will be emulsified with the condensed water, and the function of the tanks 73, which receive the mixture, is to permit such oil and water to separate. After separation, the water may be drawn off through outlets 77, and if there be any solvent still present in the oil, steam can be admitted through a pipe 78 branching from pipe 69, so as to vaporize such solvent which is then conducted through a vapor pipe 79 to a third coil 80 in the tank 60 from which the condensate flows by way of sight box 81 into the condensation main 62. The oil left in the tanks 73 may be withdrawn, as desired, by pipe 82. The condensation from the several coils in the condenser, united in the condensation main 62, is led into the separator 83, where a gravitational separation of the solvent from the water formed by the condensed steam occurs. The particular form of separator illustrated, in keeping with the remainder of the apparatus, is primarily designed for the separation of water from a heavy solvent, such as carbon tetrachloride. The water, accordingly, will overflow through a pipe 84 to waste, while the de-watered solvent overflows through another pipe 85 into the storage tank 38, previously referred to in connection with the description of the extractor.

A gasometer 87 is connected by means of a branched pipe 88 with the different pieces of the apparatus, including the storage tank 38, the extractor chamber 18, the chamber 41 containing the hydrostatic device and the several separators 26, 27 and 28 together with the filter 46, so as to maintain a uniform vapor pressure throughout the apparatus and avoid loss of solvent vapor. As the body of air or vapor within the extractor housing and above the surface of the solvent in such various parts of the apparatus changes in volume, owing to change of temperature or other cause, the gasometer will rise or fall accordingly.

It should be observed all air or vapor, or vapor mixture, which is drawn by the pumps 15, 16 and 17 through the material

on the rotating extractor drum 1, comes from within the housing 18 of said extractor and is returned to such housing after separation from the solvent or extract in the separators 26, 27 and 28, being partially returned to said housing under pressure through the port 11 and the extracted material on the drum, and otherwise through the relief valve 34 which is set to maintain a proper pressure upon said port 11. In this way no vaporized solvent is lost as no air is discharged from the apparatus and by displacing solvent in the material by air or vapor in this manner a more thorough extraction is obtained at each washing and fewer washings are required to attain a definite degree of total extraction and what is also important, the material leaves the drum much drier than it would otherwise be if merely drained without air washing; furthermore there is less solvent carried over into the steamer 52 and correspondingly less steam is required to be used there.

It will be evident that other ways of applying suction to the drum may be substituted for the pumps shown and an independent air pump may also be used to furnish air for blowing the material at the port 11. It will also be apparent that other forms of separators than those shown may be used for separating the solvent or extract from the air or vapor.

If superheated steam be used in the steamer for evaporating and deodorizing, the product leaving at 56 may be made nearly dry, that is free from water; but if no superheated steam be used and it is desired to further dry the material after steaming it may be delivered by the screw conveyer into any form of drier suitable to the purpose and herein continuously dried as desired. Certain other minor modifications, moreover, would require to be made in the details shown, in order to fit the apparatus to work with different solvents, the details shown and described being designed for the use of carbon tetrachlorid as heretofore stated; but anyone skilled in the use of solvents will readily understand the nature of the modifications necessary for the substitution of other solvents, and hence the present description is not burdened with an enumeration of them.

The general operation of the apparatus as a whole and the various steps included in our improved process or method of extraction, may be best comprehended by reference to Fig. 2, which is in the nature of a flow chart, and shows the movements of material, solvent, oil, vapor, water, etc., in the apparatus of Fig. 1. This flow sheet is, of course, purely diagrammatic, but so far as applicable, the same reference characters are employed as in said Fig. 1. In said flow

chart the materials are shown as flowing in bands differently cross-hatched to designate the different constituents, as per the key at the right; thus the material to be treated is shown in a band divided into three portions, water, insoluble and soluble. Entering the extractor chamber 18, this composite material is taken up by the drum 1 and carried around in the direction of the arrows. The residuum, still containing all three ingredients, but with the proportion of soluble much reduced, is discharged from the extractor and thence conveyed to steamer chamber 52. While such material has lost in soluble during its passage through the extractor, it has now an additional ingredient consisting of the residual solvent which is not removed in the extractor. In the steamer chamber, the material, with the soluble thus extracted to a minimum, is brought into contact with the current of steam, which passes through the steamer and is condensed at the same time that it evaporates the solvent. The latter, together with any excess of steam (which remains uncondensed), passes out into the condenser 60, while the residual material with its content of water increased by the condensed steam, but with the solvent entirely eliminated, passes downwardly and out. Reverting to the extractor, the fresh solvent from the storage tank 38 passes through the material on the drum 1 at A, taking up a relatively small amount of soluble, as represented by the narrow band. Such solvent with this small content of soluble is then passed a second time through the stream of material at B, this time taking up from the material more soluble, as shown by the increased width of the band indicating the latter constituent. The extract (mixture of solvent and soluble) thus obtained is then delivered into the base of the extractor where it is mixed with incoming material and a third time separated therefrom at C, taking up still more soluble, as shown by the increased width of the band. The resulting extract is divided into two streams, part being returned into the base of the extractor, while the other part, the finished extract as it may be termed, passes into the filter 46 and thence to the column 66. In the column the extract is brought into contact with a counter-current of steam which vaporizes the solvent in the extract, and at the same time is itself condensed. The solvent vapor and any excess of steam will be seen passing out of the top of the column to the condenser 60, while the oil or other extracted substance, together with a content of water formed by the condensed steam leaves the column at the bottom and pass into the separating tank 73 where the oil is finally obtained substantially free of water. The solvent vapor and any excess steam

after condensation in condenser 60, are combined with the condensation from the steamer chamber and passes to the separator 83, whence the water is discharged to waste and the de-watered solvent passes through the pipe 85 to the storage tank 88.

The modification in construction illustrated in Figs. 3, 4 and 5, as has already been indicated, relates entirely to the extractor. The apparatus illustrated in the figures just named, in other words, is intended to be substituted more or less bodily for the extractor in Fig. 1, including the housing or chamber 18 with the rotating drum and other parts inclosed therein. In the present case, however, certain of the pumping and separating elements of the apparatus are as a matter of convenience inclosed along with the filter mechanism, although the exterior connections and the arrangement of the apparatus otherwise remain unchanged. In the extractor shown in Fig. 1, the material to be extracted is first mixed with a quantity of extract and then is given a succession of washings with weaker extract (finishing with fresh solvent) upon the rotary drum 1, such successive washings or extractions following one another relatively quickly. We have discovered, however, that in dealing with at least certain materials, the time element is an important factor in attaining complete extraction; in other words, it is desirable between successive washings to permit the material to steep or soak in the extract or solvent, as the case may be, for a greater or less time, and when this is done, fewer washings will obtain a given degree of extraction, or, with the same number of washings, a more perfect degree of extraction may be obtained. Not only is this true, but if in addition the material and solvent be mixed mechanically while soaking between washings, or extractions, the effect is increased, this being due undoubtedly to the more rapid diffusion of the solvent within the particles of material caused by the stirring. The modified apparatus under consideration accordingly comprises, instead of a single filter drum, a series of such drums (four, 91, 92, 93 and 94 being shown), although the number may be greater or less as desired. These drums are mounted in separate compartments 95, that form sections of a closed tank, the upper portion 96 of which is removable as shown, and may be sealed against escape of vapor by placing water in the lute 97. The material to be extracted is fed in by way of a spout 98 into a hopper 99 which opens into the base of the tank compartment 95 in which is mounted the first drum 91 of the series. The operation of this hopper is identical with that in the previously described construction, and the level of the

