

Nov. 19, 1935.

K. E. STUART

2,021,616

METHOD AND APPARATUS FOR INTRODUCING REAGENTS INTO LIQUID SUSPENSIONS

Filed Nov. 9, 1934

3 Sheets-Sheet 1

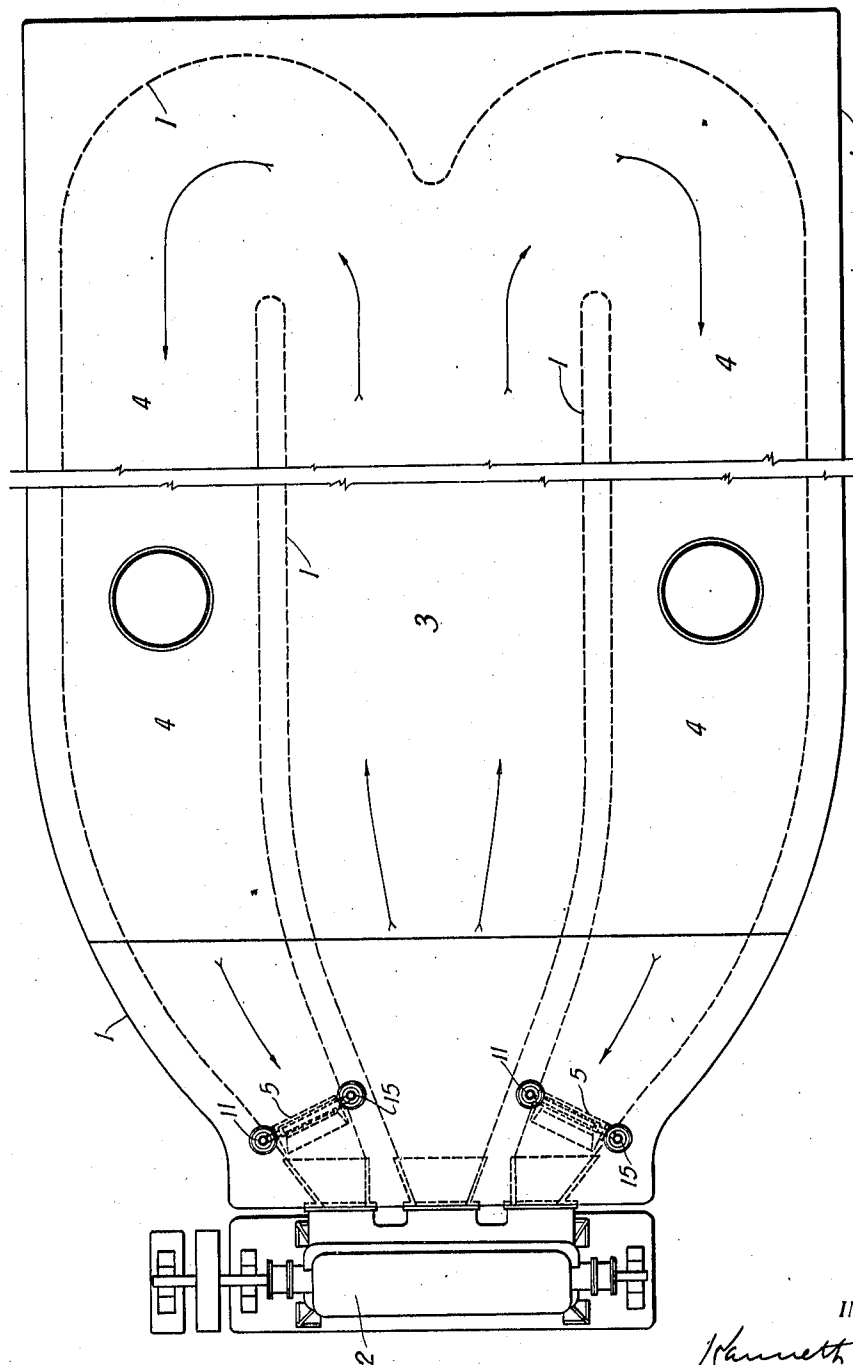


Fig. 1

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3 Sheets-Sheet 2

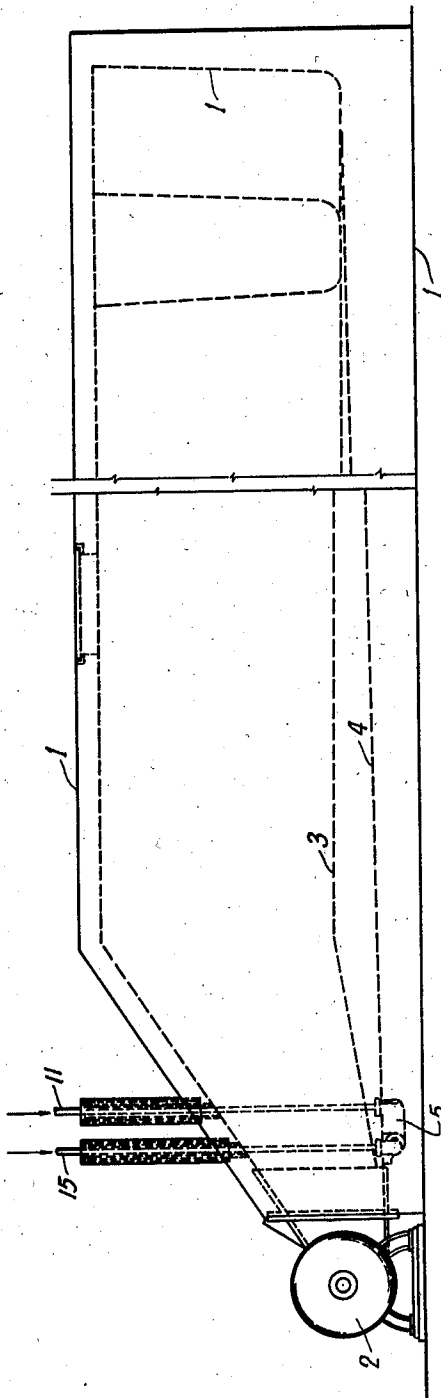


Fig. 2

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3 Sheets-Sheet 3

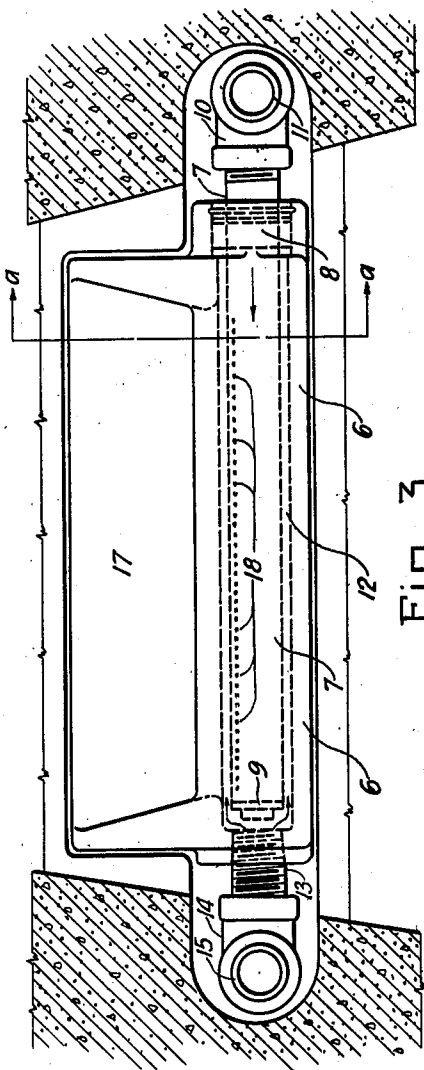


Fig. 3

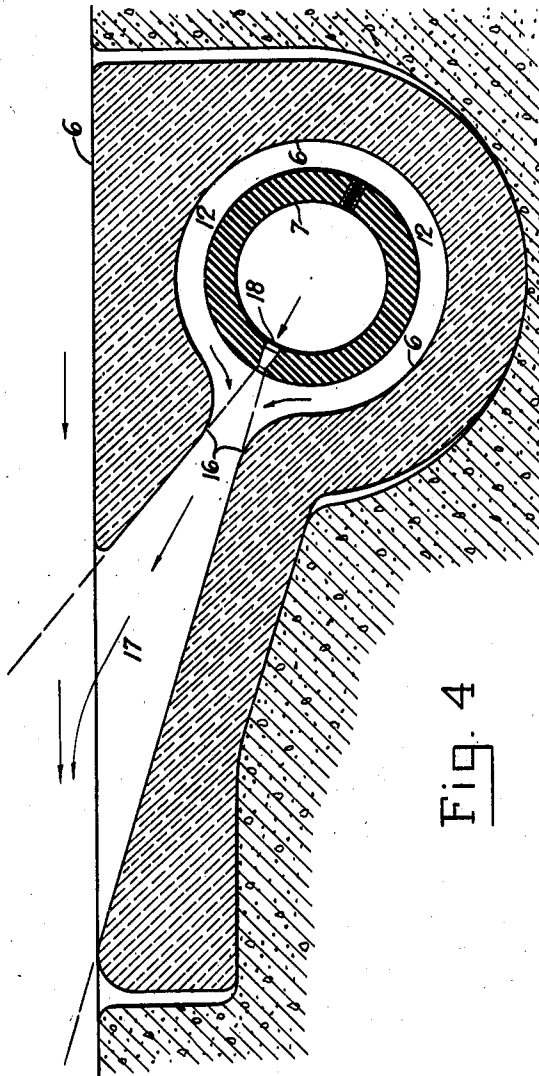


Fig. 4

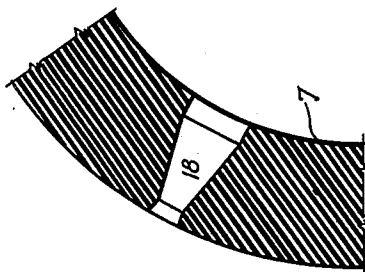


Fig. 5

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UNITED STATES PATENT OFFICE

2,021,616

METHOD AND APPARATUS FOR INTRODUCING REAGENTS INTO LIQUID SUSPENSIONS

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12 Claims. (Cl. 8—2)

My invention has for its object to secure more rapid diffusion of the reagent and more particularly when it is gaseous, throughout the liquid of the suspension and to provide simple apparatus for so doing.

One characteristic application of my invention is to the bleaching of paper pulp, and more particularly to those processes which involves a preliminary chlorination for the purpose of removing undesirable non-cellulosic constituents the bleaching of which needlessly consumes bleaching agents, while at the same time exposing the cellulose to unnecessary degradation.

It is well known that when chlorine is injected into water it tends to hydrolyze, forming both hydrochloric and hypochlorous acid. The former is of no value in the process of bleaching paper pulp. The latter is a very active oxidizing or bleaching agent and to that extent is useful. Nevertheless, if allowed to do so, it attacks and weakens the fiber. It is therefore important to perform the bleaching operation quickly. The dark color of wood fiber is due principally to lignin and other non-cellulosic constituents. It is these constituents that must be removed or bleached, the cellulose itself being mostly white and requiring little or no bleaching. The bleaching operation can therefore be expedited by first removing most of the dark constituents. These constituents can be rendered more soluble and hence more easily removable by chlorination. Therefore the first step in modern bleaching operations is a chlorination and this should be effected as rapidly and thoroughly as possible.

