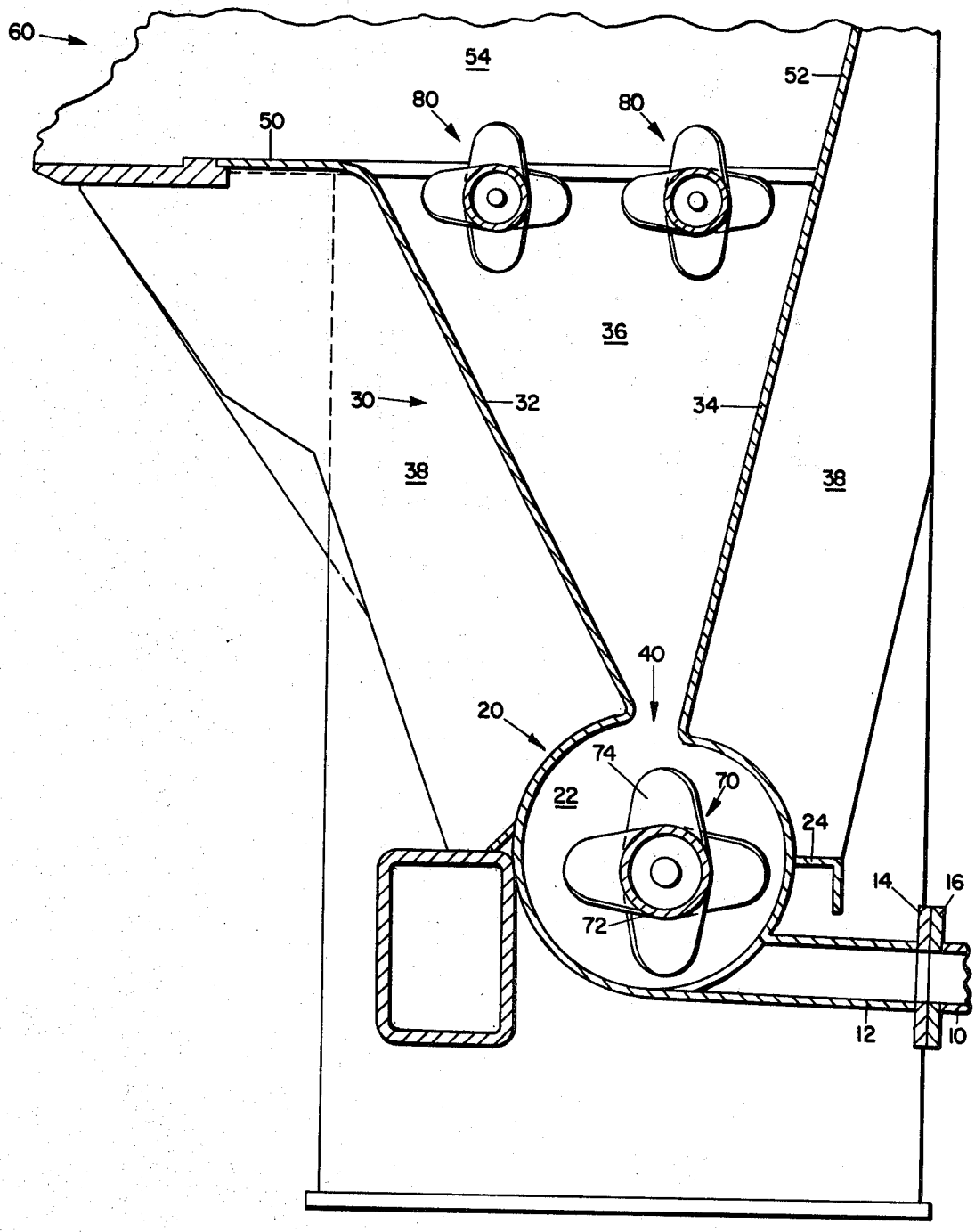
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STOCK DISTRIBUTOR

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STOCK DISTRIBUTOR

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ABSTRACT OF THE DISCLOSURE

A flow control device disposed beneath and communicating directly with the headbox of a papermaking machine and including an inlet extending transversely of the entirety of the headbox width for receiving the flow of stock from a supply point, the inlet communicating with the bottom-most sector of an explosion chamber of generally circular cross section extending transversely of the entirety of the headbox width, with the top-most sector of the explosion chamber having an opening defining a constricted passageway leading into the bottom of a vertically-extending gradually-enlarging throat also extending transversely of the entirety of the headbox width and with the top of the throat communicating with an opening in the floor of the pond of the headbox, the explosion chamber containing a single rotatable homogenizer roll and the top-most portion of the throat containing a plurality of rotatable homogenizer rolls in a spaced side-by-side relationship.

