Feb. 24, 1942. G. M. DARBY 2,274,361

FLOCCULATION

Filed Dec. 21, 1939 4 Sheets-Sheet 1

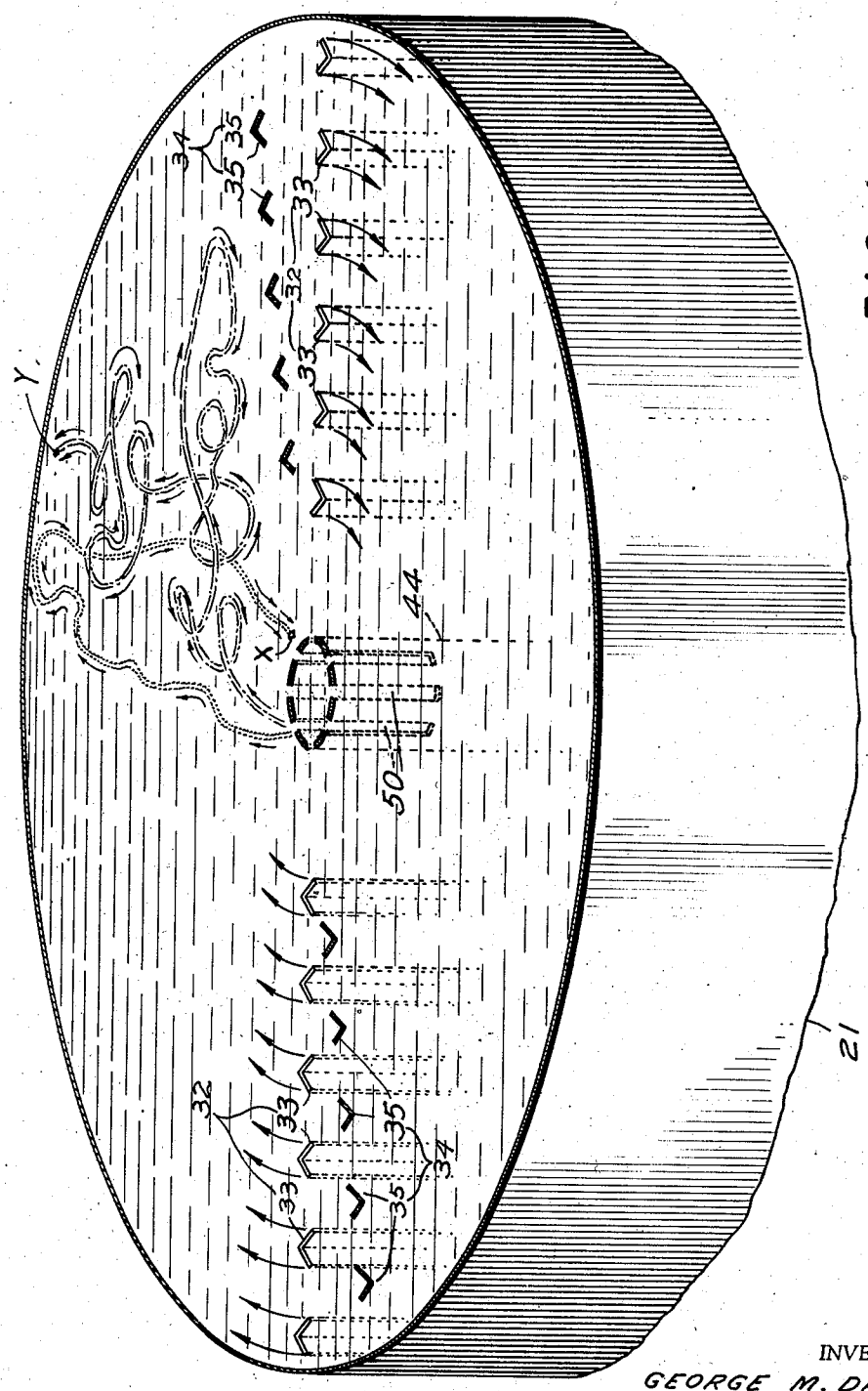


FIG. 1.