mixture within the tank is maintained by means of a regulator 100 similar to the regulator 22 in Fig. 1, and hence not shown in detail. While the tank is divided into compartments for the respective drums these compartments are interconnected by means of pipes 101 (Figs. 4 and 5), so that the same level of liquid is maintained in each. The drums are rotated all in the same direction, as indicated by the arrow in Fig. 4, by means of shaft 102 which extends lengthwise of the tank with one end outside of the same, there to be driven in any suitable manner. This shaft carries pinions 103 which mesh with gears 104 mounted on the shafts of the respective drums, such drums being axially alined in order to permit of this simple driving arrangement. In each compartment, moreover, is a short paddle shaft corresponding to the respective drums, such shafts being driven by sprocket chains 106 from the same shaft that rotates the drums. Likewise associated with each drum is a scraper 107 which operates as the scraper in Fig. 1 to remove the material from the corresponding drum and pass it into a screw conveyer 108, the latter extending through the series of compartments alongside of the drums therein. While such conveyer is thus continuous, the trough in which it runs is provided with openings 109, so that the material received in the conveyer from one drum may be discharged into the compartment of the next adjacent drum. The final discharge end of the conveyer extends without the casing of the inclosing chamber or tank. The shaft 110 of the conveyer screw similarly extends without such casing at the opposite end in order to be connected with suitable driving means, as need not be further explained. In connection with each of the filter drums, there is provided a pump 111 and a separator 112, which serve the same functions as do the corresponding parts of the first-described apparatus. The pumps are operated from the general drive shaft 102 by means of gears 113. The general construction and mode of operation of the individual filter or extractor drums in this modified apparatus are the same as in the case of the single drum in the first described form of the apparatus, each drum comprising an outer surface of filter membrane divided into sections 114 that communicate by way of ports 115 in a commutating valve member 116 with other ports 119—120—121 in a stationary valve member 118. There are, however, (see Fig. 4), only three ports 119, 120 and 121, in the stationary member in the construction under consideration, the two lowermost of which are connected by branched pipe 122 with the intake of the corresponding pump 111, while the remain-

ing port 119 is connected with the air discharge line 123 from the separator 112 into which such pump discharges. An escape valve 124 serves to relieve excessive pressure in this line 112. Port 121 is adapted to communicate only with sections entirely submerged in the mixture of material and extract in the tank compartment, while the other port 120 communicates with those sections of the drum's surface which have just passed above the level of the mixture in question. The branch of pipe 122 connected with this latter port contains a reducing valve 125 so as to cut down the air drawn by the pump, through the portion of the filter not submerged, to a point suitable to the capacity of the pump and the requirements for compressed air to be supplied through pipe 123 and port 119. At the same time it is rendered possible by this device to maintain a suitable degree of suction upon the submerged portion of the drum. It will be understood that this feature of construction can be advantageously incorporated in the case where but a single extractor drum is utilized, as shown in Fig. 1. While the air is thus returned to the same drum through the surface of which it was drawn by the action of the corresponding pump, the separated liquid is led by way of pipe 126 to a point in the same compartment adjacent to the inlet for the material to that compartment, such material being received in the case of the first compartment from the hopper 99, and in the case of each of the succeeding compartments through the respective openings 109 in the conveyer trough as already explained. The point of discharge of these pipes 126 is accordingly close to the paddle shafts 105, so that such incoming material and the liquid may be immediately mixed and the mixture then pass on into the body of the compartment. The end of each such pipe furthermore dips into a small compartment or trap 127 best shown in Fig. 5, one side of which connects with the pipe 101 that joins the adjacent compartments, while its upper portion opens into the tank in which the mixture of extract and material is maintained as described. The fresh solvent is fed in by way of a supply pipe 128, which enters the last of the series of compartments near the paddle shaft therein where it is mixed with the nearly extracted material, that is the material which, upon passing around the filter drum in said compartment, is finally discharged from the extractor through the conveyer 108. The flow of the fresh solvent through pipe 128 is controlled by a hydrostatic regulating device 129 interposed in the liquid discharge pipe 126 from the separator in the second compartment, such device including a float 130 that operates a valve 131 in the same fashion as the float 42 operates the valve 45 in the apparatus of Fig. 1. The foregoing description is believed to afford a sufficient basis for an understanding of the mode of operation of this modified apparatus. A supply of material to be extracted is maintained in the hopper 99 that opens into the first of the series of compartments, while fresh solvent is fed in by way of the pipe 128 through the regulating device 129 to the last of such series of compartments near the paddle shaft in said compartment. The fresh solvent thus supplied, after being mixed with the nearly extracted material as already described, and being filtered therefrom by the continuous filtering action of the extractor drum in such last compartment, is returned to the small chamber or trap 127 in said compartment. Only a portion of this solvent, or extract as it may properly be called, since it now carries a small proportion of the soluble, is passed on to the next compartment, because the volume of extract sucked through the filter drum in any compartment is greater than the volume of solvent fed into that compartment and only as much extract passes on to the next compartment as corresponds to the solvent feed. The last preceding observation will apply to the quantity of extract drawn through each of the succeeding filters, such quantity being greater than the flow of extract to the respective compartments from the one next adjacent thereto. A certain proportion of the weak extract obtained by the operation in this last compartment, will, however, flow over into the next where it is mixed with the material being discharged into said compartment from the conveyer 108 and is then filtered in turn on the drum in said compartment. This operation continues, stage by stage, until the first compartment in the series is reached, where the fresh material is received into the system. This material will hence obviously be mixed with the strongest extract, so that such extract as is finally discharged from this compartment, after being filtered through the drum, is of approximately the full desired strength. The rate at which this discharge takes place is controlled by the regulator 100 in the same fashion as is the discharge from the last separator in the previously described apparatus controlled by regulator 22, the surplus extract passing out through an overflow pipe 132 at a rate equivalent to that at which the fresh solvent is supplied through pipe 128. The treatment of the extract thus finally passing from the extracting apparatus through this pipe as well as the treatment of the material discharged from conveyer 108 is of course the same in this as in the previously described apparatus, and need not be

touched upon further. In the case of this modified construction of apparatus, as in the case of the first described form, it has not been deemed essential to show minor details of construction. Thus the valve mechanism shown in Fig. 4 is diagrammatic for the sake of clearness just as in the case of the valve mechanism associated with the extractor in Fig. 1. In Fig. 5 the valve mechanism is shown as it may be conveniently, although not necessarily, arranged, the stationary take-off valve 118 being of ring form slidably mounted on the drum shaft and in slidable contact with the end face of the drum through which open the passages that connect with the several sections of the cylindrical filter surface of the drum. This stationary take-off valve may be held against rotation in any convenient manner and kept in proper contact with the drum face by means of spring pressure or otherwise as described.