BACKGROUND OF THE INVENTION

(1) Field of the invention

The invention is primarily concerned with means for breaking up the currents which enter the body of the headbox and to assist in the attainment of good mixing and distribution across the width of the forming area of the papermaking machine.

My structure allows conversion of a flowing stock stream of circular cross section to a flowing, constantly-agitated stream of rectangular cross section and thence to a flowing stream of gradually-widening cross section, which allows the attainment of a well and uniformly dispersed mixture having a relatively slow forward velocity at the point of entry into the headbox pond as achieved by cooperant agitation means which induce small multi-directional currents for keeping the fibers dispersed and, accordingly, amenable to close and uniform web formation wherefore the strength of the formed web is generally more equalized in both the forward and cross directions and the uniformity of the web mass in all are more consistent than has been possible to achieve in any headbox heretofore known.

(2) Description of the prior art

Relatively complicated flow devices are known. One approach has visualized resort to multiple feeds to the headbox by means of small pipes across the machine width, the stock being normally pumped thereto through a single pipe to a manifold having a plurality of outlets leading into the headbox, each outlet serving, objectionably, to create its own set of currents or turbulences. Such a plurality of forward currents has led to unequal velocities between the points of flow, not to mention dead spots, eddies and fluctuating cross currents.

Numerous supplemental correctional devices have been resorted to, such as perforated boards, adjustable partitions, racks, discs, and the like, to eliminate the created conditions. Notwithstanding various attempts to merge these currents, it has been exceedingly difficult to destroy them altogether, wherefore they persist at the sluice, or "slice."

Headboxes have been employed having relatively large compartments, resulting in slow flows of stock streams so that the pulp fibers suspended in the carrier become quiet and flocculation and settling occur, leading to a mottled and uneven sheet. It is necessary to keep the mass moving at a velocity sufficient to preclude such state of quiet and the resultant flocculation and settling. Efforts in this direction involving the use of a plurality of adjustable partitions have encouraged the forming of longitudinal currents in the headbox flow and have allowed an excess of exposed surfaces, which tend to collect fibers, and chemicals and to form incrustations.

Other systems have incorporated explosion chambers and flow manifolds. Turbulence, caused by a sudden flow enlargement or by a quick reversal of flow direction, tends to break up flocculation and to provide additional mixing. However, it usually allows eddies, spirals and cross currents and induces air entrapment so as to disturb the sheet formation technique.

The prior constructions, aimed in various ways to solve the inherent problems, appear consistently to be attended with certain serious disadvantages and limitations which have militated against their more general adoption.

SUMMARY OF THE INVENTION

The invention relates broadly to the control of a confined stream of an aqueous suspension of papermaking fibers by way of a flow control means for the spreading and quieting of such stream in the stock conduit system of the web-forming machinery, while creating a controlled micro-current pattern in the suspension to maintain an organized dispersion of fibers and filling solids.

To produce a paper sheet having uniform physical properties, the paper stock delivered to the web-forming region of the machine should be evenly distributed across the machine width. The kinetic energy and potential energy in unit areas of the stream delivered to the web-forming region should be as uniform as possible throughout the stream cross section, and in addition, the entire stream should be maintained in a condition which is as near to a steady-state flow as it is possible to obtain.

This invention envisions a new and novel means wherein a flow spreader and headbox participate in a conjoint result of supplying a single, steady, wide, smooth, quiet, thoroughly-mixed, uniform stream of the aqueous suspension, free from large eddies, or flocculations, to the web forming component of the machine.

As is known, the headbox or flow box delivers to the web-forming means a suspension of fibers and other additives dispersed in a water vehicle, the delivery being at a predetermined velocity through an orifice or slice which extends laterally across the width of the machine, for deposit upon the web-forming means. Such web-forming means, in the case of a Fourdrinier type of machine, comprises a continuously-travelling endless wire, having a generally horizontally-extending run through which, by means including capillary action and surface tension, the water is drawn so as to leave upon the upper planar surface of the wire a mat or web of the papermaking fibers.