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FLOCCULATION

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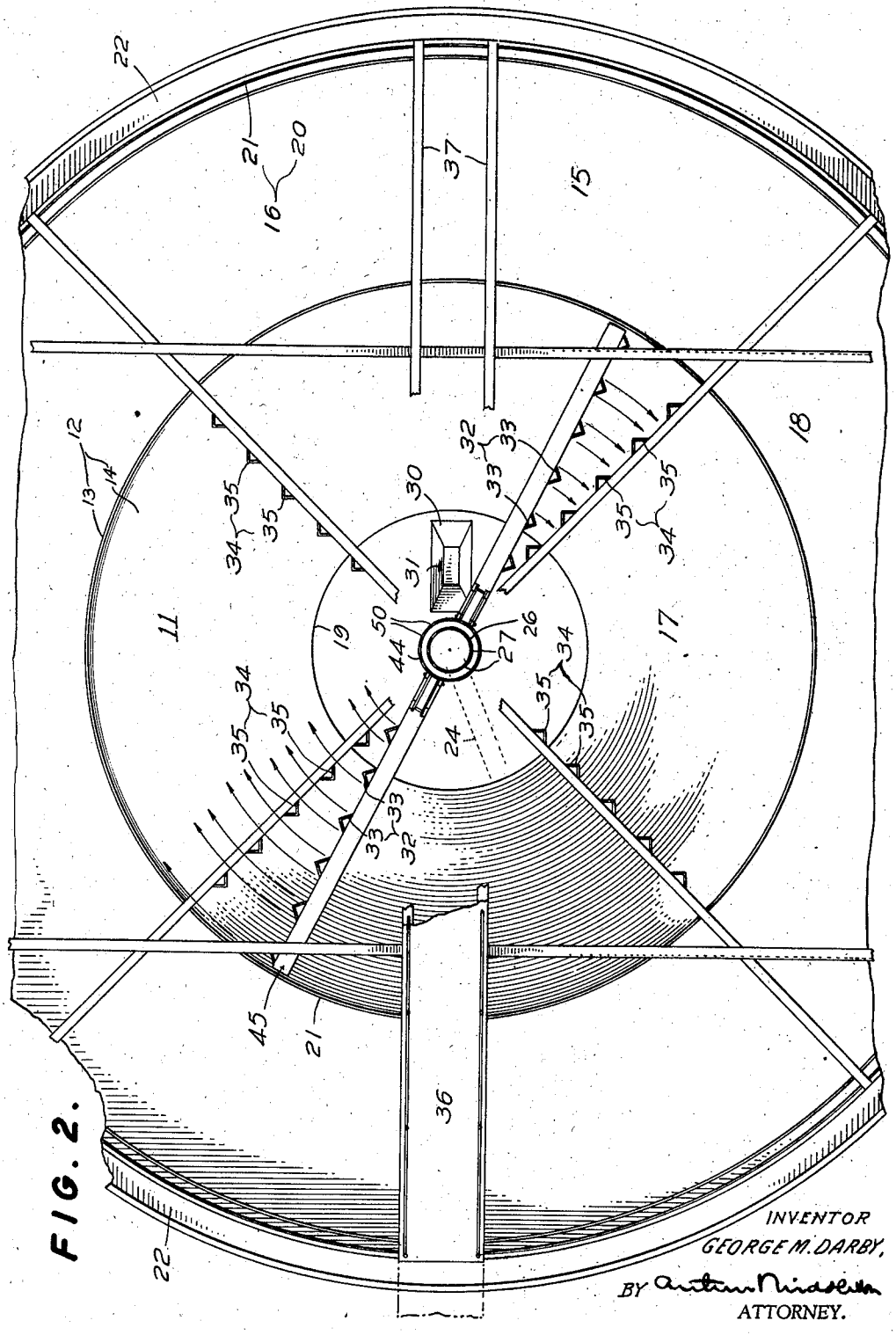


FIG. 2.

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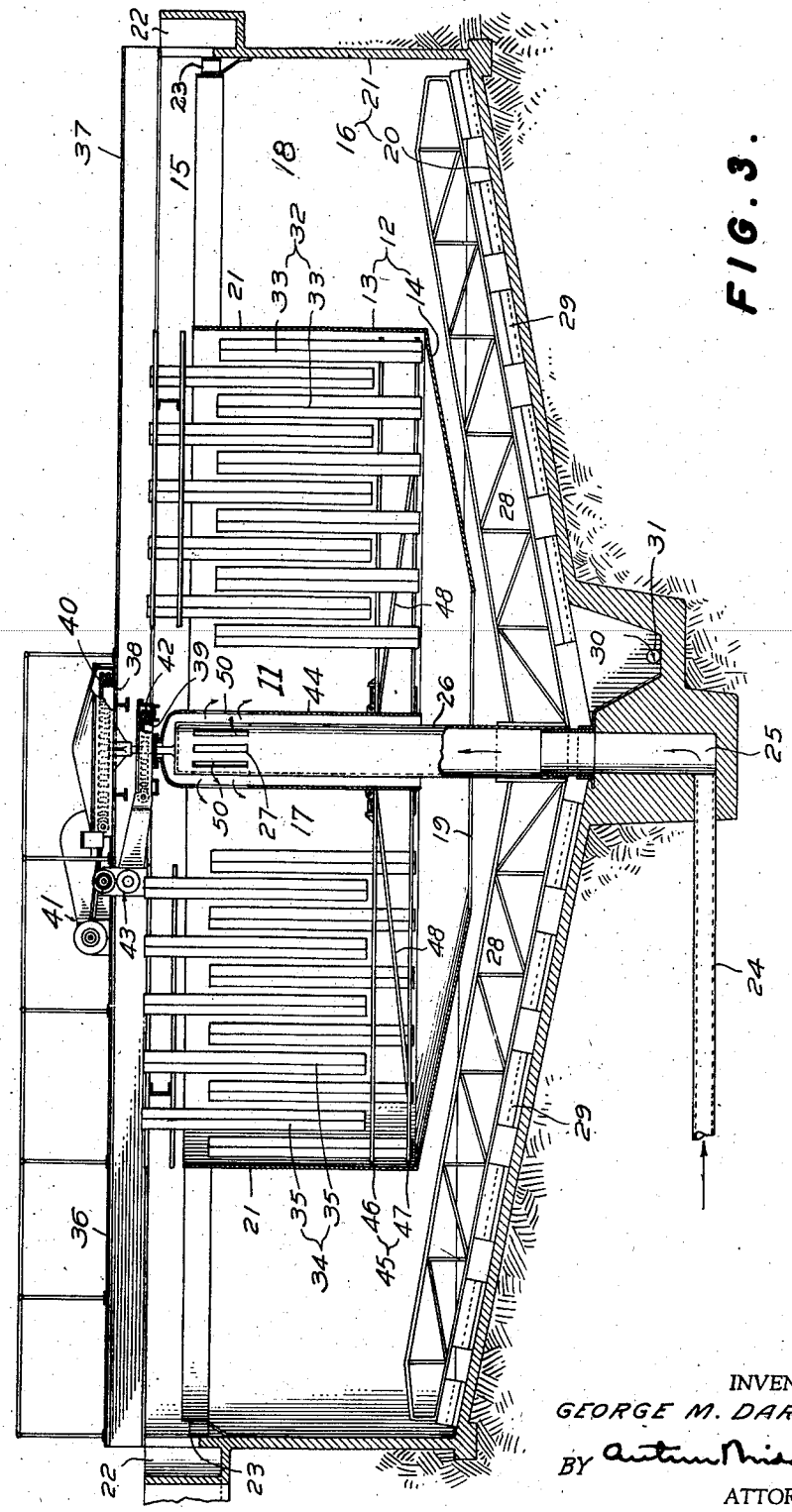


FIG. 3.