The advantages of the modified construction and course of procedure involved in the use of the apparatus shown in Figs. 3, 4 and 5 are numerous, but will be only briefly set forth. In the first place the soluble substance in the material being treated is given ample time between extractions to diffuse and dissolve in the solvent in the series of pools or puddles that are in effect formed by the successive intermixtures, this action being assisted by the mechanical stirring which such mixtures receive. The size of the filter drums can be made much smaller than in an apparatus of the type illustrated in Fig. 1 for yielding a given output. Moreover, the several drums are desirably separately mounted as shown, and thus any one of them may be quickly removed in case of necessity, and a spare drum quickly put in its place, all the drums of course being interchangeable. Accordingly, only a short shut-down would be occasioned by an accident to any one of the drums, and this is a very important consideration in a continuous process like the one described. In this modified apparatus, finally, all the pumps, pipes, separators and other fittings associated with the extractor are inclosed within the casing that incloses the filter drums, thus retaining and saving any solvent, whether liquid or vaporized, that may escape by reason of leaky joints. It will be understood, of course, that the number of washings of the layer of material on any particular drum in this last described apparatus may be increased above that shown as being provided for. As this would involve an arrangement in connection with each of the drums similar in all particulars to that illustrated in Fig. 1, it has not been deemed necessary to separately illustrate this modification in construction.

In each of the several forms of apparatus

hereinbefore considered, it will be observed that the material to be treated is caused to pass in a layer of any desired thickness on a continuously moving filter surface, whereon it is treated with and separated from the solvent one or more times, such solvent being caused to pass through the material on the filter in a current whose general direction of flow is opposite to that of the material. In this manner the untreated material is first treated with solvent containing a relatively large amount of extracted substance, then with solvent containing a less amount, and finally with fresh solvent, whereby a thorough extraction of the material and the production of an extract high in extracted matter are obtained. The successive encounters of the solvent with the material being treated occur in the case of the individual rotary extractor or filter while the material is moving with its component particles substantially at rest with respect to each other, and it is to be noted that the order of the successive encounters or contacts of the solvent with the material is opposite to the direction of movement of the latter. Similarly, in the case of the modified apparatus illustrated in Figs. 3, 4 and 5 where a series of intermixing and separating steps occur, the order of the successive encounters of the solvent here with the material is opposite to the general direction of movement of the latter through the apparatus regarded as an entirety. For convenience we may speak of the general directions of flow of the currents of solvent and material which thus encounter each other intermittently as being opposite, it being understood that the reference is to the order of the successive encounters of the solvent with the material in relation to the direction of movement of the latter.

Among the advantages of the process may be enumerated its automatic and continuous character. The weight of material and solvent in process, moreover, is small, in fact is relatively very small compared with other extraction processes in which "percolators" are used to work the material in batches. Accordingly, the capacity of the apparatus is very considerably greater for the same investment and weight than with the percolator system. It is possible to reduce the solvent loss to a minimum, as also to employ for such solvent carbon tetrachlorid which has not heretofore been successfully used in commercial practice. As has been pointed out, among other things, it is desirable, where this particular solvent is employed in working feed materials, to completely deodorize the extracted material where, as in the case of seed meals, such extracted material is to be subsequently employed for stock feed or the like.

As indicated on the diagrammatic Fig.

2, the material to be treated is regarded as being made up of a soluble and an insoluble part or component. The action of the solvent on such material is to take up such soluble component of the material being treated, forming a solution, or extract, from which the solvent is finally distilled off, leaving the oil or other extracted substance behind. The residual or insoluble material is that substantially free of oil, etc., the solvent absorbed therein being recovered as fully set forth in the preceding description. The fresh solvent is that which is thus recovered from the extracted material and from the distillation step, or from other outside sources, and is admitted to the extractor in regulated quantity, as has likewise been set forth. Except as thus initially admitted to the extractor, the solvent, it will be understood, is not a fresh or pure solvent, but contains extracted substance in solution in an amount depending upon the number of times it has come into contact with the material being treated, and other considerations. The solvent, once admitted to the system, remains in circulation, being used over and over again. Such solvent, it will further be observed, flows in a substantially closed circuit, the current being, indeed, divided or branched after leaving the extractor, some, containing the dissolved constituents of the material, going in one direction, and some, absorbed in the residue, going in another direction, but such branched currents are united into one current again in passing through the extraction stage, as shown in Fig. 2. Accordingly the term "closed circuit" may be properly applied to such solvent flow, and this despite the fact that the solvent may be in the state of a vapor in certain portions of such circuit.

In conclusion it should be explained that the term, solvent, as herein used, is not to be understood as necessarily to connote only the fluid solvent employed in our improved process, but it may also refer to such solvent with more or less of the substance to be extracted carried in solution therein, according as the context may demand. Similarly, the term, air, is meant to connote either atmosphere air, or any other gaseous body; or it may refer to the solvent in vaporized state; or to a mixture of such air or other gaseous body with such solvent vapor. The effect of the closed chamber in which the extraction process proper takes place, is to restrict this air, whatever its specific character, which may come in contact with the solvent by reason of the exposure of the latter in the chamber to such air, to a substantially particular limited body. It is furthermore appropriate in this connection, to refer to the fact that in the case of the steamer chamber in which the material dis-

charged from the extractor proper is treated, as well as in the case of the distillation column in which the final extract is treated, the thermostatic device may be arranged to control the supply of material or of extract to the particular apparatus in question, as the case may be, instead of the supply of steam to such apparatus. In other words, the object is to maintain a suitable ratio between the rate of supply of steam and material or extract, so as to regulate the degree to which the solvent in such material or extract may be recovered therefrom by maintaining a constant temperature of the mixture of solvent vapor and steam at some selected point in the vapor current passing upwardly through such apparatus.

It should be noted that the claims in the present case are restricted to the method or process aspect of the invention, claims to the apparatus having been divided out and presented in a separate application filed December 24, 1914, Serial No. 878,840. Other features of the invention which have been required to be divided out and separately presented are the method of and apparatus for regulating the supply of solvent to the mixture in the extractor chamber, such method and apparatus forming subject matter of our co-pending application filed December 24, 1914, Serial No. 878,839; and the method of separating volatile constituents illustrated in the operation of the steamer 52 and the distillation column 66, which forms the subject matter of co-pending application filed December 21, 1914, Serial No. 878,827.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the steps herein disclosed, provided the steps stated by any of the following claims or the equivalent of such stated steps be employed.