The principle hereof can be applied to the point of approach to any web forming machine.

The desideratum of supplying to each increment of the web-forming area an equal and uniform distribution of fibers, under steady-state flow conditions, in the form of a moving mass of water and fibers in suspension, with each lamina thereof moving in the machine direction at the same velocity and under such pressure as to allow a delivery velocity equal to the speed of the travelling forming wire, is well understood and accepted in the papermaking art.

Disturbingly, a high flow velocity is usually associated with violent currents in the flow direction. In some cases,

the desired deflocculation is achieved, but at the expense of creating irregularities across the web, due to uneven streams within the greater mass of fiber suspension. Such lack of uniformity deleteriously affects the web strength and causes unevenness which interferes with the quality of the end product.

It is well known that pulp fibers will flocculate or settle unless agitated or kept in motion or caused by some physical-chemical means to oppose each other, which flocculation will cause a mottled or blotchy formation and which settling will cause a massing of fibers, with the masses breaking away and causing spots in the sheet, and if large enough, breaks at the presses and/or at other points.

This condition presents consistent difficulties to the task of delivering a uniform suspension of fibers to the web-forming region, and is aggravated by the problems inherent in avoiding the formation of currents in the suspension.

As to directionality, an absence of parallel flow in the machine direction signifies a presence of cross currents which cause variations in the quantity of fibers delivered across the lateral width of the forming area, resulting in heavy and light areas across the formed sheet. This is known as "skating."

It follows, therefore, that optimum formation depends upon two factors: (1) a uniform flow of the mixture of pulp and water to the web-forming area; and (2) a uniform dispersion of the fibers upon the carrying medium.

BRIEF DESCRIPTION OF THE DRAWING

The figure is a broken side elevational view of a stock distributor of the invention disposed generally beneath the headbox of a papermaking machine (not shown).

DESCRIPTION OF THE PREFERRED EMBODIMENT

The outflow end of a delivery section comprises a first or inflow or feeder conduit **10** of generally rectangular cross section and of a width which extends transversely of the headbox to the extent of the width of the headbox, all to the end of defining an inlet slot or adjacent slots of a cross section generally similar to that of a sluice.

A single fishtail or fanshaped inlet of such cross section is preferred over a plurality of circular pipes disposed in a side-by-side relation, all in order to allow a flow into the next-succeeding component with a minimum of strong individual currents.

The flow may be distributed transversely across the headbox width by other inlet systems such as by the use of a multiplicity of T conduits wherein the flow from a single conduit is broken down into subdivisions a plurality of times preferably by multiple fishtails, before actual ingress is made into the next-succeeding component.

The single fishtail type of flow spreader having a main axis extending in a generally horizontal plane is known to comprise horizontally-extending upper and lower walls, which walls generally diverge away from each other between their entry and discharge extremities and a pair of oppositely-spaced outwardly diverging side walls, each merging smoothly with the respective adjacent edges of the upper and lower walls, thereby to form an enclosed fan-shaped flow chamber.

By such flow spreader structure, the stock is constrained to flow horizontally-forwardly through the fan-shaped flow chamber defining an ever-widening side-to-side dimension or width.

The width of the exit extremity will correspond to the lateral width of the associated head box and the machine width.

Here again, it will be observed that the flow spreader has widened the rectangular section progressively and gradually to the full width of the machine wherefor the stock flows therein in a constantly widening stream and flows outwardly therefrom to the related components.

The spreading length is according to the width of the flow inlet and the width of the flow box and the spreading angle is within limits that will permit uniform spreading of the flow.

Stated otherwise, the fiber suspension is transformed from its flow of circular cross section to a flow of relatively flat cross section within the flow spreader and is spread evenly widthwise of the machine so as to preclude the development of uneven stock conditions at the web forming area.

The first conduit has an exit terminal or outflow suitably joined to a second conduit **12** of corresponding cross section and dimensions by means of coupled flanges **14** and **16**, as shown.

As will appear, the flow to the headbox is by means of a conventional pumping mechanism, not shown, from a supply point, also not shown, through first or inflow or feeder conduit **10** and second conduit **12**.

Second conduit **12** has an inboard terminal which merges tangentially into and communicates with the lowermost sector of an explosion chamber **20** of generally-circular cross section, said explosion chamber having a width which extends transversely of the headbox for the entirety of the headbox width.