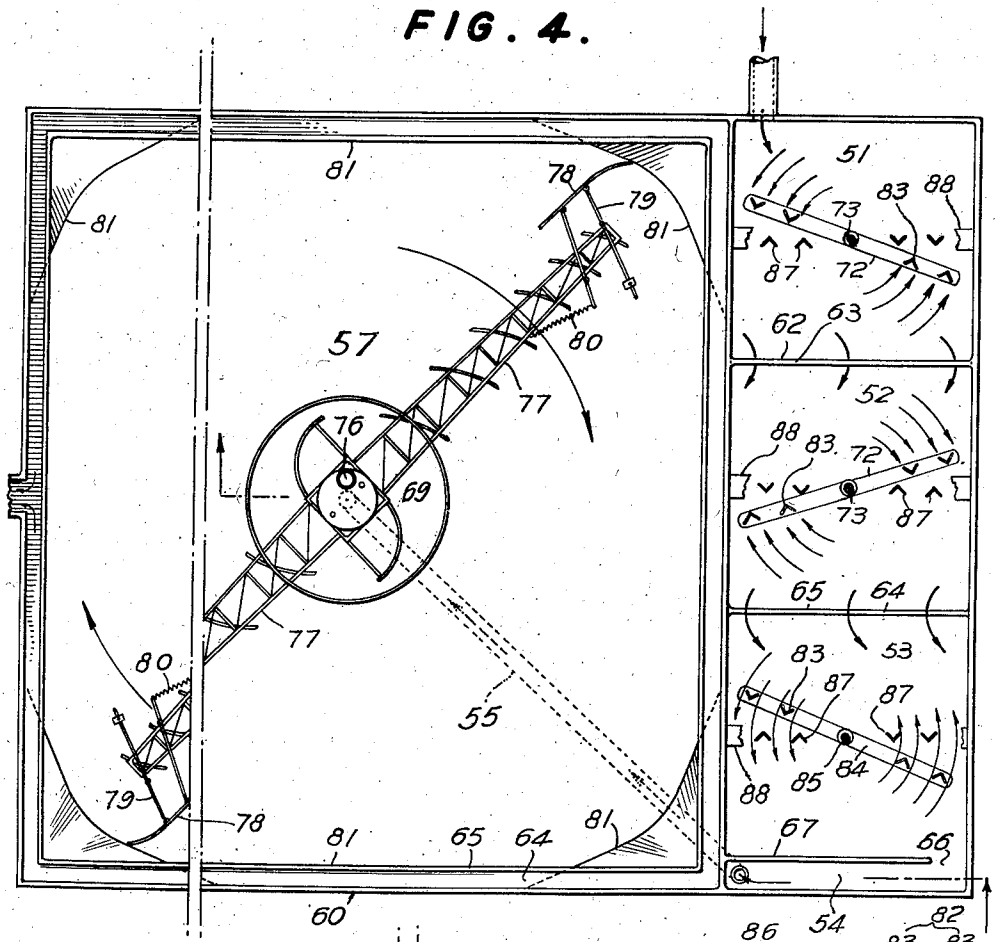
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FLOCCULATION

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FIG. 4.



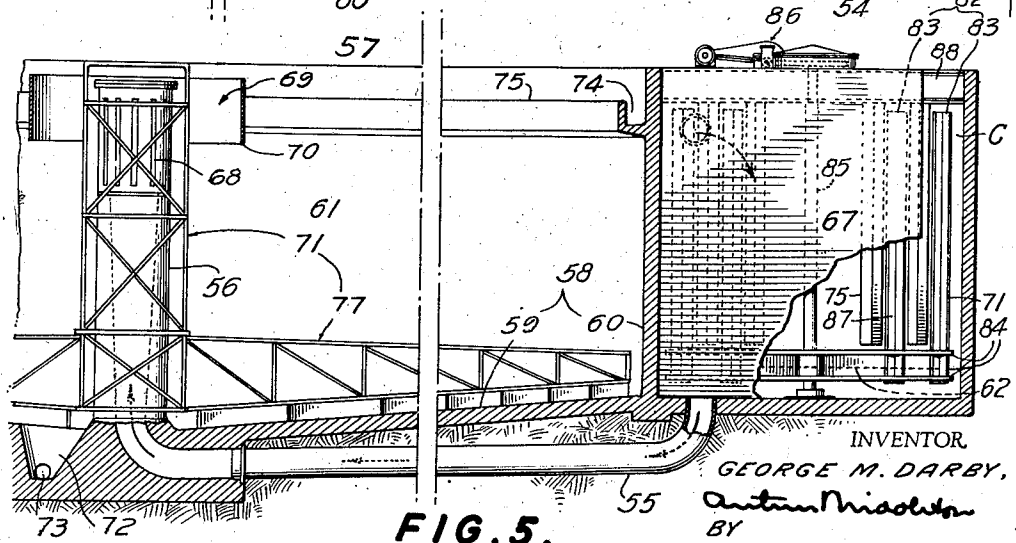


FIG. 5.

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Patented Feb. 24, 1942 2,274,361

UNITED STATES PATENT OFFICE

2,274,361

FLOCCULATION

George M. Darby, Westport, Conn., assignor to The Dorr Company, Inc., New York, N. Y., a corporation of Delaware

Application December 21, 1939, Serial No. 310,373

5 Claims. (Cl. 210—16)

This invention relates to the clarification or purification of liquids and more particularly by a treatment thereof that involves mild agitation conducive to flocculation as a step for facilitating subsequent clarification as by sedimentation.

