

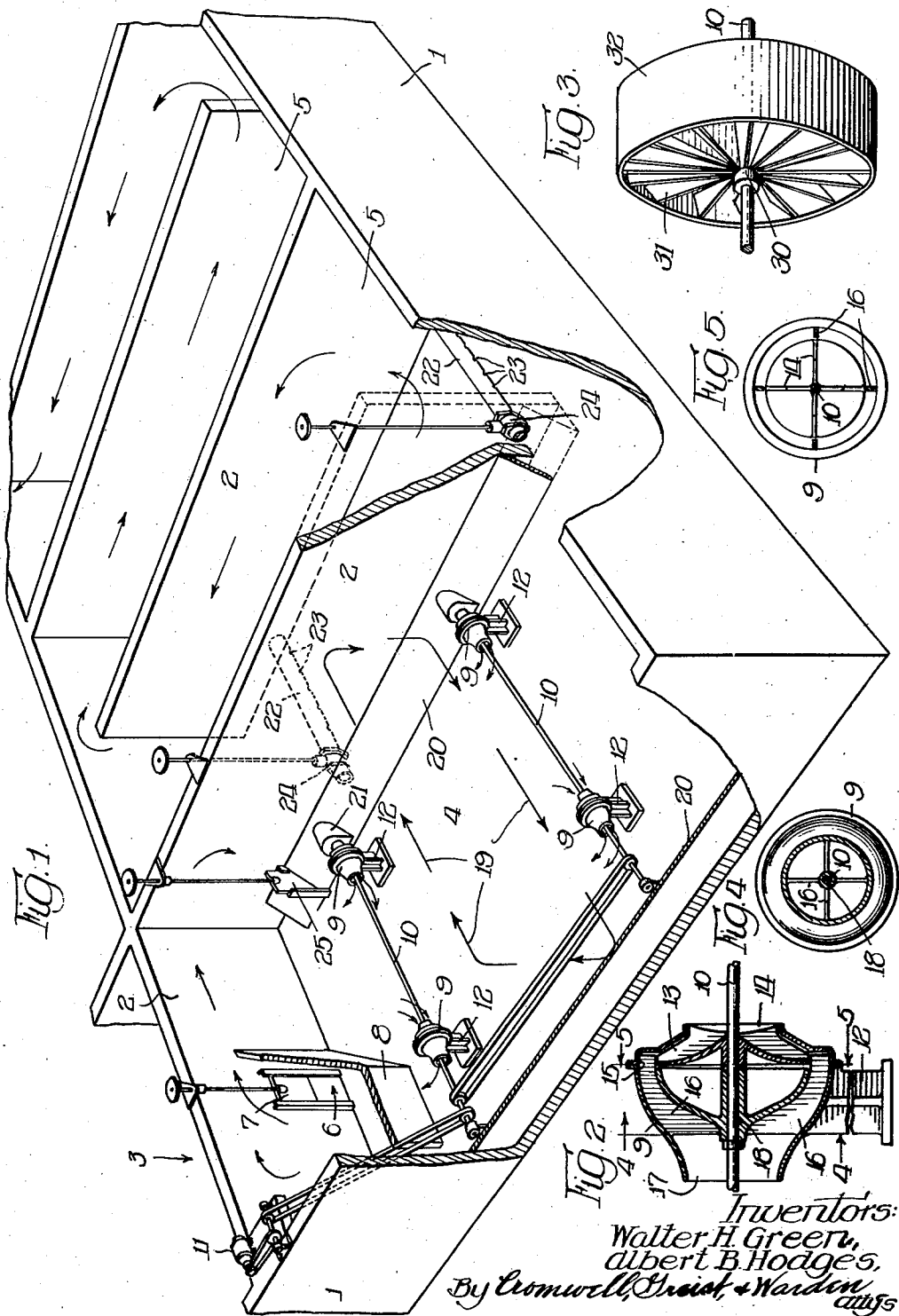
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LIQUID TREATING METHOD AND DEVICE

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LIQUID TREATING METHOD AND DEVICE

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This invention relates to the treatment of liquids and to apparatus therefor wherein the liquid is purified by the separation therefrom of solid particles by sedimentation, and is directed to improving such treatment through the provision of an improved method and apparatus therefor.