Explosion chamber **20** is closed at its opposite ends by vertically disposed side walls **22** and may be supported with respect to the papermaking machine as by suitable cross rails, such as **24** or the like.

As will appear, the desideratum is to convert the flow from the rectangular cross section of second conduit **12** to the round section of explosion chamber **20**.

A throat, generally indicated by numeral **30**, is essentially of a fan or fishtail configuration having a main axis extending in a generally-vertical plane and will be seen to comprise outwardly-inclined front and rear walls **32** and **34** respectively, said walls generally diverging from each other from their lower to their upper extremities, and a pair of oppositely-spaced vertically-disposed side walls **36** (only one of which is shown) at opposite sides of the headbox, which side walls **36** merge with the respective side walls **22** of the explosion chamber.

Walls **32** and **34** will be understood to extend transversely of the headbox to the extent of the width of the headbox and to be supported by suitable webs or similar supporting members **38**, walls **32** and **34** connectiing to walls **36** at the respective corners in a throat-defining manner.

The lower extremities of walls **32**, **34** and **36** of the explosion chamber merge into the respective side edges of a slot **40** formed in the topmost portion of the wall of the explosion chamber and also extending transversely through the width of the headbox, while the upper extremities of walls **32**, **34** and **36** merge into the respective floor **50**, rear wall **52**, and side walls **54** of the headbox, generally indicated by numeral **60**.

Thus, the throat defines a passageway having an ever-widening approach to the headbox pond.

A large quiet headbox will eliminate currents but such allows the fibers expression of their tendency to coagulate. A smooth flow at relatively slow speed, with the fibers at rest relative to one another, is known to allow conditions that promote flocculation, slime formation and stock accumulation in the dead spots.

Contrariwise, a strong agitation, while mixing the fibers thoroughly and dispersing them will create the very objectionable cross currents and eddies I seek to avoid.

The design hereof, accordingly, is a compromise between the two extremes and comprehends interference devices to promote the required agitation so as to disperse the fibers.

The flow box or head box per se comprehends transversely-spaced vertically-extending side walls **54** and **54** and interconnected transversely-spaced vertically-extending forward and rearward walls and a bottom wall **50** to define a pond therewithin.

As is conventional, a slice, not shown, is provided, the stock and water suspension flowing from the head box through the slice, said slice having the primary function to deliver a sheet of liquid of uniform thickness and equal velocity across the width of the web-forming instrumentalities.

Explanitorily, the operation of a paper machine for a grade or type of paper must be such as to deliver a constant amount of fibers at all times. The amount of water accompanying the fiber onto the web-forming elements may be varied to improve the formation or change the qualities of the finished sheet. In other words, the consistency (pounds of fiber/pounds of water) in the head box can be varied and the adjustment of the top lip of the slice will allow a constant head to be maintained. For example, if the machine tender wishes to reduce the head box consistency by adding more water, he can raise the top slice lip, increase the opening, and still maintain the head.

A homogenizer roll **70**, of the type disclosed in my patent, No. 3,224,929 of Dec. 21, 1965, is disposed within explosion chamber **20**, being suitably journalled at its opposite ends in the opposite side walls **22**.

The roll may comprise a longitudinally-extending rotatable cylindrical shell or tube **72** having outwardly-projecting solid trunnions at opposite ends of said shell for insertion through the respective adjacent side wall of the explosion chamber in suitable journal or bearing means mounted in said side walls whereby the agitating unit may be positioned between and intercoupled with the confining opposite explosion chamber walls in running relationship therewith.

On the outer peripheral surface of shell **72**, a multiplicity of radially-arranged outwardly-extending fins or vanes **74** are stationarily secured, each fin or vane being disposed angularly or obliquely relatively to the longitudinal axis of the shell.

The fins are grouped as groupments or sets, the fins of each groupment or set being arranged in a longitudinally-extending row in equi-spaced distance from each other and parallel relationship as to each other, with the axis of the row being parallel to the longitudinal axis of the shell.

The fins of a groupment or set divide the surface area of the shell along the axis thereof as defined by said groupment or set into a plurality of substantially equal segmental sections.

The fins of one set in one row and the fins of another set in the adjacent row are disposed in angularly intersecting planes as the shell is rotated.

