Jan. 9, 1923. 1,441,731.

W. R. MATHIS.

METHOD AND APPARATUS FOR TREATING SLUDGE.

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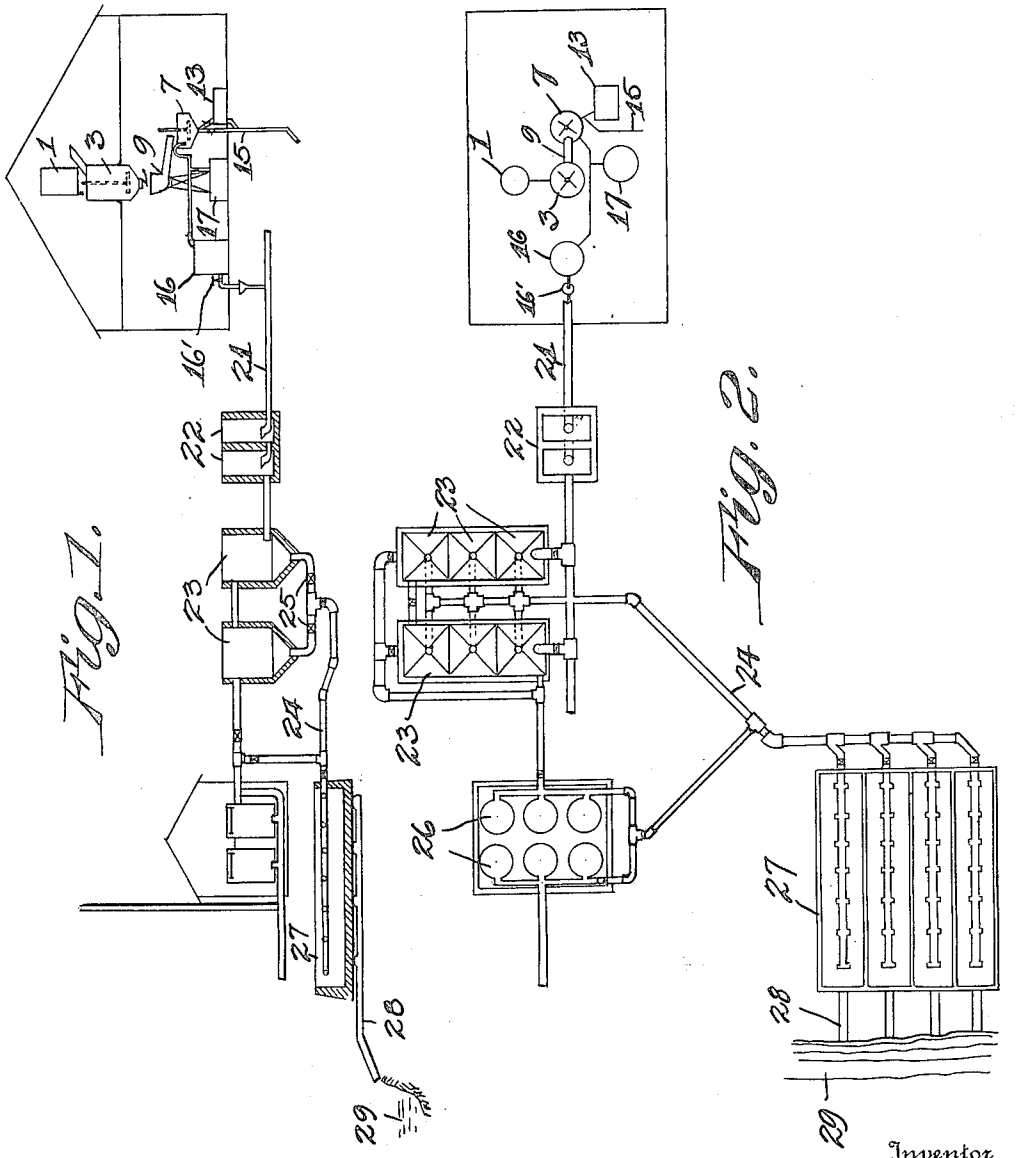


Fig. 1.