In Patent No. 2,268,475, granted December 30, 1941, upon the basis of my application Serial No. 297,341, filed on September 30, 1939, there is described a type of flocculation apparatus including (*a*) a structure defining a flocculation station having a feed inlet discharging into one section thereof and an outlet means leading from the opposite section whereby for the body of liquid therein there is a general progressive flow-path and bodily flow movement substantially aligned with the structure; (*b*) primary agitating paddles providing flocculating blades located in a manner to conform substantially to the flow-path of the forwardly moving body of liquid in the station, with each blade disposed at a non-right angle to its forward path of movement, being thus adapted for imposing on liquid encountered thereby an impulse in a lateral and deflective direction away from the blade; and (*c*) secondary and reflector baffles providing flow reflecting blades adapted to be engaged by a quantity of liquid agitated, impelled or deflected by the flocculating blades for causing lateral reflection therefrom or further deflection thereby of the agitated liquid impelled into engagement therewith.

In said patent the primary flocculating blades are shown as vertically disposed and as moving about a vertical axis. Such vertical blades are shown angularly disposed with respect to their path of movement so that suspended particles encountered by the blades were deflected laterally thereof. A technical effect aimed at for that flocculating apparatus when using vertically disposed blades, was to impart a maximum amount of horizontal deflective motion to the suspended particles while effecting a minimum of vertical motion or displacement thereof for this has been found to be far superior in flocculating effectiveness to emphasized vertical deflective motion.

Further investigation has shown, however, that superior flocculative results are obtainable if flocculating blades are made substantially V-shaped in cross-section and are disposed so that the apex of each V is directed toward the direction of movement of its blade. Investigations have also demonstrated that still better results are obtained if the reflector baffles are also V-shaped in cross-section but are oppositely directed as compared with the apexes of the flocculating blades. My blades or baffles which are open V-shape in cross-section may be said to be chevron shaped members. Such movable chevron shaped members or primary flocculating blades are effective only for uni-directional or continuous closed path operation. They are employed in sets and are movable in closed paths about a common axis, as for example, along horizontal paths about a vertically-extending axis common thereto. The chevron shaped reflector or secondary baffles are usually installed in sets as stationary members but it is to be noted that it is feasible to install them in a manner according to which they may move in closed paths about an axis common to the movable primary flocculating blades but in opposite directions with respect to the direction of movement of the flocculating blades.

The basis of the present invention is a member of substantial length that is chevron shaped or open V-shaped in transverse cross-section and the invention is directed to the employment of such members in a flocculating apparatus as flocculating blades or as reflector baffles, and also the utilization of such members in the manner explained herein.

The novel features of the present invention revolve about the employment of such movable flocculating blades in sets of vertically-extending agitating blades which are relied upon for imparting mild agitation to liquid whereby certain advantageous and sought-for results may be obtained incident to the forward horizontal movement of such V blades of which the apex acts as a leading edge.

The invention has in view the employment of such blades in effecting or producing mild or gentle agitation (*a*) conducive to the coagmenting and amassing into settleable flocs and floc colonies of flocculatable material suspended in liquid and undergoing treatment and (*b*) also conducive to the furthering or completing of reacting treatment with respect to liquid which has been chemically or otherwise dosed with material provided for that purpose either prior to or during the agitation treatment.

In flocculation, it is now generally accepted that the speed of any agitating paddles must not exceed 1.5 feet per second. Therefore, with this limitation as to maximum speed, it has become a problem of how to get the maximum number of collisions of particles of turbidity—and the V-shaped blades seem to be the answer.

It is this maximum speed that also justifies

the use of the fixed baffles for they increase the number of collisions. And as compared with the straight blades paddles and baffles of my co-pending application, the open V-shaping of the baffles and paddles of this invention are startlingly effective in inducing an increased number of collisions—all while still maintaining the paddle speed at optimum velocity.

The invention also contemplates and comprehends the employment of such V-shaped blades in sets for agitating liquid undergoing flocculation treatment and the embodiment of sets of such members in apparatus wherein liquid is held while being gently but positively agitated by such blades. The blades are disposed so that the apex portions thereof progressively engage the liquid undergoing treatment during the time the blades are being moved forwardly in and relative to the liquid with the apex portion thereof foremost.

The accompanying drawings, which constitute part of this specification, are illustrative of the features and structural characteristics underlying this invention. The structures illustrated are indicative of the invention, its utility and of its physical embodiment and employment. It will be manifest, however, from that which follows that the underlying characteristics and basic features of the invention can be employed and embodied in diverse manners and in various forms without departing from the spirit and scope thereof.

In the drawings there are illustrated forms of flocculating or agitating apparatus which have thus far proved to be satisfactory and which may be viewed as of preferred types. Nevertheless, the structures illustrated are to be considered as typical of diverse forms by which the invention may be realized.

In said drawings:

Fig. 1 is a perspective and diagrammatic partial view indicative of a transverse section of liquid-holding tank having sets of vertically-extending chevron shaped members including turntable flocculating blades and associated reflector baffles of which the blades repetitively move along closed horizontal paths, of which the apex of each blade leads, and of which the apexes of the baffles are pointed rearwardly with respect to the direction of movement of the blades. The top portion of this figure is illustrative of a horizontal section taken through the tank, the body of liquid therein and of the associated blades and baffles and is illustrative of particle movements consequent to the repetitive moving along closed horizontal paths of the V-shaped flocculator blades relative to the V-shaped reflector baffles.

Figs. 2 and 3 are respectively plan and vertical sectional views of a combined flocculation and sedimentation unit employing a flocculation apparatus embodying the invention.

Figs. 4 and 5 are respectively plan and vertical sectional views of another form of combined flocculation and sedimentation unit wherein there is employed a plurality of flocculation apparatus arranged in series and of which each flocculation apparatus is constructed and designed for realizing the present invention.