The invention is particularly directed to a preliminary treatment of the liquid for the purpose of altering the character of contained sediment so that it will subsequently settle more readily and/or completely and to the provision of improved apparatus for such preliminary treatment.

A preliminary treatment for this purpose is not in itself new, since it has been common for many years to employ both chemical and physical means to this end. As an example of chemical means may be cited the addition of alum to water, thereby effecting a chemical reaction by which a floc is produced. The pH value of the water is altered at the same time, which is often advantageous. As examples of physical action may be cited the stirring of water by paddles revolved about a vertical or horizontal axis, and the practice of flowing the liquid over or around baffles. Such mechanical devices are in the great majority of cases employed merely for the purpose of mechanically distributing a reagent through the liquid so that all the liquid will be affected by the reaction that takes place, and the conditions established are not usually those favorable to flocculation. In general it is desirable to use some such mixing device prior to the entry of the liquid within the action of the present device.

In the treatment of water with alum it was long ago found advantageous to enlarge the baffle chamber through which the water passed beyond the requirements for mere mixing as by so doing a better coagulating effect was produced and better sedimentation was had. Devices employing paddles in one way or another were also used for this effect.

Commonly used and well known treatments of water are for the clarification thereof by removal of suspended solids and for the softening of the water to remove or reduce excessive hardness. These two treatments differ chemically but as ordinarily carried out differ little mechanically or as to apparatus employed. In general a water to be clarified is dosed with a coagulant such as alum and passed through a mixing chamber into a settling basin for separation of as much solids as may be by sedimentation and

then through filters to a place of storage or use. In softening, the water is dosed with some reagent, usually lime and perhaps also soda, and passed through the same sort of mixing and settling chambers to the filters. These two processes have been extensively practiced for a long period.

For many years no agitation was employed other than for mixing as above referred to. Later it was found that if the agitation was prolonged beyond that necessary for mere mixing, the nature of the floc or precipitate resulting could be improved with respect to subsequent settling. While agitation was thus practiced, little attention was paid to the mode of agitation except to prolong it somewhat and to limit the maximum speed of the periphery of the agitator blades short of that which was found because of its violence to break up the floc. This limitation on blade speed prevented proper agitation from being had in large sized basins with the usual type of agitator. Consequently, until recently with large capacity apparatus the choice was between a short period of relatively better agitation and a longer period of poorer agitation, unless a plurality of separate small basins were employed which is objectionable for several reasons.

A general object of this invention is to prepare a liquid for sedimentation by a preliminary treatment thereof adapted to condition contained solids into a form better suited for separation by sedimentation.

Another object of this invention is to improve flocculation in a liquid undergoing treatment by imparting thereto a general rolling motion of relatively low velocity that is reasonably uniform throughout the volume of liquid undergoing agitation but effective to induce a considerable degree of internal motion including eddies within this motion.

A further object is to provide a method of agitation of the kind referred to wherein the formation or building up of flocs is promoted by having, additionally, localized currents of higher velocity and appreciable volume, the velocity of such currents being below that at which flocs will be broken down, and the energy in the currents being used to impart and/or sustain the main motion, to increase the amount of eddying and to carry flocs from one part of the basin to another so that flocs of different kinds or in different stages of formation may be brought together.

Another object is to provide agitation wherein

there is a main forward motion of a body of water by displacement but wherein there is imparted to the water a cross motion so that the water moves in a generally spiral path, the cross motion being set up and maintained by imparting energy to a relatively small portion of the body of water undergoing treatment and transmitting or transfusing this energy to the whole body in a way to secure the desired movement thereof.

Another object is to provide such agitation through the use of relative small impeller or energy imparting members or units which may be employed in number and placing and spacing so that effective and uniform agitation may be had in basins or volumes of water of any size or amount, and this at low cost both for the apparatus and of power for operation.

A still further object is to provide an apparatus of relatively small size and of simple and durable construction whereby motion of the sort referred to may be imparted to and maintained in large bodies of water.

These and other objects will be apparent from the herein contained disclosure, and by reference to the accompanying drawing, in which

Fig. 1 shows in perspective a diagrammatic view of a water-treating plant constructed in accordance with our invention;

Fig. 2 is a vertical sectional view of one of the impellers shown in Fig. 1;

Fig. 3 is a perspective of a modified form of impeller which may be employed in our improved apparatus;

Fig. 4 is a sectional view taken along line 4—4 of Fig. 2; and

Fig. 5 is a sectional view taken along line 5—5 of Fig. 2.