We therefore particularly point out and distinctly claim as our invention:—

1. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in causing a continuous current of the material, and a current of solvent flowing in a closed circuit, to encounter each other intermittently; and at one point in such current of solvent separating out from the same any dissolved constituents of such material.

2. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in causing a continuous current of the material, and a current of solvent flowing in a closed circuit, to encounter each other intermittently, the order of the successive encounters of the solvent with the material being opposite to the direction of flow of the latter; and at one point in

such current of solvent separating out from the same any dissolved constituents of such material.

3. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in causing a continuous current of the material, and a current of solvent flowing in a closed circuit, to encounter each other intermittently; at one point in such current of solvent separating out from the same any dissolved constituents of such material; and restricting the air that may come in contact with the solvent to a substantially particular limited body.

4. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in causing a continuous current of the material, and a current of solvent flowing in a closed circuit, to encounter each other intermittently, the order of the successive encounters of solvent with the material being opposite to the direction of flow of the latter; at one point in such current of solvent separating out from the same any dissolved constituents of such material; and restricting the air that may come in contact with the solvent to a substantially particular limited body.

5. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in causing a continuous current of the material and a current of solvent flowing in a closed circuit to encounter each other intermittently in a closed chamber, whereby the air that comes in contact with the solvent is limited to a substantially particular limited body, substantially as described.

6. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in maintaining a continuous current of the material; circulating a body of fluid solvent; and at intervals passing said solvent through said material so as to wash the latter, the general direction of flow of the solvent, as it thus passes through said material, being opposite to that of such current of material.

7. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in maintaining a continuous current of the material; circulating a body of solvent; at intervals passing said solvent through said material so as to wash the latter, the general direction of flow of the solvent, as it thus passes through said material, being opposite to that of such current of material; and restricting the air that may come in contact with said solvent to a substantially particular limited body.

8. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in maintaining a continuous current of the material; circulating a body of solvent in a closed circuit; and at intervals passing said solvent through said material on a suitable filter, the general direction of flow of said solvent, as it thus passes through said material, being opposite to that of such current of material.

9. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in continuously moving said material in one general direction, supported on a filter surface; circulating a body of fluid solvent in a closed circuit, such solvent in a portion of its circuit flowing in a generally opposite direction from such material; and at intervals passing such oppositely flowing solvent through said material while supported on such filter surface.

10. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in continuously moving said material in one general direction, supported on a filter surface; circulating a body of fluid solvent, such solvent in a portion of its circuit flowing in a general opposite direction from such material; at intervals passing such oppositely flowing solvent through said material while supported on such filter surface; and restricting the air that may come in contact with such solvent to a substantially particular limited body.

11. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in moving said material, supported on the surface of a rotary filter; at intervals passing a fluid solvent through said material while thus supported and restricting the air that may come in contact with the solvent being restricted to a substantially particular limited body.

12. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in supporting said material on a continuously moving filter surface; at intervals passing a fluid solvent through said material while thus supported; and limiting the air that comes in contact with the solvent to a substantially particular body, substantially as described.

13. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in supporting said material on a filter surface continuously rotating in the same direction; maintaining a current of fluid

solvent flowing in a generally opposite direction; at intervals passing said solvent through said material while thus supported; and limiting the air that comes in contact with the solvent to a substantially particular body, substantially as described.

14. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in mixing the material with a fluid solvent; separating such solvent and material by filtration; and mechanically displacing residual solvent from said material with air.

15. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in causing currents of the material and a fluid solvent whose general directions of flow are opposite to encounter each other intermittently; and mechanically displacing residual solvent from said material with air after each encounter.

16. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in maintaining currents of said material and a fluid solvent, respectively, flowing in general opposite directions; at intervals washing said material with said solvent; and mechanically displacing residual solvent from said material with air after each such washing.

17. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in maintaining currents of said material and a fluid solvent, respectively, flowing in general opposite directions; at intervals passing said fluid solvent through said material on a suitable filter; and passing a current of air through said material after thus passing said solvent therethrough.

18. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in moving said material, supported on a filter surface; at intervals passing a fluid solvent through said material while thus supported; and passing a current of air through said material after thus passing said solvent therethrough.

19. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in moving said material in one general direction, supported on a filter surface; maintaining a current of fluid solvent flowing in a generally opposite direction; at intervals passing said solvent through said material while thus supported; and passing a current of air through said material after thus passing said solvent therethrough.

20. The method of separating the more soluble constituents of a material from the

less soluble constituents thereof, which consists in causing currents of the material and a fluid solvent whose general directions of flow are opposite to encounter each other intermittently; and mechanically displacing residual solvent from said material after each encounter with the same air used over and over again.

21. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in maintaining currents of said material and a fluid solvent, respectively, flowing in general opposite directions; at intervals washing said material with said solvent; and mechanically displacing residual solvent from said material after each such washing with the same air used over and over again.

22. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in maintaining currents of said material and a fluid solvent, respectively, flowing in general opposite directions; at intervals passing said fluid solvent through said material on a suitable filter; and passing a current of air which has previously been so used through said material after thus passing said solvent therethrough.

23. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in moving said material, supported on a filter surface; at intervals passing a fluid solvent through said material while thus supported; and passing a current of the air which has previously been so used through said material after thus passing said solvent therethrough.

24. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in moving said material in one general direction, supported on a filter surface; maintaining a current of fluid solvent flowing in a generally opposite direction; at intervals passing said solvent through said material while thus supported; and passing a current of the air which has previously been so used through said material after thus passing said solvent therethrough.

25. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; and causing a current of solvent to encounter such moving material.

26. The method of separating the more

soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; and causing a current of solvent to encounter such moving material a plurality of times.

27. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; and causing a current of solvent to encounter such moving material a plurality of times, the order of the successive encounters of the solvent with the material being opposite to the direction of movement of the latter.

28. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; causing a current of solvent to encounter such moving material; intermixing the solvent with content of dissolved material resulting from such encounter, with more material to be treated; and so on as before.

29. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; causing a current of solvent to encounter such moving material a plurality of times; intermixing the solvent with content of dissolved material resulting from the last of such encounters, with more material to be treated; and so on as before.

30. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with re-

spect to each other; causing a current of solvent to encounter such moving material a plurality of times, the order of the successive encounters of the solvent with the material being opposite to the direction of movement of the latter; intermixing the solvent with content of dissolved material resulting from the last of such encounters, with more material to be treated; and so on as before.

31. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; and causing a current of fresh solvent to encounter such moving material.

32. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; and causing a current of fresh solvent to encounter such moving material a plurality of times.

33. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; and causing a current of fresh solvent to encounter such moving material a plurality of times, the order of the successive encounters of such current of solvent with the material being opposite to the direction of movement of the latter.

34. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; causing a current of fresh solvent to encounter such moving material; adding the solvent with content of dissolved material resulting from such encounter to the body

of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

35. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; causing a current of fresh solvent to encounter such moving material a plurality of times; adding the solvent with content of dissolved material resulting from the last of such encounters to the body of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

36. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; causing a current of fresh solvent to encounter such moving material a plurality of times, the order of the successive encounters of the solvent with the material being opposite to the direction of movement of the latter; adding the solvent with content of dissolved material resulting from the last of such encounters to the body of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

37. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; recovering the solvent from such extract; and causing a current of such recovered solvent to encounter such moving material.

38. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its

component particles substantially at rest with respect to each other; recovering the solvent from such extract; and causing a current of such recovered solvent to encounter such moving material a plurality of times.

39. The method of continuously separating the more soluble constituents of material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; recovering the solvent from such extract; and causing a current of such recovered solvent to encounter such moving material a plurality of times, the order of the successive encounters of such current of recovered solvent with the material being opposite to the direction of movement of the latter.

40. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; recovering the solvent from such extract; causing a current of such recovered solvent to encounter such moving material; adding the solvent with content of dissolved material resulting from such encounter to the body of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

41. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; recovering the solvent from such extract; causing a current of such recovered solvent to encounter such moving material a plurality of times; adding the solvent with content of dissolved material resulting from the last of such encounters to the body of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

42. The method of continuously separating the more soluble constituents of a ma-

terial from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other; recovering the solvent from such extract; causing a current of such recovered solvent to encounter such moving material a plurality of times, the order of the successive encounters of such current of recovered solvent with the material being opposite to the direction of movement of the latter; adding the solvent with content of dissolved material resulting from the last of such encounters to the body of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

43. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other, and then discharging the same; recovering the solvent from such extract and discharged material; and causing a current of such recovered solvent to encounter such moving material.

44. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other, and then discharging the same; recovering the solvent from such extract and discharged material; and causing a current of such recovered solvent to encounter such moving material a plurality of times.

45. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter with its component particles substantially at rest with respect to each other, and then discharging the same; recovering the solvent from such extract and discharged material;

and causing a current of such recovered solvent to encounter such moving material a plurality of times, the order of the successive encounters of such current of recovered solvent with the material being opposite to the direction of movement of the latter.

46. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter, with its component particles substantially at rest with respect to each other, to a point of discharge; recovering the solvent from such extract and discharged material; causing a current of such recovered solvent to encounter such moving material; adding the solvent with content of dissolved material resulting from such encounter to the body of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

47. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter, with its component particles substantially at rest with respect to each other, to a point of discharge; recovering the solvent from such extract and discharged material; causing a current of such recovered solvent to encounter such moving material a plurality of times; adding the solvent with content of dissolved material resulting from the last of such encounters to the body of solvent in the first step; intermixing more material to be treated with such body of solvent; and so on as before.

48. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a body of suitable solvent; thereupon separating the extract, consisting of such solvent with its content of dissolved material, from the undissolved portion of such material; moving the latter, with its component particles substantially at rest with respect to each other, to a point of discharge; recovering the solvent from such extract and discharged material; causing a current of such recovered solvent to encounter such moving material a plurality of times, the order of the successive encounters of such current of recovered solvent with the material being opposite to the direction

of movement of the latter; adding the solvent with content of dissolved material resulting from the last of such encounters to the body of solvent in the first step; inter-

5 mixing more material to be treated with such body of solvent; and so on as before.

49. In an extraction process using a volatile solvent, the steps which consist in supporting a continuous current of the material on a moving filter surface; continuously

10 treating such current of material with a current of the solvent, thereby producing an extract and leaving the material spent; recovering solvent from the extract; return-

15 ing such recovered solvent to the current used in treating the material; and restricting the air which may come into contact with the solvent in the foregoing steps to a substantially particular limited amount.

50. In an extraction process using a volatile solvent, the steps which consist in supporting a continuous current of the material on a moving filter surface; continuously

20 treating such current of material with a current of the solvent, thereby producing an extract and leaving the material spent; recovering solvent from the spent material; returning such recovered solvent to the current used in treating the material; and restricting the air which may come into

25 contact with the solvent in the foregoing steps to a substantially particular limited amount.

51. In an extraction process using a volatile solvent, the steps which consist in supporting a continuous current of the material on a moving filter surface; continuously

30 treating such current of material with a current of the solvent, thereby producing an extract and leaving the material spent; recovering solvent from the extract and spent material; returning such recovered solvent to the current used in treating the material; and restricting the air which may come into

35 contact with the solvent in the foregoing steps to a substantially particular limited amount.

52. In a method of the character described, the steps which consist in mixing a supply of the material to be treated with

40 a fluid solvent containing the extracted substance; drawing a layer of the resulting mixture onto a movable filter, whereby such solvent is separated from the material; and subsequently passing fresh solvent through the material on said filter.

53. In a method of the character described, the steps which consist in simultaneously and continuously mixing a supply of the untreated material with a fluid

45 solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto the surface of a rotary filter drum, whereby such solvent is continuously separated from the material; and then passing solvent containing a rela-

tively smaller amount of such substance than the solvent used in the first step through the material on said filter.

54. In a method of the character described, the steps which consist in simultaneously and continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substances; drawing a layer of the resulting mixture onto the surface of a rotary filter drum, whereby such solvent is continuously separated from the material; and then passing solvent containing a relatively smaller amount of such substance than the solvent used in the first step through the material on said filter, the solvent from such last described step being mixed with the material in the first described step.

55. In a method of the character described, the steps which consist in simultaneously and continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto the surface of a rotary filter drum, whereby such solvent is continuously separated from the material; passing solvent containing a relatively smaller amount of such substance than the solvent used in the first step through the material on said filter; and then passing fresh solvent therethrough.

56. In a method of the character described, the steps which consist in simultaneously and continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto the surface of a rotary filter drum, whereby such solvent is continuously separated from the material; passing solvent containing a relatively smaller amount of such substance than the solvent used in the first step through the material on said filter; and then passing fresh solvent therethrough, the solvent from the next to last described step being mixed with the material in the first described step.

57. In a method of the character described, the steps which consist in feeding the material to be treated into a mixture of fluid solvent and previously fed material; drawing a layer of the resulting mixture by suction onto a movable filter surface, whereby such solvent is in part separated from the material; and then drawing a current of air through such layer, thereby mechanically displacing residual solvent.

58. In a method of the character described, the steps which consist in continuously feeding a supply of the material to be treated into a mixture of fluid solvent and previously fed material; drawing a layer of the resulting mixture by suction onto the surface of a rotary filter, whereby such

solvent is continuously separated from the material; and continuing the suction to thereupon draw a current of air through such layer, thereby mechanically displacing residual solvent.

59. In a method of the character described, the steps which consist in mixing the material to be treated with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter surface, whereby such solvent is in part separated from the material; and then drawing a body of air through such layer over and over again, thereby mechanically displacing residual solvent.

60. In a method of the character described, the steps which consist in continuously mixing a supply of the material to be treated with a fluid solvent; drawing a layer of the resulting mixture by suction onto the surface of a rotary filter, whereby such solvent is continually separated from the material; continuing the suction to thereupon draw a current of air through such layer, thereby displacing residual solvent and limiting the air thus used, so that substantially the same air will be used over and over for this purpose.