The flocculating apparatus, of which a horizontal section of the flocculating zone is diagrammatically illustrated by Fig. 1, is comprehended in and by a more complete embodiment in a flocculation and sedimentation unit shown in Figs. 2 and 3, which follows somewhat the design of Patent No. 2,143,750. The flocculation apparatus 11 of these figures comprehends an inner tank-like structure 12 having a cylindrical marginal wall 13 and an apertured bottom 14. It is illustrated in association with a sedimentation apparatus 15 having an outer settling tank 16 providing a basin that surrounds and underlies the inner tank-like structure 12. The tank-like structure 12 defines the outer margins and lower limits of a flocculation zone 17. The arrangement is such that the flocculation section or zone 17 is concentrically disposed with respect to surrounding and underlying sections that together provide a section or zone 18 wherein sedimentation takes place. It will be noted that the flocculation zone 17 and the sedimentation zone 18 are in constant hydraulic communication with each other because of an opening 19 left in the lower portion of the structure 12 that defines the flocculation zone.

As to the sedimentation tank 16, this has an inwardly sloping bottom 20 with a cylindrical marginal wall 21 rising therefrom and is provided with an effluent launder 22 for receiving supernatant liquid flowing thereinto over a weir 23 thereof, that determines the normal level of liquid within the sedimentation and flocculation zones that are concentrically disposed with respect to each other and that are comprehended within the settling tank.

Liquid to be treated is supplied to the unit through a feed pipe 24 that delivers into an enlarged stationary upflow section 25 from which the liquid to be treated is conducted upwardly through a turnable discharge section 26 having ports 27 from which the liquid is delivered so it is received in the upper interior portion of the flocculation zone 17.

The floor of the sedimentation tank is progressively cleaned or raked by suitable mechanism that comprises rake arms 28 equipped with sediment-engaging elements in the form of raking blades 29 depending therefrom so that incident to a turning of the arms in closed paths about a vertically-extending axis the sediment engaged by the raking blades will be impelled toward and ultimately delivered into a sediment receiving sump 30 from which it may be conducted by any suitable means, as for example, the sludge-withdrawal pipe 31.

As to the flocculation apparatus, this embodies sets 32 of vertically-extending paddles or agitating blades 33 which are movable relative to sets 34 of cooperatively disposed vertically-extending baffles 35. The movable agitating blades are primary flocculating elements and are arranged so as to have horizontal movement about a vertically-extending axis that is concentric with the axis about which the sludge-raking mechanism turns. The baffles 35 are of secondary importance as compared to the movable blades 33. These vertically-extending blades 33 and baffles 35 are V-shaped in horizontal cross-section. The apex portions of the movable flocculating blades 33 provide leading edges pointing forwardly with respect to their direction of travel while the apex portions of the baffles 35 point oppositely or rearwardly with respect to the direction of travel of the flocculating blades. The V is open and its sides are straight as this has been found to produce or give the preferred and desired type of agitation movements. The opposite slopes or double deflecting surfaces provided by each movable blade and by each baffle produce a multitude of diverse horizontal liquid flow movements from and throughout each horizontal section of the flocculation zone whereby

substantially every particle of turbidity has a meandering flow movement quite different from any other particles with the result that multitudinous and effective collisions of the several articles of turbidity are realized, to wit, of a character conducive to floc development.

While the flocculating apparatus has been embodied in flocculation and sedimentation units of which one form is shown in Figs. 2 and 3 and another is shown in Figs. 4 and 5, it is to be understood that the invention in so far as it pertains to flocculating apparatus, can be carried out in widely differing forms of construction especially as to the solids separating-out features.

In any form of combined flocculation and sedimentation unit, the settling tank may be viewed as a means provided for receiving flocculated material that is delivered thereinto against a static head determined by a high point in the overflow means of the tank constituting part of a liquid transfer or decanting means that determines the normal functioning level of the liquid within the flocculation zone or station. As the result of feed of liquid into one end section of the flocculation station, such as into the top or upper portion thereof, there is a consequent vertical displacement along a general flowpath within the tank section or zone towards a discharge area or section vertically spaced from the receiving section. This is for example, along a path downward towards and through a lower discharge area adjacent the bottom of the flocculation station. Therefore, in considering any embodiment chosen herein for illustrative purposes, the specific solids separating-out apparatus or sedimentation station or section should be broadly viewed as (1) an instrumentality for receiving and treating flocculated material and (2) for determining the normal level of liquid undergoing flocculation within the flocculation zone. In the present invention, the novel features of construction revolve about the flocculation station, the structural features and arrangement of the parts constituting them, and the new flocculation treatment practiced therein and accomlished by the conjoint action of the particularly shaped blades and baffle members. The sedimentation unit associated therewith is to be viewed as illustrative of such features as are unnecessary to impart utility and completeness to the invention to which this case is directed.

Except for the changes in structural features relating to the utilization and employment in the flocculating apparatus of the V or chevron shaped agitating blades and associated deflector baffles the structural features of the combined unit of Figs. 2 and 3 are substantially the same as those of the combined unit constituting the basis of U. S. Patent No. 2,143,750 or of the unit illustrating the flocculating apparatus of my pending application Serial No. 297,341 and its associated relationship with the sedimentation apparatus of said application.

In order that this case may be complete, the combined unit of Figs. 2 and 3 will be described in relatively complete detail. The unit of these figures embodies a stationary beam or truss construction providing a platform **36** that is fixedly positioned with respect to tank **16**. The platform includes horizontal beams **37** that extend across the sedimentation tank and which rests upon opposite portions of the marginal wall of the tank whereby the beams and platform, of which they constitute a part, are supported by and from the settling tank structure. In the construction shown the cylindrical wall **13** of the inner tank-like structure that defines the flocculation section or zone **17** is suitably supported as by transverse members extending from said platform.