The hydrolysis of chlorine in water is not instantaneous and does not go on indefinitely. Only about one tenth of a per cent of hypochlorous acid can ordinarily be built up in a water solution. After that, the chlorine begins to go into solution. When the chlorine in solution has reached about one half of one per cent, the chlorine ceases to go into solution, commences merely to bubble through the water. In order to contact chlorine rapidly with paper pulp it is therefore necessary to inject it more rapidly than it can hydrolyze or go into solution, i. e., it must be injected in as nearly as possible at atomized condition and brought quickly into contact with the material to be chlorinated, so that it will combine with such material before it has had time to hydrolyze.

For this purpose it has heretofore been customary to inject chlorine through a perforated pipe or porous diffuser, or to mix it with a stream of water in a water-operated injector and intro-

duce the stream of water and chlorine through a perforated pipe. In the latter case, between the injector and the perforated pipe there is a time interval during which hydrolysis is proceeding. Moreover, if the paper pulp is circulating the perforated pipe itself projecting into the stream acts as an obstacle to flow and tends to cause irregular distribution of the chlorine throughout the mass of pulp.

My invention resides in the discovery that an injector may be submerged in the water suspension of pulp in such a way that the stream of water and chlorine impinges directly upon the material to be chlorinated at the very mouth of the injector, thus eliminating the time interval just referred to, during which hydrolysis is taking place. Moreover, if the pulp is circulating, as in the type of commercial apparatus known as a "bellmer", the injector may be spread out into a fan and built into the bottom of the bellmer, so that it will deliver the chlorine across the width of the bellmer while offering no resistance to flow. If desired, the thrust of the jet of water and chlorine may be utilized to assist the flow by giving to the jet a forward component.

My invention will be better understood by reference to the drawings, in which

Fig. 1 is a plan view of a bellmer embodying two of my injectors.

Fig. 2 is an elevation of the same.

Fig. 3 is an enlarged plan view of my injector.

Fig. 4 is a cross-section through my injector along the line *a—*a** of Fig. 3, looking in the direction of the arrows, to a still more enlarged scale.

Fig. 5 is a greatly enlarged sectional view of the water pipe of my injector, showing the form and construction of the orifices therein.

Referring to Fig. 1:

1 is the concrete wall of the bellmer and 2 the engine which lifts the stream of water and pulp into the central passage 3, where it flows by gravity in the direction of the arrows to the outer return passages 4, 4. This will be better understood by reference to Fig. 2. 5, 5 are two injectors of my invention, located as shown, in the return passages 4, 4, preferably as near as convenient to the engine 2, where the passages narrow and the velocity correspondingly increases.

The construction of injector 5 will be better understood from Figs. 3 to 5. From these figures it will be seen that the injector consists of a tubular casing 6 in which is co-axially aligned a pipe 7 which enters casing 6 through the stuffing box 8. Pipe 7 is closed at one end by plug 9. The other end of pipe 7 is connected through el-

bow 10 and pipe 11 to a source of water under pressure, (not shown) as a city water main. Between casing 6 and pipe 7 is an annular clearance 12, which is connected through pipe 13, elbow 14 and pipe 15 to a source of chlorine under pressure, as a commercial chlorine shipping container (not shown). Along one side of casing 6 is formed a slot 16, which has a filleted approach and flared exit, the whole constituting a venturi 17, of which the slot 16 constitutes the throat. Along one side of pipe 7 is a row of orifices 18, 18 directed into the throat of the venturi 17. The orifices 18 are preferably of the conical type in which the diameter diminishes in the direction of flow. In this type of orifice the molecules of water are crowded toward each other in passing through the restriction and rebound when beyond it, so as to follow paths diverging at approximately the angle of the cone which constitutes the orifice itself. This is illustrated by the dotted lines in Fig. 4. The molecules of water similarly diverge in every other plane passing through the axis of the cone. It is this which induces the zone of reduced pressure at the throat of the venturi; that is to say, the spreading apart of the molecules creates voids between them into which the gas contained in the annular clearance 12 flows to satisfy the partial vacuum in these voids. In this way the stream of water is for all practical purposes atomized. The gas is likewise atomized and the molecules of gas are intimately diffused through the molecules of water, in accordance with the theory of injectors.