61. In a method of the character described, the steps which consist in continuously feeding a supply of the untreated material into a mixture of fluid solvent and previously fed material; drawing a layer of the resulting mixture by suction onto a movable filter surface, whereby such solvent is in part separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; and subsequently drawing fresh solvent, and air through such layer by suction.

62. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter surface, whereby such solvent is in part separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; subsequently drawing fresh solvent, and air through such layer by suction and limiting the air thus used, so that substantially the same air will be used over and over again for this purpose.

63. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto a moving filter surface, whereby such solvent is continuously separated from the material; continuing such action to draw a current of air through such layer, thereby

displacing residual solvent; then drawing solvent and air again through such layer by suction, such latter solvent containing a relatively smaller amount of such substance than the solvent used in the first step and limiting the air thus used, so that substantially the same air will be used over and over again.

64. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto a moving filter surface whereby such solvent is continuously separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; then drawing solvent and air again through such layer by suction, such latter solvent containing a relatively smaller amount of such substance than the solvent used in the first step, limiting the air thus used, so that substantially the same air will be used over and over again; and using the solvent from such last-described step to mix with the material in the first described step.

65. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto a rotating filter surface whereby such solvent is continuously separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; then drawing solvent and air again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent resulting therefrom being used in the preceding suction step and then, finally, mixed with the material in the first described step, and limiting the air thus used, so that substantially the same air will be used over and over again.

66. In a method of the character described, the steps which consist in mixing the material to be treated with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter surface whereby such solvent is separated from the material; continuing the suction to thereupon draw a current of air through such layer, thereby displacing residual solvent; and then blowing the same air through such layer in the opposite direction to free the latter from the filter surface.

67. In a method of the character described, the steps which consist in continuously mixing a supply of the material to be treated with a fluid solvent; drawing a layer of the resulting mixture by suction onto a

rotating filter surface whereby such solvent is continuously separated from the material; continuing the suction to thereupon draw a current of air through such layer, thereby displacing residual solvent; separating the air and solvent thus drawn through such layer; and then blowing the separated air through such layer in the opposite direction to free the latter from the filter surface.

68. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter surface, whereby such solvent is in part separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; subsequently drawing fresh solvent and air through such layer by suction; separating the air and solvent drawn through such layer in the foregoing steps; and then blowing the separated air through such layer in the opposite direction to free the latter from the filter surface.

69. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto a rotating filter surface whereby such solvent is continuously separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; then drawing solvent and air again through such layer by suction, such latter solvent containing a relatively smaller amount of such substance than the solvent used in the first step; separating the air and solvent drawn through such layer in the foregoing steps; and then blowing the separated air through such layer in the opposite direction to free the latter from the filter surface.

70. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto a rotating filter surface whereby such solvent is continuously separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; then drawing solvent and air again through such layer by suction, such latter solvent containing a relatively smaller amount of such substance than the solvent used in the first step; using the solvent from such last described step to mix with the material in the first described step; separating the air and solvent drawn through such layer in the foregoing steps; and then blowing the separated air through

such layer in the opposite direction to free the latter from the filter surface.

71. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto a rotating filter surface whereby such solvent is continuously separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; then drawing solvent and air again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent resulting therefrom being used in the preceding suction step and then, finally, mixed with the material in the first described step; separating the air and solvent drawn through such layer in the foregoing steps; and then blowing the separated air through such layer in the opposite direction to free the latter from the filter surface.

72. In a method of the character described, the steps which consist in continuously mixing a supply of the untreated material with a fluid solvent containing a certain amount of the extracted substance; drawing a layer of the resulting mixture onto a rotating filter surface whereby such solvent is continuously separated from the material; continuing such suction to draw a current of air through such layer, thereby displacing residual solvent; then drawing solvent and air again through such layer by suction, a plurality of times, fresh solvent being used the last time and the solvent resulting therefrom being used in the preceding suction step and then, finally, mixed with the material in the first described step; independently separating the air and solvent drawn through such layer in foregoing steps, respectively, and then collecting the air from such separations and blowing the same through such layer in the opposite direction to free the latter from the filter surface.

73. In an extraction process, the steps which consist in maintaining a mixture of material and fluid solvent in a closed chamber; drawing a layer of such mixture by suction onto the surface of a filter movable within said chamber, whereby solvent is separated from the material; then raising the filter surface, with such layer of material, above the mixture; finally removing such layer from such surface and discharging the same from said chamber without opening the latter to the outside air; and returning to said chamber any air withdrawn by such suction therefrom, so as to maintain a substantially particular limited body of air therein.

74. In an extraction process, the steps

which consist in maintaining a mixture of material and fluid solvent in a closed chamber; drawing a layer of such mixture by suction onto the surface of a filter movable within said chamber, whereby solvent is separated from the material; then raising the filter surface with such layer of material, above the mixture, and passing fresh solvent through such layer while supported on such surface; finally removing such layer from such surface and discharging the same from said chamber without opening the latter to the outside air; and returning to said chamber any air withdrawn by such suction therefrom, so as to maintain a substantially particular limited body of air therein.

75. In an extraction process, the steps which consist in maintaining a mixture of material and fluid solvent in a closed chamber; drawing a layer of such mixture by suction onto the surface of a filter movable within said chamber, whereby solvent is separated from the material; then raising the filter surface, with such layer of material, above the mixture and drawing air through such layer, thereby displacing residual solvent; finally removing such layer from such surface and discharging the same from said chamber without opening the latter to the outside air; and returning to said chamber any air withdrawn by such suction therefrom, so as to maintain a substantially particular limited body of air therein.

76. In an extraction process, the steps which consist in maintaining a mixture of material and fluid solvent in a closed chamber; drawing a layer of such material by suction onto the surface of a filter movable within said chamber, whereby solvent is separated from the material; then raising the filter surface, with such layer of material, above the mixture; alternately drawing air through such layer, thereby displacing residual solvent, and passing fresh solvent through such layer; and finally removing such layer from such surface and discharging the same from said chamber.

77. In a continuous extraction process, the steps which consist in maintaining a mixture of material and fluid solvent in a closed chamber; continuously drawing a layer of such mixture by suction onto the surface of a filter moving in said chamber, whereby solvent is separated from the material as the filter surface rises above the mixture; continuously removing such layer from such surface and discharging the same from said chamber without opening the latter to the outside air; and returning to said chamber any air withdrawn by such suction therefrom, so as to maintain a substantially particular limited body of air therein.

78. In a continuous extraction process, the steps which consist in maintaining a mixture of material and fluid solvent in a closed

chamber; continuously drawing a layer of such mixture by suction onto the surface of a filter moving in said chamber, whereby solvent is separated from the material as the filter surface rises above the mixture; passing fresh solvent through such layer while supported on such surface; finally continuously removing such layer from such surface and discharging the same from said chamber without opening the latter to the outside air; and returning to said chamber any air withdrawn by such suction therefrom, so as to maintain a substantially particular limited body of air therein.