Fig. 2.

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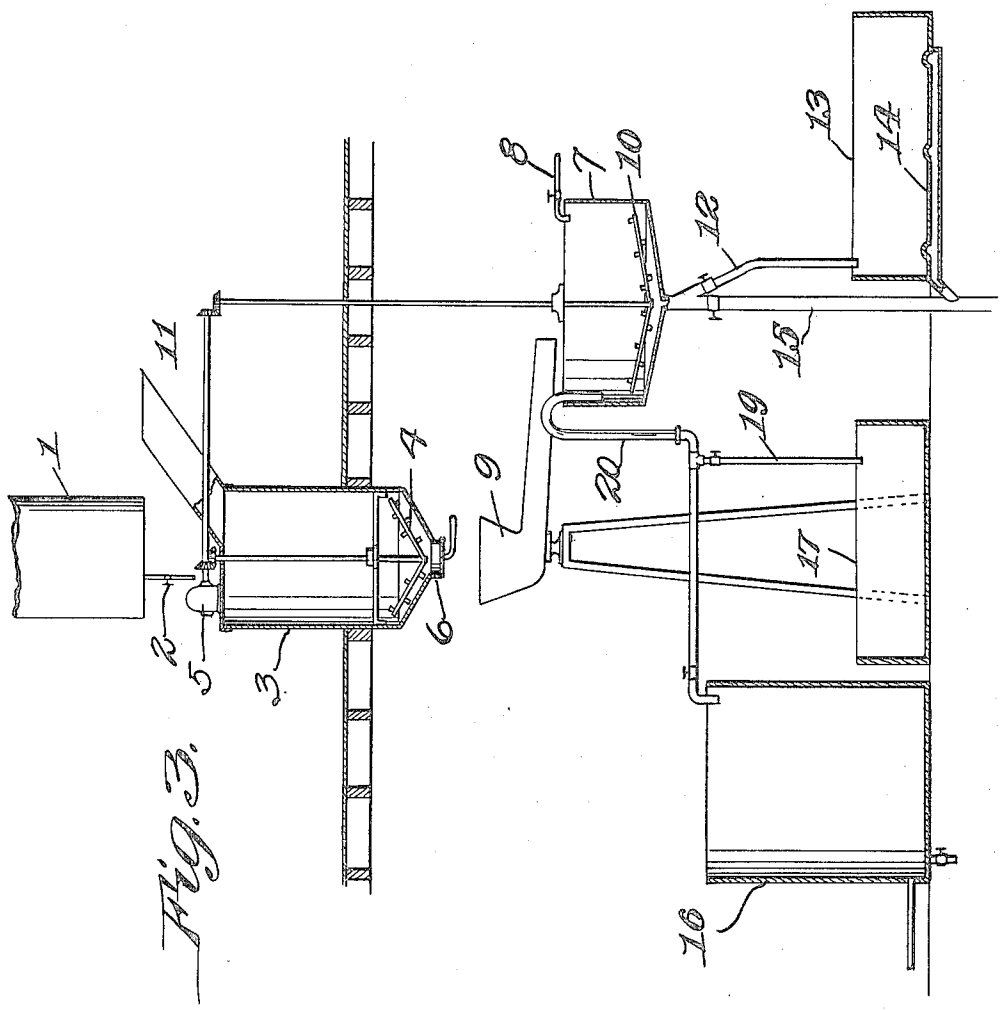


Fig. 3.

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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR TREATING SLUDGE.

Application filed May 26, 1921. Serial No. 472,875.

To all whom it may concern:

Be it known that I, WALTER R. MATHIS, a citizen of the United States, residing at Atlanta, in the county of Fulton and State of Georgia, have invented certain new and useful Improvements in Methods and Apparatus for Treating Sludge, of which the following is a specification.

This invention relates to an apparatus for and a method of coagulating and reclaiming the coagulants of water systems which may be used repeatedly after treatment, as hereinafter described.