The orifices 18 are aligned with the throat 16 of venturi 17 and spaced apart at such a distance that their streams contact and blend into a continuous sheet of water at the throat of the venturi. Thus the jet takes the form of a sheet of water and chlorine which may be extended transversely of the stream of pulp so as to better distribute the chlorine to the pulp, as illustrated in Fig. 1.

The entire injector assembly, comprising casing 1, venturi 17 and pipe 7, etc., may be let into the concrete floor of the bellmer and the venturi directed upwardly and forwardly with the mouth of the venturi flush with the floor of the bellmer, as illustrated in Fig. 4. With this construction the injector offers no obstruction to flow of the pulp but, on the contrary, the thrust of the jet tends to assist the flow.

The casing 6, which is preferably integral with venturi 17, may be of chemical stoneware, which is entirely unaffected by wet chlorine. The pipe 7, plug 9, elbows 10, 14 and pipes 11, 13 and 15 may be of hard rubber, pipes and fittings of this material in all standard sizes being now commercially available. The orifices 18 are preferably formed in pipe 7 itself by drilling through both sides, reaming out one row of holes from the inside to give the conical shape and plugging the opposite row of holes, as illustrated in Figs. 4 and 5.

When the water and chlorine are shut off from pipes 11 and 15 respectively the water in the bellmer will back up into these pipes as high as the water level in the bellmer. These pipes should therefore be of hard rubber up to this level, beyond which point ordinary steel pipes may be used. The pulp in the bellmer will not back up into annular clearance 12 as its consistency is such that it packs loosely into the venturi and bridges over the throat 16. It cannot therefore enter clearance 12 or orifices 18, to any considerable extent. Any loose individual fibers that

may enter will be readily blown out again when the streams of water and chlorine are turned on.

My invention therefore provides a simple, durable and nearly trouble-proof apparatus that is at the same time more efficient than any heretofore known, in that the chlorine is better diffused throughout the mass of pulp with less time for hydrolysis and no obstruction to flow.

While I have illustrated my invention as applied to the chlorination of paper pulp in a bellmer, I do not wish to be limited thereto, as it is obviously suited to other purposes, and in general to any situation in which it is important to rapidly diffuse a reagent into a liquid suspension of finely divided solids. Neither do I wish to be limited to the exact construction illustrated, as many modifications in design and materials of construction are obviously possible.

For example, the invention is not limited to the type of jet illustrated but, on the contrary, any type of simple or multiple jet directed at any angle is within the scope of the invention, provided it is submerged in such a way that the stream of liquid and reagent is delivered directly against the material to be reacted upon, in contradistinction to the prior practice of mixing the liquid with the reagent at a distance and conveying it to the reaction zone, as through a pipe.

What I claim is:

1. An apparatus for introducing elemental chlorine into a body of pulp in a water suspension comprising in combination with an open-type container for said suspension an injector and connections for conveying water and chlorine under pressure thereto, said injector being completely submerged beneath the surface of the suspension near the bottom of said container and adapted to deliver its stream of water and chlorine directly against the suspension and means for circulating said suspension.

2. An apparatus for introducing elemental chlorine into a body of pulp in a water suspension comprising in combination with an open-type container for said suspension an injector terminating in a venturi and connections for conveying water and chlorine under pressure thereto, said injector being completely submerged beneath the surface of the suspension near the bottom of said container and adapted to deliver its stream of water and chlorine against the suspension at the mouth of the venturi and means for circulating said suspension.

3. An apparatus for introducing elemental chlorine into a water suspension of pulp flowing at relatively low velocity in a bellmer comprising in combination with said bellmer and the pulp circulating means associated therewith an injector terminating in a venturi and connections for conveying water and chlorine under pressure thereto, said injector being set into the bottom of the bellmer with the mouth of the venturi flush with the surface thereof.

4. An apparatus for introducing elemental chlorine into a water suspension of pulp flowing at relatively low velocity in a bellmer comprising in combination with said bellmer and the pulp circulating means associated therewith an injector and connections for conveying water and chlorine under pressure thereto, said injector being submerged in the suspension near the bottom thereof and delivering its stream of water and chlorine in a direction having a forward component with respect to the direction of flow.