The platform or truss construction carries concentric stationary bearing members **38** and **39** that are vertically spaced with respect to each other. The upper stationary bearing member **38** supports a horizontally turnable bearing member **40** and from the latter there is carried the turnable ported discharge section **26** of the feed supply means. The rake carrying arms **28** extend from the lower end of said turnable feed discharge section **26** and are carried therefrom so as to be turned therewith. The lower end of the turnable discharge section **26** is juxtaposed and overlaps the stationary section **25** of the feed discharge means whereby there is avoided any substantial leakage through any space which may exist between the stationary section **25** and the turnable ported discharge section **26**. Motivated means comprising speed reducing and power transmission gearing is provided at **41** as part of a clarifier drive head mechanism and functions for imparting horizontal turning movement to the bearing member **40** and to the members supported therefrom whereby the turnable feed discharge section **26** serves to conduct upflowing liquid and to deliver it as incoming feed into the upper portion of the flocculation zone and also to impart horizontal turning movement to the sediment raking mechanism of which it constitutes a part.

A second or lower turnable bearing member **42** is mounted upon the lower stationary bearing **39** and horizontal turning movements are imparted thereto from a motivated means **43** comprising suitable speed reducing and power transmission gearing. The mechanism that includes the parts just referred to is sometimes referred to as the flocculator drive head. A tubular carrying member **44** is dependably supported from the turnable bearing member **42** and in turn supports from the lower end thereof oppositely extending blade carrying frames **45** embodying upper and lower radiating members **46** and **47** and braces or tension members **48**. This tubular carrier **44** surrounds the ported feed discharge terminal **26** and is provided with flow passageways at **50** for permitting a direct flow of liquid from the discharge ports of member **26** through the flow passageways **50** into the upper interior portion of the flocculation zone **11**. The agitating blades **33** extend upwardly and are carried by the radiating frames **45** and therefore it will be seen that the horizontal turning of the bearing **42** will effect the horizontal movement of the sets **32** of paddles **33** through the medium of the depending carrier **44** and the blade carrying frames **45** just described. Said vertically-extending flocculating blades **33** are horizontally spaced to provide spaces for the reception of the reflector baffles **35** heretofore referred to, and at least some portions of the upwardly extending blades rise past and beyond the lower ends of the deflector baffles whereby the flocculating blades and the deflector baffles have vertically overlapping arrangement as the set of flocculating blades move relative to and past the deflector baffles.

As to the reflector baffles **35**, it will be noted that they are arranged in sets and supported from the stationary platform. They extend vertically and are horizontally spaced so as to permit the passage of the movable agitating blades **33** as the latter move in closed horizontal paths.

It has been pointed out that the invention of this case primarily revolves about the employment of what may be viewed as longitudinally-extending members chevron shaped in cross-section. These members are arranged in sets. Of the members constituting some of these sets, some have been referred to as primary agitating or flocculating blades, while others have been referred to as secondary or reflector baffles. Fig. 1 brings out this arrangement vividly and therein, as in Figs. 2 and 3, the agitating blades are arranged in sets **32** composed of the individual V-shaped members **33**. The reflector baffle members, in this figure, are arranged in sets **34** composed of the individual V-shaped members **35**. Movement of the blades **33** tend to set up horizontal currents without imparting any substantial vertical movement to the liquid body through which they move. The vertical movement of the liquid body is substantially only that consequent to the feed of the liquid to be treated into one section of the body, such as in the top thereof, and discharge passage of treated liquid from the other end of the body, such as from the lower portion thereof. The sets of secondary chevron baffles **35** principally function to divide laterally liquid contacting therewith and to deflect liquid which has been forced laterally against them as the result of the forward movement of the primary agitating blades **33**. As the result of this deflection, there is effected a further horizontal distortion of the currents or flow movements previously imparted to the liquid by the agitating blades. The result of the conjoint action of these agitating blades and reflecting baffles is a series of direction changes in the movements for practically each particle of turbidity in the liquid. It may be viewed and properly stated that no two particles take exactly the same flow path. The diverse flow movements and different characters of particle movements in the mass are illustrated in Fig. 1 wherein one particle as (X) may move along a meandering path indicated by the finely dotted lines and whereby another particle as (Y) may take an entirely different type of meandering path indicated by the dot and dash lines.

Figs. 1, 2 and 3 show that the agitating blades and the reflector baffles **35** substantially overlap whereby there is a substantial depth of flocculation zone or agitation area between the upper and lowermost sections of the region defined within the tank-like structure **12**. It will also be noted from what has preceded that the feed of liquid into this flocculating space is upwardly through and from the turnable feed discharge section **26**, the upper portion of which is apertured at **27**. That the feed thus supplied is permitted to pass through openings **50** of the carrier **44** so as to be ultimately delivered into the upper portion of the liquid within the flocculation section provided within the inner tank-like structure **12** and that the lower portion of the latter is provided by an annular section **14** having the aperture **19** constituting a discharge area that permits a passage of flocculated material from the lower end of the flocculating apparatus **11** or inner tank-like structure **12** thereof in amounts or quantities according to the rate or quantity of material fed for treatment. It will be noted that the settling tank **16** and the overflow weir **23** thereof constitute or provide a liquid discharge means leading from the flocculating apparatus whereby the continuous type of feed to and consequent discharge from the flocculating apparatus is enabled to be realized.

In the unit of Figs. 4 and 5 there are disposed in serial arrangement, three flocculating apparatus or flocculating sections successively designated as **51**, **52** and **53**. The last mentioned of these flocculating sections has a trough-like channel serving as an intermediate open duct **54** into which liquid having flocculated matter suspended therein flows on its way from the flocculating sections on its way to and through a conduit or pipe **55** into an upwardly-extending hollow pier **56** of a mechanically raked sedimentation apparatus **57**. This sedimentation apparatus embodies a settling tank **58** having a floor portion **59** from which there rise marginal walls **60** defining the outer limits of a cornered sedimentation section or zone **61**. These marginal walls **60** are arranged substantially in the form of a square of which the inner section of the corners are somewhat rounded particularly in the lowermost regions that are proximate the tank floor.