The rows, there being 4 in number in the illustrated embodiment, are equidistant from each other, they being disposed approximately 90° from each other, though it will be understood that the number of rows can be varied so that the angle therebetween may be greater than or less than said 90°.

As to their angular or oblique disposition, the fins of adjacent rows are alternately disposed to effectuate the reversing of cross currents which serve to mix the stock and to reorient the fibers so that many of them will have their longitudinal axes at right, or approximately right, angles to the direction of flow instead of being aligned with the flow, as is normal, thereby serving to tend to equalize directional strength and to aid in the formation of the web.

Further as to their angular or oblique disposition, the fins of one axial row may be arranged at a certain angle relative to the shell longitudinal axis, and the fins of the next adjacent axial rows are preferentially, though not obligatorily, arranged at an angle opposed to the said certain angle in the said one axial row for purposes of effectuating, upon the shell rotation, opposing sets of miniature or localized cross currents in the sense that the set of miniature or localized cross currents enduced by the said one axial row are opposed by the set of miniature or localized cross currents induced by the said adjacent axial row to allow a wobbling or back-and-forth movement, on which is repeated over and over as the shell is rotated. Thereby a shearing action results which causes the stock to be deflected first in one direction and then in the opposite direction so as to allow complete overlapping and intermingling before delivery to the throat **30**, simultaneously avoiding stock flocculation and minimizing the development of erratic eddy currents and other non-uniform flow conditions.

Stated otherwise, the adjacent rows function to establish a wobbling or constantly changing movement in the flow of the stock stream flowing therepast, to the end that the assemblage functions as an improved means for insuring more random distribution of the fibers.

A rotative movement is imparted to the homogenizer roll by a power means, not shown.

As the shell is rotated within a single cycle of 360° of rotation, the fins present segments of mutating planes relative to the axis of the shell so as to create the said wobble action by impelling the stock first in one direction and then in another whereby the flow is transversely broken into a plurality of very fine cross currents. The fins rotate to impart a wobble effect to the streams, as they flow between the fins and then flow into and merge with adjacent eddies to effect the ultimate desired interweaving and uniform fiber distribution in the sheet formation. By such rotative movement, the shive problem wherein the fibers tend to deposit and to string on the fins and the shell is solved.

The function of the roll in the explosion chamber is to subject the stock to direct agitation so as to destroy any longitudinal currents before they enter the throat. Such agitation also precludes any stagnation or clotting or lumping or adhering of fibers to the explosion chamber walls or to the components of the roll for the reason that the activity in this area is so great as to avoid same.

The roll is placed in such manner as to act upon the inflow into the explosion chamber and at the same time to avoid any short circuiting, being slightly offset with respect to the main central axis of the explosion chamber.

The rearward edge of slot **40** will be observed to be lower than or below the horizontal plane of the forward edge of the slot so as to permit avoidance of the throw naturally generated by the rotating of homogenizer roll **70**, all to the end that currents are cut as they enter the explosion chamber. That is, the turning of the roll against the currents and dispersing them, will tend to throw the flow to the afterchamber and to force same toward the papermaking machine, following the left hand side of the explosion chamber wall as viewed in the drawing. The arrangement as shown offsets this effect.

A pair of homogenizer rolls **80**, also of the general design as taught in my earlier patent, supra, are disposed in the topmost portion of throat **30**, each being journalled in the opposite side walls **36**.

The rolls are disposed in the same horizontal plane in manner such that their agitator fins or blades reach upwardly into the lower planes of the pond as they are rotated.

The rolls are close together so that, whereas relatively high velocities will occur in the throat, there is an inherent tendency for the stock to stagnate at lower velocities. The new currents of desirable characteristics are created by the homogenizing action, in the pond prior to the slice. In effect, the rolls serve to "put life" into the fibers of the suspension in the pond.

The number of homogenizer rolls used in this position will depend upon the required dimensions of the head box, which involves volumes consistant with quantities suspension required for a given range of web production.

The rolls generally comprehend an arrangement and operation of a plurality of units disposed in manner to keep the pond alive, to eliminate flocking, to destroy objectionable currents, and to better prepare the stock for

delivery to the slice and the forming wire or mold under controlled conditions of uniform velocity flow.