For purpose of illustration we will describe our invention in connection with the treatment of raw water to clarify it. In a modern large sized filter plant as used to purify water for municipal supply, for which our improved apparatus is particularly adapted, the raw water is dosed with a coagulant, as alum, and then subjected to agitation for perhaps two to five minutes. This agitation is for the purpose of distributing the alum throughout the water, and perhaps also for aiding solution of the alum, and is relatively violent. In older practice the water was discharged directly from this agitating chamber into the settling chamber but in accordance with present practices it is preferred to interpose a chamber or zone for secondary agitation between the mixing chamber and the settling zone. This secondary agitation is provided because it has been found possible thereby to reduce the amount of alum or other reagent required, to reduce the time required for settling and so the size of the required settling basin and to improve the quality of the treated water. A separate basin or chamber may be provided for this agitation or the agitating apparatus may be installed in part of the settling basin, at the entrance end thereof of course.

In such a plant the treatment is continuous or progressive, water flowing continually through the mixing chamber into the agitating zone to the settling chamber and through the latter. The settling chamber is usually baffled to prevent short circuiting and so secure full time for sedimentation. It is important also that short circuiting through the agitating zone be prevented and it has been proposed to divide this into a series of chambers for this purpose. By agitation

as herein proposed this is not necessary as short circuiting is effectually prevented.

Since the building up of the flocs results from repeated contacts which permit the flocs to cohere, special means are provided for securing such contacts by establishing within the main flow local currents in the same direction but at higher velocities which not only produces additional eddies but brings together flocs that would otherwise remain remote. Means are provided also whereby flocs may be brought back from beyond the zone of agitation for remingling with the newly treated water and freshly formed flocs.

In Fig. 1, the numeral 1 indicates a basin which is divided into sections or chambers by partitions some of which are shown as partial partitions so that they may serve as baffles to direct the flow. The chamber 3, which is not shown complete, serves as an entrance chamber and may be fitted with stirrers to provide the initial mixing of the treating reagents and water. The treating chemicals, alum, lime, etc., are ordinarily added, by feeding means not shown, to the water in chamber 3 or to the water as it enters this chamber. However, the chemicals may be added to the water at the entrance to chamber 4, in which event chamber 3 may be dispensed with.

Chamber 4 serves as the agitating zone and is provided with agitating means later described. The several chambers 5 serve as settling space. In the partition between chambers 3 and 4 is an opening 6 shown provided with a sluice gate 7 by which the flow may be cut off, and in chamber 4 beyond this opening is shown a baffle 8 to divert the incoming stream of water into the direction of flow desired in chamber 4. This baffle 8 is not essential and good results may be had without it, but is desirable because it utilizes the energy in the entering water to establish the desired flow thus saving some power. The baffle also prevents the entering stream shooting some distance across the basin before being absorbed in the general motion. Impeller units 9 are shown mounted on shafts 10 which are adapted to be turned by motor 11 through immediate gearing and chain. Any suitable means may be used for driving the shafts 10 and for supporting it. In the drawing it is supported on bearings set on the walls and partition and on pedestals 12.

In Fig. 2 is shown an impeller member or unit of preferred type. As shown it comprises a part 13 that is substantially like the impeller of a centrifugal pump, mounted on shaft 10 to be rotated thereby, having an inlet at 14 and discharging at the periphery into annular ring 15. From 15 the water flows forward through stream lined passages having vanes 16 to stop rotation and is discharged axially forward through central discharge opening 17. It will be noted that the vanes 16 extend over into ring 15 dividing it into several chambers and preventing rotation within the ring of the water discharged from 13. The shaft 10 turns in bearing 18 supported within 9 by the vanes 16. The several openings and passages are liberally proportioned and a relatively slow rotation of part 13 will move and discharge relatively large volumes of water at low velocity.

With this construction the impeller part 13 may be given a relatively high speed either or both lineally or angularly without destructive effect on the flocs since there is little relative motion between the water and the impeller. Also, rotation of the water is stopped just beyond the impeller, and the velocity of the water

through the casing is low. It is not the absolute motion of the water but its motion relative to a solid surface or other water that tears apart or destroys the flocs.