A further object of the invention is to remove from the raw water of water works valuable clay products, adapted for use in various arts and industries such as the ceramic art, paint pigments, etc.

Another object of the invention is to reclaim the coagulant from the sludge in an economical way. Economical as to time required, results obtained and apparatus employed.

Another object of the invention is to simplify the mechanical devices, that have heretofore been employed in the control of coagulating chemicals and to render the same more efficient.

Another object of the invention is to arrange the devices and methods employed so that they may quickly and readily be adapted to any system of coagulant feeding and control as now in general use.

Another object of the invention is to eliminate certain objectionable features of the present method of coagulant control so that less labor and supervision will be necessary to keep the devices in repair.

With the foregoing objects outlined and other objects in view which will appear as the description proceeds, the invention consists in the novel features hereinafter described in detail, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

Referring to the drawings:

Figure 1 is a partial sectional view of the most of the devices employed.

Figure 2 is a plan view of the devices shown in Figure 1.

Figure 3 is an enlarged sectional view of the digesting, mixing, crystallizing tanks and drying vats, etc., shown in Figure 1.

With the understanding that the same numerals designate like parts in all the views, 1 is a tank to store the re-agent used to dissolve the coagulant and separate it from the extraneous matter, in the present case and as an example, sulphuric acid is used. A predetermined amount of acid is allowed to pass through the valve 2 into a digesting tank 3 after which is added thereto slowly, with constant stirring, other substances to be described. These substances are mixed and stirred by an agitator 4 operated by any suitable power, as by hand or by an electric motor 5.

After being thoroughly mixed and digested, the mixture now being in a pasty condition, the mass is allowed to escape from the tank 3 through any suitable valve as 6 into a second tank, designated as a dissolving tank 7, through the spout 9. Into dissolving tank 7 water is discharged through the pipe 8 and valve as shown, in quantity sufficient to bring the digested coagulant contained in the mass into a water solution of the desired strength. The spout, or conveyor 9 is any convenient conduit from the bottom of tank 3 to the tank 7, the latter being conveniently placed to one side of the tank to provide an arrangement for extending the stirring apparatus whereby an additional stirrer 10 in the tank 7 may be operated by the same shaft 11 extending from the motor.

After the water and the digested mass from the tank 3 has been thoroughly mixed and allowed to stand in the tank 7 it will be found that a thick deposit will be precipitated in the bottom of the tank 7 and that this deposit will consist of pure clay, in appearance snow white, and having properties that render it more or less valuable in the ceramic arts, or the use as paint pigment, since the deposit will be free from the common clay impurities such as iron oxide, sand, organic matter, etc.

The clay deposit from tank 7 may be run through a discharge pipe 12 onto a dehydrating or drying bed 13 having an especially arranged porous bottom 14 and through which the water may be drained

out through the pipe system 15 and thence discharged into the sewer or waste; or if it is desired to discharge all of this clay product directly in the sewer or waste the same may be accomplished by discharging directly from the tank 7 through the pipe 15.

After the mass containing the digested coagulant has passed through the tank 3 into the tank 7 and kept constantly agitated with the required amount of water, the coagulant will be dissolved thereby and then may by syphoned from tank 7 into a solution storage tank 16 after it is freed from its deposit of clay and other foreign matter.

17 represents a crystallizing tank that may be used to crystallize the salt when it is desired to store the coagulant in solid form, it being supplied with the solution through a branch pipe 19 from the syphon 20.

The coagulant solution contained in the storage tank 16 may be measured in definite quantities through any orifice device 16′ to the raw water influent into the pipe 21. This pipe 21 brings the water from the water system mains.

22 represents suitably designed mixing chambers special features of which will be designated on individual installations, the function of which is to thoroughly mix the raw water and the chemicals (coagulants) this being an especially necessary condition, with the raw water influent. After the water and the coagulant are thoroughly mixed in the mixing chamber 22 it is passed to settling basing 23—23 conveniently supplied with hopper-shaped bottoms of the proper slope. These settling basins 23—23 have capacity carefully calculated and constructed so that the proper retention period is attained for the efficient precipitation of the suspended matter and other impurities being carried by the raw water. The sludge having been precipitated in the hopper shaped sumps of the settling basins, the partially purified water may be drawn from the top of these basins and delivered to the filters 26 where the remaining sludge and impurities are removed. From thence the purified water is delivered to any suitable storage for distribution to the consumer.