The combined flocculation and sedimentation unit of these figures is in plan of rectangular formation of which the three flocculation apparatus or sections are arranged along one side of the relatively square settling tank. The marginal wall of or for each flocculation apparatus defines a relatively square flocculating zone or space. The feed to the first apparatus or flocculating section **51** is into the upper portion thereof. There is a discharge from the lower end of section **51** through a passageway left at **62** under the partition or wall member **63** and leading into the second flocculating section **52**. The general flow through the first flocculating section **51** is progressively downward. Within the second section **52** the general flow is progressively upward and the flocculated liquid passes from the second flocculating section over a submerged weir **64** provided at or by the upper portion of a partition or wall member **65** and flows into the upper portion of the third section. From the flocculating section **53**, the flocculated liquid passes through an opening left at **66** by the partition or wall member **67**, into the trough-like channel or open duct **54**. The wall member **67** in in fact a partial partition that stops short of a vertical wall of the flocculating apparatus. The opening **66** is in the form of a vertically-extending slot between a vertical edge portion of the partition **66** last referred to and an adjacent section of the marginal wall of the third flocculating apparatus, or flocculating section **53**. The slot or opening thus left provides a discharge area leading from the last of the serially disposed flocculation sections into the intermediate receiving space or trough-like channel **54** heretofore referred to. From the bottom of this intermediate receiving space the flocculated liquid flows into and through the pipe or conduit **55** into the upwardly extending hollow pier **56** and from the upper portion of the latter through ported discharge openings **68** into a stilling well **69** the outer margins of which are defined by an annular ring **70** that is centrally disposed with respect to the marginal walls **60** of the sedimentation apparatus **57**. A horizontally-turnable sediment raking mechanism **71** is provided for transferring sediment from diverse sections of the sedimentation tank to a sediment receiving sump **72** from which it is hydraulically passed from the apparatus as by a discharge pipe or conduit **73**. In the instance of the sedimentation apparatus **57** of this

unit there is an effluent launder 74 providing a weir 75 over which supernatant liquid passes on its way to the launder which leads from the unit. It will be noted that this overflow weir determines the normal operative level of the liquid in the combined unit, to wit, in the sedimentation zone or section 61 and the flocculation sections 51, 52 and 53 all of which are in constant hydraulic communication whereby the liquid level in all is at all times substantially the same. The sediment raking mechanism 71 is turnably mounted on the pier in a manner well known in the art and suitable motivated means comprising speed reducing and power transmission gearing is provided at 76 for turning the sediment raking mechanism in closed horizontal paths about the pier by which the raking mechanism is supported. The sediment raking mechanism embodies rake carrying arms 77 and guided corner exploring elements 78 that are swingably mounted through the medium of links 79 from the outer end of the arms 77. These corner exploring elements 78 are horizontally movable in-and-out according to operative requirements and to attain this end they are supported from the outer ends of the links 79 that are horizontally swingable and that are in turn pivotally mounted on the rake carrying arms 77. Springs 80 are employed to provide yieldable pressing means for continuously forcing the corner exploring elements to the outermost permissible position therefor but for permitting a retracted or inward movement as they are forced inwardly because of a camming engagement thereof with a guiding surface or marginally closed camming section provided at 81 within the lower portion of the settling tank.

As to the flocculating apparatus or sections 51, 52 and 53 each of these has sets 82 of vertically-extending primary agitating blades 83 that are V or chevron shaped in cross-section. These blades are supported by and extend upwardly from radial frames 84 that are in turn carried by and through the medium of a suitably supported vertical shaft 85. Suitable motivated means comprising speed reducing and power transmission gearing is provided at 86 for turning said shaft and for thereby moving the agitating blades in closed paths about a vertically-extending axis concentric with the shaft. Sets of vertically-extending secondary or reflector baffles 87 that are V or chevron shaped in cross-section are carried by and depend from transverse supporting members 88.

The arrangement and operation of the agitating blades and reflector baffles of these flocculating units are substantially the same as the operative arrangement and employment of the corresponding blades 33 and baffles 35 of the flocculating apparatus heretofore discussed in connection with Figs. 1 to 3.

As to the motivated means or mechanism referred to in several portions of this specification, it is to be noted that they are preferably actuated from a source of power providing a variable speed control for the parts actuated thereby. The sediment raking mechanisms when operated generally move at relatively slower velocities in order not to disturb or upset any sedimentation operation being carried out in the section served thereby. As to the flocculation units these generally move at a somewhat faster angular velocity than that imparted to the sediment raking mechanism.

The novelty respecting the flocculation apparatus of the present case, as has already been indicated, revolves about the employment of the chevron shaped member and more particularly about the conjoint employment of the V-shaped movable agitating blades and deflector baffles.

The manner in which the V blades function is important to efficient flocculation, especially in that the speed of the movable blades through the liquid, and past the deflecting baffles must be at a rate that is less than the yield point of the liquid. Any shearing action must be avoided. Otherwise the fragile flocs will be torn apart or disintegrated. Any such tendency is to be discouraged. Therefore, the flocculating action of the V-shaped elements or members of this invention is in sharp distinction to the action of agitators or mixers wherein shearing effects are made use of to disintegrate or smooth out lumps. Such agitators have their moving elements rotate at a speed that is greater than the yield point of the slurry that they are to mix. This is just the opposite to the effects required of the V-shaped members of this invention.