In Fig. 3 is shown a modified form of impeller that may be used in accordance with our invention in place of or with the more preferred form of agitator described heretofore. This modified impeller has a central hub portion 30 mounted on shaft 10. From the hub portion a plurality of angularly disposed water-deflecting vanes 31 of conventional construction extend substantially radially, the outer ends of the vanes being connected by a circular band 32.

In operation, the basin 4 is filled with water and on rotation of shafts 10 water is drawn in through impeller inlets 14 and discharged forwardly through 17 with added velocity and energy. This stream tends to travel directly forward but is resisted by the surrounding water into which it diffuses and into which its energy is absorbed until there is equilibrium. On continued rotation of shafts 10 the whole body of liquid within the basin will gradually acquire a velocity corresponding to the energy delivered. Equilibrium is reached when the friction equals the rate of delivery of energy if inlet 6 is closed and there is no flow through basin 4. When there is a flow through 4, as there normally is, equilibrium is reached when the friction plus the energy required to impart velocity to incoming water equals imparted energy.

The number of the shafts 10 and the number of size of impellers 9 mounted on them will be varied to correspond with the size of the basin and the volume of flow through it. There is, however, a wide range for preference, since with more shafts 10 there may be fewer impellers mounted on each, or these may be smaller, or they may be rotated more slowly, and vice versa. In general it is better to have more and smaller impellers 9 and closer together, rather than fewer and larger ones. Also, it may be well to have more than one shaft 10 close to the inlet end, or to put more impellers on the first shaft, or to provide larger impellers thereon so as to more quickly bring up the entering water to the desired velocity. Once the water has attained its velocity it will be maintained for a long time and over a considerable distance so that subsequent shafts 10 can be a considerable distance apart.

Due to the imparted energy and motion the water in the bottom part of the basin moves until it strikes a side wall where it is deflected upward and in the upper part of the basin returns to the opposite wall where it is deflected downward. With no flow through the basin a particle tends to travel in a closed circuit as indicated by the arrows 19 but with continual increments of water entering the basin this motion assumes a spiral form due to displacement toward the outlet. The actual path of a particle is of course, and desirably, very much distorted from this theoretical path due to eddies, to the drawing of water into inlets 14, to the effect of the jets discharged through outlets 17, etc. One of the objects sought and of the advantages of this system lies in this complexity of flow whereby more opportunities for contact are provided to build up the floc, while at the same time there is the general forward spiral flow from inlet to outlet of the basin. It is to be observed, that a larger number of shafts 10, with more and smaller impellers 9 will give a more complex flow than the reverse construction.

Along and at the bottom of the side walls of

basin 4 are shown inclined surfaces 20 which aid in causing the water striking the wall to be deflected upward at the one side and horizontally at the other. In the drawing there is shown an open space behind the one such surface to form a channel the purpose of which will now be described. One of the impellers 9 is shown joined to this conduit by a hood 21 so that liquid can be drawn through and out of this conduit. Of course, more of the impellers may be so connected or other conduits may be provided to other impellers. Pipes 22, provided with pick-up openings 23, and with valves 24, are shown extending out from the channel across the bottom of the settling basin. On opening a valve 24 sludge may be drawn back and mixed with the new water in basin 4 to promote flocculation and sedimentation in a known manner. The channel behind 20 may be closed at both ends or either or both ends may be open and provided with a gate as 25 permitting water to be drawn in from either end of the mixing basin. While the shafts 10 and impellers 9 are shown mounted horizontally in the bottom of the basin it is obvious that they could be above the medium depth, the choice being largely one of convenience or cost. It is also possible, and, in a relatively narrow and deep basin it may be desirable, that shafts 10 be vertical and members 9 may discharge either upward or downward although downward discharge is usually preferable.

The velocities of the jets issuing from 17 is susceptible to considerable variation. In general, as referred to above, it is better to have a larger volume projected at lower velocity and to obtain this larger volume by a greater number of smaller units than a few larger ones. It appears to be possible with this apparatus to go beyond the limit of three feet per second at which the floc was supposed to be injured. The permissible upper limit is not yet known and doubtless it varies with conditions to some extent. Velocities of at least double this old limit are thought permissible. Whatever the upper velocity limit may be, it is not recommended that it be employed, unless under special conditions. In general, because of power consideration and otherwise, the general motion of the body of water in the agitating zone should be left as low as possible consistent with prevention of accumulation of sediment on the bottom of the basin. In the past and with other types of agitation and agitators, the tendency has been to approach the maximum permissible speed. With the method and apparatus of the present invention velocities approaching the minimum are found preferable.