A special arrangement of wash-water effluent from the filter beds are provided to conduct the filter wash-water into the sludge draining pipe 24 together with the sludge removed from the settling basins 23—23.

At predetermined times the sludge from the bottom of the settling basins 23—23 is passed through pipes 24 supplied with suitable valves 25 and allowed to pass onto the dehydrating beds 27 having a porous bottom arranged so as to be placed in service in sections as illustrated. On these sectional drying beds the sludge is freed of all surplus water and allowed to remain ready for further use as required. The water from the dehydrating bed is conducted off in pipes 28 in a convenient sewer 29 or waste.

When the system is first put into operation the coagulating chemicals may be bought in the open market. The chemicals generally employed are aluminum sulphate, or iron sulphate. This material is dissolved in water to the required strength in dissolving tank 7 as described and conducted into storage tank 16 from whence it is measured in definite quantities through any orifice device 16′ into the raw water influent pipe 21 through the chemical solution pipe shown.

Ordinarily, the clay which I propose to collect in the dehydrating tank 13 is wasted, together with the coagulants, both of which constitute a part of the sludge which collects in the bottom of the settling basins and upon the top of the filter beds. These substances, which are valuable, have been usually passed into the waste. I am aware, however, that others have proposed to utilize this sludge as a coagulant, but it is new so far as I can ascertain to treat this sludge and use it as I propose, that is to say, this sludge is drawn from the bottom of the settling basins 23—23, and from the filter beds, and is passed to the dehydrating beds and is dried. I then propose to use this dried sludge as a source of coagulants, after the process of separation as described heretofore, over and over to coagulate and remove the impurities in the raw water to be purified.

The method I have adopted is that after the sludge is dried on the dehydrating beds 27 I collect it in its dry state and re-deposit it in storage near the digestion tank 3 from which place it is proposed to reclaim the coagulants therefrom as described and after the first run of the coagulant through the system to use the same over and over again instead of having to buy new chemicals such as commercial filter alum to be dissolved in tank 7. I have found that I can do this and in some cases preserve as much as 95% of the coagulant originally dissolved in tank 7.

Of course the substances and impurities in the raw water supply depend upon the constituents of the soil of the watershed or source, and the usual characteristic impurities consist of clay, organic matter, dissolved solids and other suspended matter. When the dried sludge is digested in the tank 3 with sulphuric acid a typical reaction follows as represented below:

$$Al_2(OH)_3+3H_2SO_4=Al_2(SO_4)_3+3H_2O+3H.$$

In other words, the sludge in combination with the sulphuric acid forms aluminum sul-

phate, water and hydrogen. When the sludge is conducted from the coagulating basins and the filter beds to the dehydrating beds 27 and dried a typical analysis would show the following constituents:

Iron oxide and alumina	18.77%	Equivalent to 3.54% coagulants.
Matter insoluble in H_2SO_4	65.56%	
Organic matter soluble in H_2SO_4	30.90%	
Total, on dry basis	100.00%	

When the dried material (sludge) is removed from the dehydrating beds 27 and returned to the storage to be used in the digestion tank 3 and then through the dissolving tank 7, it may be used in the place of the first charge of commercial alum, because at this stage of the process it has been reconverted into a solution that accomplishes the identical purpose for which the alum is used, besides being free from any foreign substance that would tend to clog the feeding valve or devices, or the chemical feed lines.