The V-shaped members are designed so that they will split or divide the liquid they encounter into streams that spread gently around the moving blades so that there is a minimum of slippage between adjacent vertical planes of liquid. In other words, stream-line effects are not desired. The split liquid is spread to have its direction gradually changed ever so gently but enough to cause it to engage the angled face or faces of a deflector baffle with a force insufficient substantially to disintegrate the flocs, but yet with sufficient force to cause the zig-zagging described. When flocculating liquids of the type referred to, a maximum speed of the moving V-blades of 1.5 feet per second embodies a sufficient factor of safety so that the yield point of the liquid is neither equalled nor exceeded. The speed of the blades should never be such that movement of the blades causes, in the liquid, zones of alternate compression and release for such would also disintegrate the flocs. To these ends and under these conditions, it has been found that most efficient flocculation is attained with the speeds specified, when the angle formed by the wings of the V of any one blade as shown in the drawings, is 90°, namely a right angle.

I claim:

1. In the treating of liquid for conditioning into settleable form flocculatable solids suspended therein and especially those not normally settleable to convert such solids into settleable flocs the method comprising maintaining a body of liquid by supplying incoming liquid thereto at one elevation and passing liquid in quantity equal to that of the incoming liquid from another general elevation for realizing a continuous general vertical flow movement of the liquid, imposing on the suspended solids of the vertically-flowing liquid general substantially horizontally-impelled and horizontally-deflected flow movements by moving in the body repetitively along horizontally-closed paths about a vertical axis vertically-extending horizontally-spaced-apart impelling paddles V-shaped in cross-section disposed with the apex portions of the V's foremost and the wings of the V's rearmost with respect to the forward paths of movement of the impelling paddles, horizontally deflecting the horizontally-impelled liquid flow movement by vertically-extending horizontally-spaced-apart deflecting blades disposed so that at least certain portions thereof vertically overlap portions

of said impelling paddles, the spacing of the impelling paddles and the spacing of the deflecting blades being such that the impelling paddles can repetitively pass the deflecting blades without interference therewith, and moving the impelling paddles at speeds not substantially in excess of 1.5 feet per second and thereby at substantially less than the yield point of the liquid of the body whereby disintegration of formed flocs is discouraged and shearing action between the impelling paddles and deflecting blades is substantially avoided.

2. Apparatus for treating liquid for conditioning into settleable form flocculatable solids suspended therein and especially those not normally settleable; which apparatus comprises a tank for maintaining a body of liquid to the flocculated; means for delivering incoming liquid into the maintained liquid body in the tank at one general elevation thereof; means for passing liquid from another general elevation thereof whereby there is a general vertical flow of liquid within said liquid body; and flocculating mechanism for the liquid body and tank comprising horizontally- spaced vertical liquid-impelling chevron-shaped members movable with their apices leading and cooperating vertical horizontally-spaced liquid-deflecting blades coextending with the impelling members for at least a portion of their length and so disposed in horizontal spacing that the impelling members can pass the deflecting blades without interference therewith; means for supporting said liquid-deflecting blades; a movable carrier comprising a horizontally-turnable bearing member supported with respect to the tank and providing transverse elements from which the impelling members are supported; and means for turning said carrier and said impelling members at speeds not substantially in excess of 1.5 feet per second that are conducive to the coagmentation of suspended flocculatable solids into flocs and to the conditioning of flocs into settleable form; the liquid-impelling faces of the impelling members being adapted to spread and move horizontally the liquid engaged thereby while in the vicinity of the trailing wings of each chevron-shaped member there is consequential horizontal movement of liquid from the rear edges thereof towards and into the region immediately behind the interior of the chevron-shaped members.

3. An apparatus for treating liquids according to claim 2 in which the deflecting blades have liquid-diverting surfaces generally disposed to oppose the forward movement of the liquid impelled towards the same and which slant relative to the path of movement of the impelling paddles whereby said deflecting blades deflect horizontally therefrom liquid impelled towards the same incident to the horizontal turning movement of the impelling members.

4. Apparatus for treating liquids according to claim 2, in which the deflecting blades also are of chevron-shape in cross-section and are disposed with apex portions thereof pointing in direction opposite to the forward paths of movement of the impelling members as and when the impelling members move past the deflecting blades.

5. Apparatus for treating liquid for conditioning in settleable form flocculatable solids suspended therein and especially those not normally settleable; which apparatus comprises a tank for maintaining a body of liquid to be flocculated; means for delivering incoming liquid into the maintained body in the tank at one general elevation thereof; means for passing liquid from another general elevation thereof whereby there is a general vertical flow of liquid within the liquid body; and flocculating mechanism comprising horizontally-movable horizontally-spaced vertical liquid-impelling members providing forward liquid-impelling angled faces for spreading generally horizontally liquid within the vertically-flowing liquid body, a movable carrier having a horizontally-turnable bearing member supported with respect to the tank and providing a transverse structure from which the impelling members are supported, means for turning said carrier and said impelling members in paths about a vertical axis whereby the latter moves at speeds not substantially in excess of 1.5 feet per second and less than the yield point of the liquid to be treated but that is conducive to the coagmentation of suspended flocculatable solids into the flocs and to the conditioning of flocs into settleable form meanwhile discouraging shearing of such flocs; said impelling members being characterized in that they are of chevron shape and substantially right-angled in cross-section as well as disposed with the apex portions foremost and the open portions rearmost with respect to the forward paths of travel of the members whereby the forward faces of the impelling members impel and spread liquid engaged thereby and whereby in the vicinity of the trailing edges of each said chevron members there is consequential horizontal movement of liquid from said rear edges thereof towards and into the region immediately behind the open portions of the chevron members, and horizontally-spaced-apart vertical baffles providing angled liquid-deflecting faces for substantially horizontally deflecting liquid spread thereto by the impelling members disposed to be passed by the impelling members which have at least a portion thereof co-extending with at least a portion of the baffles.

GEORGE M. DARBY.

Certificate of Correction

Patent No. 2,274,361. February 24, 1942.

GEORGE M. DARBY

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, lines 43 and 44, for "turn-table" read *turnable*; page 3, first column, line 5, for "articles" read *particles*; line 30, for "This" read *That*; page 6, first column, line 17, claim 2, for the words "to the" read *to be*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of March, A. D. 1947.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.