79. In a continuous extraction process, the steps which consist in maintaining a mixture of material and fluid solvent in a closed chamber; continuously drawing a layer of such mixture by suction onto the surface of a filter moving in said chamber, whereby solvent is separated from the material as the filter surface rises above the mixture; drawing air through such layer, thereby displacing residual solvent; finally continuously removing such layer from such surface and discharging the same from said chamber without opening the latter to the outside air; and returning to said chamber any air withdrawn by such suction therefrom, so as to maintain a substantially particular limited body of air therein.

80. In a continuous extraction process, the steps which consist in maintaining a mixture of material and fluid solvent in a closed chamber; continuously drawing a layer of such mixture by suction onto the surface of a filter moving in said chamber, whereby solvent is separated from the material as the filter surface rises above the mixture; alternately drawing air through such layer, thereby displacing residual solvent, and passing fresh solvent through such layer; finally continuously removing such layer from such surface and discharging the same from said chamber without opening the latter to the outside air; and returning to said chamber any air withdrawn by such suction therefrom, so as to maintain a substantially particular limited body of air therein.

81. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in forming a moving layer out of a mixture of said material and solvent, in which layer the particles of material are substantially at rest with respect to each other; separating admixed solvent from such layer; and then washing such layer by passing solvent therethrough.

82. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in forming a moving layer out of a mixture of said material and solvent, in which layer the particles of material are

substantially at rest with respect to each other; separating admixed solvent from such layer; and then drawing air through such layer, thereby displacing residual solvent.

83. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in forming a moving layer out of a mixture of said material and solvent, in which layer the particles of material are substantially at rest with respect to each other; separating admixed solvent from such layer; and then alternately drawing air through such layer, thereby displacing residual solvent, and washing such layer by passing solvent therethrough.

84. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in forming a moving layer out of a mixture of said material and solvent, in which layer the particles of material are substantially at rest with respect to each other; separating admixed solvent from such layer; then washing such layer by passing other solvent therethrough and restricting the air that may come in contact with such material and solvent in the foregoing steps to a substantially particular limited body.

85. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in forming a moving layer out of a mixture of said material and solvent, in which layer the particles of material are substantially at rest with respect to each other; separating admixed solvent from such layer; then drawing air through such layer, thereby displacing residual solvent and restricting the air that may come in contact with such material and solvent in the foregoing steps to a substantially particular limited body.

86. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in forming a moving layer out of a mixture of said material and solvent, in which layer the particles of material are substantially at rest with respect to each other; separating admixed solvent from such layer; then alternately drawing air through such layer, thereby displacing residual solvent, and washing such layer by passing solvent therethrough and restricting the air that may come in contact with such material and solvent in the foregoing steps to a substantially particular limited body.

87. In a method of the character described, the steps which consist in mixing a supply of the material with a fluid solvent; drawing a layer of the resulting mixture by suc-

tion onto a movable filter, whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step and then, finally, mixed with the material in the first described step; and automatically regulating the supply of fresh solvent by the proportion of extracted substance in such solvent following one of the foregoing suction steps.

88. In a method of the character described, the steps which consist in mixing a supply of the material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter, whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step and then, finally, mixed with the material in the first described step; and automatically regulating the supply of fresh solvent by the proportion of extracted substance in such solvent following the intermediate suction step.

89. In a method of the character described, the steps which consist in mixing a supply of the material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter, whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step and then, finally, mixed with the material in the first described step; and maintaining the bulk of the mixture substantially constant by returning thereto solvent from the first described suction step.

90. In a method of the character described, the steps which consist in mixing a supply of the material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter, whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step and then, finally, mixed with the material in the first described step; automatically regulating the supply of fresh solvent by the proportion of extracted substance in such solvent

vent following one of the foregoing suction steps; and maintaining the bulk of the mixture substantially constant by returning thereto solvent from the first described suction step.

91. In a method of the character described, the steps which consist in mixing a supply of the untreated material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter, whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step, and then finally, mixed with the material in the first described step; recovering the solvent from the extracted material after the last suction step and from the mixture of solvent and extracted substance resulting from the first described suction step; and returning such recovered solvent to the process as fresh solvent.

92. In a method of the character described, the steps which consist in mixing a supply of the untreated material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter; whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step and then, finally, mixed with the material in the first described step; recovering the solvent from the extracted material after the last suction step and from the mixture of solvent and extracted substance resulting from the first described suction step; returning such recovered solvent to the process as fresh solvent; and automatically regulating the return of such recovered solvent by the proportion of extracted substance in the solvent following one of the foregoing suction steps.

93. In a method of the character described, the steps which consist in mixing a supply of the untreated material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter, whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step and then, finally, mixed with the material in the first described step; recovering the solvent from the extracted material after the last suction step and from the mixture

of solvent and extracted substance resulting from the first described suction step; returning such recovered solvent to the process as fresh solvent; and maintaining the bulk of the mixture of untreated material and solvent substantially constant by returning thereto solvent from the first described suction step.

94. In a method of the character described, the steps which consist in mixing a supply of the untreated material with a fluid solvent; drawing a layer of the resulting mixture by suction onto a movable filter, whereby such solvent is separated from the material; then drawing solvent again through such layer by suction a plurality of times, fresh solvent being used the last time and the solvent containing a certain amount of extracted substance resulting from such last time being used in the preceding suction step and then, finally, mixed with the material in the first described step; recovering the solvent from the extracted material after the last suction step and from the mixture of solvent and extracted substance resulting from the first described suction step; returning such recovered solvent to the process as fresh solvent; automatically regulating the return of such recovered solvent by the proportion of extracted substance in the solvent following one of the foregoing suction steps; and maintaining the bulk of the mixture of untreated material and solvent substantially constant by returning thereto solvent from the first described suction step.

95. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in causing currents of the material and a fluid solvent, whose general direction of flow are opposite, to encounter each other intermittently, and then recovering the solvent from the undissolved and dissolved constituents and restricting the air that may come in contact with the solvent to a substantially particular limited body.

96. In an extraction process involving the separation by means of a filter of undissolved solid matter from the solution of the extracted matter in a volatile solvent, the steps which consist in circulating air in a closed circuit through such filter, and limiting the air thus used to a substantially particular body, substantially as described.

97. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in continuously feeding unextracted material into a mixture of such material and solvent containing extractable matter in solution; continuously feeding to such mixture such solvent containing extractable matter; continuously separating undissolved material and such solvent con-

taining extractable matter in solution from the aforesaid mixture by means of a filter; circulating air in a closed circuit through such filter; and restricting the air thus used to a substantially particular limited body, substantially as described.

98. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in continuously feeding unextracted material into a mixture of such material and solvent containing extractable matter in solution; continuously feeding to such mixture such solvent containing extractable matter, the bulk and consistency of the mixture being maintained substantially constant; continuously separating undissolved material and such solvent containing extractable material from the aforesaid mixture by means of a filter; circulating air in a closed circuit through such filter; and restricting the air thus used to a substantially particular limited body, substantially as described.

99. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in continuously feeding unextracted material into a mixture of such material and solvent containing extractable matter in solution; continuously feeding to such mixture such solvent containing extractable matter, the bulk and consistency of the mixture being maintained substantially constant; continuously separating undissolved material and such solvent containing extractable material from the aforesaid mixture by means of a filter; circulating air in a closed circuit through such filter, and limiting the air thus used to a substantially particular body, substantially as described.

100. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in simultaneously separating undissolved solid material as a layer moving out of a mixture of said material and a solution of the extracted matter in such solvent, recovering the solvent from such solution, and mixing such recovered solvent with additional material to be extracted.

101. In an extraction process wherein the material containing extractable matter is treated with a volatile solvent, the steps which consist in simultaneously separating undissolved solid material as a layer moving out of a mixture of said material and a solution of the extracted matter in such solvent, recovering the residual solvent from the undissolved solid material, and mixing such recovered solvent with addition of material to be extracted.

102. In an extraction process wherein the material containing extractable matter is

treated with a volatile solvent, the steps which consist in simultaneously separating undissolved solid material as a layer moving out of a mixture of said material and a solution of the extracted matter in such solvent, recovering the solvent from such solution and from the undissolved solid material, and mixing such recovered solvent with additional material to be extracted.

103. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently intermixing and thereupon separating a current of the material and a current of solvent, the latter being thus separated by filtration and flowing in a closed circuit.

104. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently intermixing and thereupon separating a current of the material and a current of solvent, the latter being thus separated by filtration and flowing in a closed circuit, and the current of material flowing in a generally opposite direction to that of the solvent.

105. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently intermixing and thereupon separating a current of the material and a current of solvent, the latter being thus separated by filtration and flowing in a closed circuit; and restricting the air that may come in contact with the solvent to a substantially particular limited body.

106. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently intermixing and thereupon separating a current of the material and a current of solvent, the latter being thus separated by filtration and flowing in a closed circuit, and the current of material flowing in a generally opposite direction to that of the solvent; and restricting the air that may come in contact with the solvent to a substantially particular limited body.

107. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently intermixing and thereupon separating a current of the material and a current of solvent, the latter flowing in a closed circuit; and at one point in such current of solvent separating out from the same any dissolved constituents of such material.

108. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently in-

termixing and thereupon separating a current of the material and a current of solvent, the latter flowing in a closed circuit, and the current of material flowing in a generally opposite direction to that of the solvent; and at one point in such current of solvent separating out from the same any dissolved constituents of such material.

109. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently intermixing and thereupon separating a current of the material and a current of solvent, the latter flowing in a closed circuit; and at one point in such current of solvent separating out from the same any dissolved constituents of such material; and restricting the air that may come in contact with the solvent to a substantially particular limited body.

110. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermittently intermixing and thereupon separating a current of the material and a current of solvent, the latter flowing in a closed circuit; and the current of material flowing in a generally opposite direction to that of the solvent; and at one point in such current of solvent separating out from the same any dissolved constituents of such material; and restricting the air that may come in contact with the solvent to a substantially particular limited body.

111. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent, and thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; and separately intermixing the latter with solvent, and thereupon separating such solvent, with its content of dissolved material, from the remaining undissolved portion of such material, the solvent from such last separation step being intermixed with the material in the first step.

112. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing fresh material with a suitable solvent, and thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material; and separately intermixing the latter with fresh solvent, and thereupon separating such solvent, with its content of dissolved material, from the remaining undissolved portion of such material, the solvent from such last separation step being intermixed with the material in the first step.

113. The method of separating the more

soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent, thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material, and moving the latter with its component particles substantially at rest with respect to each other to a point of discharge; separately intermixing such discharged material from the first series of steps with solvent, thereupon separating such solvent, with its content of dissolved material, from the remaining undissolved portion of such material; and causing a current of the solvent from such last series of steps to encounter the moving material in such first series.

114. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing such material with a suitable solvent, thereupon separating such solvent, with its content of dissolved material, from the undissolved portion of such material, and moving the latter with its component particles substantially at rest with respect to each other to a point of discharge; separately intermixing such discharged material from the first series of steps with solvent, thereupon separating such solvent, with its content of dissolved material, from the remaining undissolved portion of such material; and causing a current of the solvent from such last series of steps to encounter the moving material in such first series, such solvent being thereupon intermixed with the material in such first series of steps.

115. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent; drawing out of such mixture by suction a moving layer of material, wherein the component particles are substantially at rest with respect to each other, and a current of solvent containing dissolved constituents; interrupting said current of material and mixing the same with solvent containing less dissolved constituents than that from which it was separated; drawing out of the mixture so obtained a moving layer of material and a current of solvent as before; and adding such last current of solvent to the mixture in the first step.

116. The method of continuously separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent; separating out from such mixture by suction and filtration a moving layer of the undissolved material, wherein the component particles are sub-

stantially at rest with respect to each other, a current of solvent being simultaneously derived by such suction; interrupting said current of material and intermixing it with solvent containing less dissolved constituents than that from which it was separated; separating from the mixture thus obtained a second moving layer of material and a current of solvent; and intermixing such last named current of solvent with material to form the mixture in the first step.

117. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent so as to form a series of pools; separating such material and solvent from the mixtures in such pools, respectively; and transferring such material and solvent to other pools, so as to maintain, in effect, a current of material and a current of solvent.

118. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent so as to form a series of pools; separating such material and solvent from the mixtures in such pools, respectively; and transferring such material and solvent to other pools, so as to maintain, in effect, a current of material and an oppositely flowing current of solvent.

119. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent so as to form a series of pools; separating such material and solvent from the mixtures in such pools, respectively; and transferring such material and solvent to other pools, so as to maintain, in effect, a current of material and an oppositely flowing current of solvent, such current of

solvent flowing in a substantially closed circuit.

120. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent so as to form a series of pools; separating such material and solvent by filtration from the mixtures in such pools, respectively; and transferring such material and solvent to other pools, so as to maintain, in effect, a current of material and a current of solvent.

121. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent so as to form a series of pools; separating such material and solvent by filtration from the mixtures in such pools, respectively; and transferring such material and solvent to other pools, so as to maintain, in effect, a current of material and an oppositely flowing current of solvent.

122. The method of separating the more soluble constituents of a material from the less soluble constituents thereof, which consists in intermixing the material and a suitable solvent so as to form a series of pools; separating such material and solvent by filtration from the mixtures in such pools, respectively; and transferring such material and solvent to other pools, so as to maintain, in effect, a current of material and an oppositely flowing current of solvent, such current of solvent forming a substantially closed circuit.

Signed by us this 4th day of October, 1912.

EDWIN O. BARSTOW.

THOMAS GRISWOLD, JR.

Attested by—

WILL RICHARDSON,

CARL WINKLER.