Basically, by such rolls, I provide means whereby the stock stream meets identical resistance across its entire width and is evenly fed to the forming surface at a single, selected velocity. Simultaneously therewith, I cure other specific prior art defects inclusive of the formation of light and heavy streaks running in the machine direction at regular or varying spaced intervals across the machine width by the deliberate and intentional creation of a pattern of a multiplicity of minute cross currents for effecting improved random dispersion of the fibers.

As known, a momentary speed increase followed by a sudden speed decrease creates small eddy currents which break up fiber flocs. Pin racks, perforated plates and rolls have all been heretofore used for this purpose.

The agitating units hereof effectuate a reduction in area through which the fluid flows.

At the point of reduced area, the stock velocity is increased and upon moving past the agitating unit or units, the velocity of stock and water is again decreased.

Rotative movement is imparted to each roll by a power means, not shown. Preferably the rolls are rotated in opposite directions and in timed relation to the rate of stock flow, though they may be rotated in the same directions, if desired, and/or at varying rates of speed so that they are rotated either in unison or out of unison and at constant or variable speeds.

By the employment of a multiplicity of such rolls at the inlet to the pond, the agitating action is spread over the entirety of the area within the throat discharge and the pattern of fine currents created thereby is spread out with the currents gently overlapping each other so as to enhance the uniformity.

As the fins are rotated within a 360° cycle, they circumscribe a wobbling effect as they each rotate about a point defining the center of the shell. Being so mounted, they produce a fine pattern of rapidly recurring and reversing currents. That is, they present segments of mutating planes so as to impart an oscillatory motion to the streams of stock passing therebetween and thereby effectuate the random distribution of the fibers uniformly and evenly at all points throughout the length of the roll as the converging streams intermingle upon having passed between the fins on the roll.

The rolls of the pair are disposed in alignment as to each other in a plane angularly related to the horizontal axis of the stock in the pond thereabove.

All prior art headbox designs have one feature in common; the rectifying rolls thereof, whether stacked longitudinally with respect to the flow or otherwise do not effectively destroy the longitudinal flow patterns. "Holey" rolls of prior art designs do not help to obviate the clotting effect. As the indenting moves toward spreaders of larger size and to flows of greater speeds, the "holey" rolls in effect tend to serve as dams and to dam the flow so that clotting above the rolls frequently results. The usual technique to prevent this clotting is to lower the pond level but such only further restricts the flow.

Herein, I provide agitating units within the headbox transversely of the flow so as to effectuate a breaking in the pattern at every one-quarter turn of each said unit.

The rate of turning contemplated is within a ratio of 2:1 and 10:1, relative to the rate of forward flow past the agitators, all so as to effectuate a continuous and repetitive pattern of small cross currents.

It is believed that the gist of the invention will be clearly understood from the foregoing disclosure and accordingly, further analysis thereof at this point is considered unnecessary, as I have in accordance with the provisions of the patent statutes, described the construction and principle of operation of my invention together with the apparatus which I believe to represent one of the best embodiments thereof, to the end that others can, by applying current knowledge, readily adapt it for various applications without omitting features which, from the standpoint of prior art, fairly constitute essential characteristics of its generic and/or specific aspects.

The claims are desired to include within the scope thereof all of said suitable variations, modifications and equivalents by which substantially the results of the invention may be obtained through the use of substantially the same or equivalent devices or means. Accordingly, limitation hereof should only be made as determined by a proper interpretation of the prior art and the scope of the subjoined claims, in which it is my intention to claim all novelty inherent herein as broadly as possible.

I claim:

1. In a flow control apparatus of the class described comprising:

a primary conduit for containing a flowing stream of fluid,

said primary conduit being laterally-diverging and increasing in width from its inflow to its outflow,

an explosion chamber of substantially circular cross section and of a width complemental to the width of the primary conduit at its outflow end and having a slot formed therein and extending transversely through the width thereof,

the rearward edge of the slot being disposed below the horizontal plane of the forward edge of the slot,

a throat disposed vertically above the explosion chamber and communicating with the slot,

the throat being fan-shaped and having a general configuration of walls converging away from each other from their lower to their upper ends,

a headbox communicating with and disposed vertically above the throat,

primary agitating means comprising a rotatable finned homogenizer roll within the explosion chamber disposed parallel to but slightly offset with respect to the main central axis of the explosion chamber, and

secondary agitating means comprising at least two rotatable finned homogenizer rolls disposed within the throat in the same horizontal plane adjacent the discharge into the headbox.

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