Hence the system comprises the injection of the solution from the tank 16, thence through the measuring orifice 16', thence through the chemical feed line to the point of injection in the raw water influent pipe 21, thence to the mixing chamber 22 together with the water to be treated, thence to the settling basins 23—23, conducting from the bottom of the coagulating basins the precipitated coagulant and the suspended matter (sludge) to the dehydrating beds 27 and drying the same, and conducting the partially purified and settled water from the top of the settling basins 23—23 to the filter beds to entrap the remaining sludge for the purpose of reclamation of the same, as well as to complete the purification of the water, then using the dried sludge as a source of coagulating chemical by digesting in sulphuric acid and dissolving the resultant mass in water to separate the sulphate solution from the insoluble and organic matter and then decanting the sulphate solution into the storage tank 16 to be used over again as before stated in the beginning of this description of the cycle. The insoluble clay product that remains in the tank 7 may be drawn off and dried in the dehydrating bed 13 for further valuable purposes as explained before.

I find that it is only necessary to add about five to ten per cent of ordinary commercial filter alum, or its equivalent of ore, to the ordinary procedure of water treatment, to supplement the yield of coagulant from the sludge treated by the process here described to keep the system running indefinitely, thus reducing the cost to a minimum. I have found in actual practice that the dried sludge is as efficient and much less trouble to manipulate than the sludge without drying on account of the freedom of insoluble matter in the coagulating solution produced, which insoluble matter found in ordinary filter alum clogs fittings and valves, etc.

In addition to the above advantages of this process there is obtained a considerable quantity of pure clay as heretofore described, collectible into tank 13 which is of considerable value commercially.

It is apparent that my method of treatment of sludge may be changed in various details and the apparatus and devices used are capable of different forms and changes without materially altering the invention.

What I claim is:

1. An apparatus for treating sludge comprising a mixing tank adapted to be connected to a water main, a mixing chamber also connected to the water main, settling chambers connected to the mixing chamber and a dehydrating vat with a porous bottom connected to the bottoms of the settling chambers whereby suitable chemicals may be introduced in desired quantities into the water main to coagulate impurities of water, the mixing chambers producing a thorough mixing of the chemicals with the water and the resulting coagulant drawn off from the bottom of the settling chambers and conducted to the dehydrating vat for drying purposes.

2. An apparatus to be used in the treatment of sludge comprising chemical mixing vats provided with stirrers, a dehydrating vat for drying the clay separated from the chemicals, connections between the clay dehydrating vat and the chemical mixing vat, connections from the chemical mixing vat to a water main, a mixing chamber connected to the water main, a settling chamber having a conical bottom, a second dehydrating vat for drying the coagulants in the settling chamber, and connections between the settling chamber and the coagulant dehydrating vat, whereby the clay of the chemicals may be separated therefrom before introduction into the water main and the coagulants in the water main may be withdrawn from the settling chamber directly to the coagulant dehydrating vat to be dried.

3. The method of treating water of water works comprising the mixing of suitable chemicals to be used, allowing the impurities in the same to settle, introducing the mixed and purified chemicals into the water to be treated, mixing the water and chemicals to coagulate the impurities in the water, separating the coagulant from the water, drying the same and using it as a chemical to again purify the water of the system.

4. The process of purifying chemically the water in water mains comprising mixing of the chemicals containing a comparatively large volume of clay, allowing the clay to settle, drawing it off and drying the same, conducting the purified chemicals to a water

main, thoroughly mixing in a mixing chamber the water and purified chemicals to coagulate the impurities in the water, conducting the coagulant to a settling chamber, conducting from the bottom of the settling chamber the coagulated materials in the water to a dehydrating vat and drying the same and conducting from near the top of the settling chamber the purified water and delivering it into the main and using the dried coagulant and other chemicals to purify more water.

5. The method of treating water of water works comprising the mixing of suitable chemicals to be used and allowing the impurities in the same to settle, introducing the mixed and purified chemicals into the water of a water main, mixing the water and chemicals to coagulate the impurities in the water in settling chambers, drawing from the top of the chambers the partially clarified water and conducting it to the filter bed, separating the coagulant from the water left in the settling chambers and using the coagulant as a chemical to again purify the water of the system.

In testimony whereof I affix my signature.

WALTER R. MATHIS.