In the operation of a plant provided with this improved system, the water enters the agitating zone ordinarily carrying some sediment which may be increased by further precipitation taking place within the zone. Due to the action of the apparatus provided there is imposed upon the progressively forward movement caused by the successive increments of entering water, a cross-wise rolling motion of mildly turbulent nature. The result is the general spiral flow from inlet to outlet of the zone as above spoken of. This causes particles that settle out of the water above to be caught and carried up by the stream below so that the tendency is to retain particles in suspension.

As referred to above, and as will be apparent upon consideration of the invention, both the method and apparatus disclosed herein are susceptible of wide adaptation and modification. All such variations coming within the scope of the

invention are intended to be included in the appended claims.

We claim:

1. An apparatus for treating a flowing stream
5 of water comprising a dosing zone an agitating
zone and a settling zone arranged in series and
a plurality of jet-forming impellers located in
said agitating zone, said impellers being mounted
10 on shafting parallel to and adjacent a boundary
of said zone and adapted on rotation of said
shafting to form and direct jets of water in the
direction of the axis of said shafting.

2. In apparatus for treating a flowing body of
water the combination of a dosing zone an agi-
15 tating zone and a settling zone in serial relation,
a shaft mounted in said agitating zone parallel
to and adjacent a wall thereof, a plurality of
impellers mounted on said shaft, said jet-form-
ing impellers being adapted on rotation of said
20 shaft to cause and direct jets of water within
the body thereof and parallel to said shaft.

3. In apparatus for the treatment of a flow-
ing body of water an agitating zone having an
inlet at one end and an outlet at the opposite
25 end thereof, a plurality of parallel shafts mount-
ed in the lower part of said zone across the direc-
tion of flow from inlet to outlet thereof, a jet-
forming impeller member on each shaft, and
means for rotating said shafts, said impeller
30 members being adapted on rotation of said shafts
to produce unidirectional jets of water along said
shafts.

4. An apparatus for treating a flowing body of
liquid, comprising a dosing compartment, an agi-
35 tating compartment having an inlet and outlet,
and a settling compartment arranged in serial re-
lation, shafting mounted in the agitating com-
partment parallel to a boundary thereof, said
shafting being positioned adjacent the inlet of
40 said agitating compartment and across the direc-
tion of flow from the inlet to the outlet thereof,
an impeller mounted on said shaft and operable
on rotation thereof to create and direct a flow of
water along said shaft, and a conduit leading

from said settling compartment to the intake side
of said impeller for conducting water from said
settling compartment to said agitating compart-
ment upon rotation of said shaft.

5. An apparatus for the treatment of a flowing
5 body of water comprising a dosing chamber
where reagent is added to the water, an agitating
chamber having an inlet and an outlet, and a set-
tling chamber arranged serially, jet-forming me-
chanical impellers located in said agitating cham-
10 ber adjacent the bottom thereof, and adapted to
form and direct through water in said agitating
chamber a plurality of unidirectional horizontal
jets of water in direction parallel to a boundary
of said agitating chamber and transverse to a
15 line joining said inlet and outlet.

6. The method of treating water which com-
prises adding a floc-forming reagent to water to
be treated, progressing said water through an
agitating zone by forward displacement, mechani-
20 cally producing horizontal jets in said water ad-
jacent the bottom thereof, and directing said jets
through the water in said agitating zone substan-
tially perpendicularly to the direction of displace-
ment to produce a generally transverse roll
25 therein across the direction of displacement.

7. The method of softening water, which com-
prises dosing the water with a floc-forming re-
agent, passing the dosed water through an agi-
tating zone by forward displacement, mechani-
30 cally producing horizontal jets in said water, ad-
jacent the bottom thereof, and directing said jets
through the water in said agitating zone in a di-
rection transversely of the direction of displace-
ment of said water and in a direction to cause
35 substantially the whole body of said water to ro-
tate about an axis lying in the direction of dis-
placement while producing local eddies therein
and to cause the flocs in said water to take a
generally spiral course through said agitating
40 zone.

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