5. An apparatus for introducing elemental

chlorine into a water suspension of pulp flowing at relatively low velocity in a bellmer comprising a tubular casing extending transversely of said flow and submerged at the bottom of said suspension, a pipe leading from a source of water under pressure and passing through a stuffing box into said casing in co-axial alignment therewith, said pipe terminating within said casing in a closed end, a clearance of annular cross section between said pipe and casing, a connection to said clearance from a source of chlorine under pressure, a slot along one side of said casing and a row of orifices along one side of said pipe directed into said slot, said orifices being conical, with the smaller end outward, whereby the stream from each orifice is caused to fly into rapidly divergent droplets, said orifices being so spaced that the streams therefrom contact each with the adjacent streams near the entrance to said slot and form a continuous sheet of water substantially filling the cross section of the slot, said slot having the form of an elongated venturi adapted to cooperate with the jets to create a zone of reduced pressure at the entrance to the venturi, the whole constituting an efficient injector in which chlorine is atomized and diffused throughout the water of the jet and delivered by it directly against the pulp.

6. The method of reacting elemental chlorine with a body of pulp in a water suspension which comprises introducing the chlorine into an atomizing jet of water completely submerged beneath the surface of the suspension and impinging directly upon the suspension, whereby the chlorine is quickly and intimately contacted in finely dispersed state with a large body of pulp to produce chiefly a chlorinating effect upon the pulp.

7. The method of reacting elemental chlorine with a body of pulp in a water suspension which comprises introducing the chlorine into an atomizing jet of water upwardly directed from the bottom of the suspension and impinging directly upon the suspension while circulating the suspension, whereby the chlorine is quickly and intimately contacted in finely dispersed condition with a large body of pulp to produce chiefly a chlorinating effect upon the pulp.

8. The method of reacting elemental chlorine with a body of pulp in a water suspension flowing at relatively low velocity which comprises introducing the chlorine into an atomizing jet of water completely submerged beneath the surface

of the suspension and impinging directly upon the suspension, whereby the chlorine is quickly and intimately contacted in finely dispersed condition with a large body of pulp to produce chiefly a chlorinating effect upon the pulp.

9. The method of reacting elemental chlorine with a body of pulp in a water suspension flowing at relatively low velocity in a gravity stream which comprises introducing the chlorine into an atomizing jet of water completely submerged beneath the surface of the suspension and impinging directly upon the suspension, whereby the chlorine is quickly and intimately contacted in finely dispersed condition with a large body of pulp to produce chiefly a chlorinating effect upon the pulp.

10. The method of reacting elemental chlorine with a body of pulp in a water suspension flowing at relatively low velocity in a gravity stream which comprises introducing the chlorine into an atomizing jet of water upwardly directed from the bottom of the suspension and impinging directly upon the suspension, whereby the chlorine is quickly and intimately contacted in finely dispersed condition with a large body of pulp to produce chiefly a chlorinating effect upon the pulp.

11. The method of reacting elemental chlorine with a body of pulp in a water suspension flowing at relatively low velocity in a gravity stream which comprises introducing the chlorine into an atomizing jet of water upwardly directed from the bottom of the suspension and impinging directly upon the suspension and forwardly directed with respect to the flow of the suspension, whereby the chlorine is quickly and intimately contacted in finely dispersed condition with a large body of pulp to produce chiefly a chlorinating effect upon the pulp.

12. The method of reacting elemental chlorine with a body of pulp in a water suspension flowing at relatively low velocity in a gravity stream which comprises introducing the chlorine into a plurality of atomizing jets of water spaced transversely of said flow, upwardly directed from the bottom of said suspension and impinging directly upon the suspension, whereby the chlorine is quickly and intimately contacted in finely dispersed conditions with a large body of pulp to produce chiefly a chlorinating effect upon the pulp.

KENNETH E. STUART.