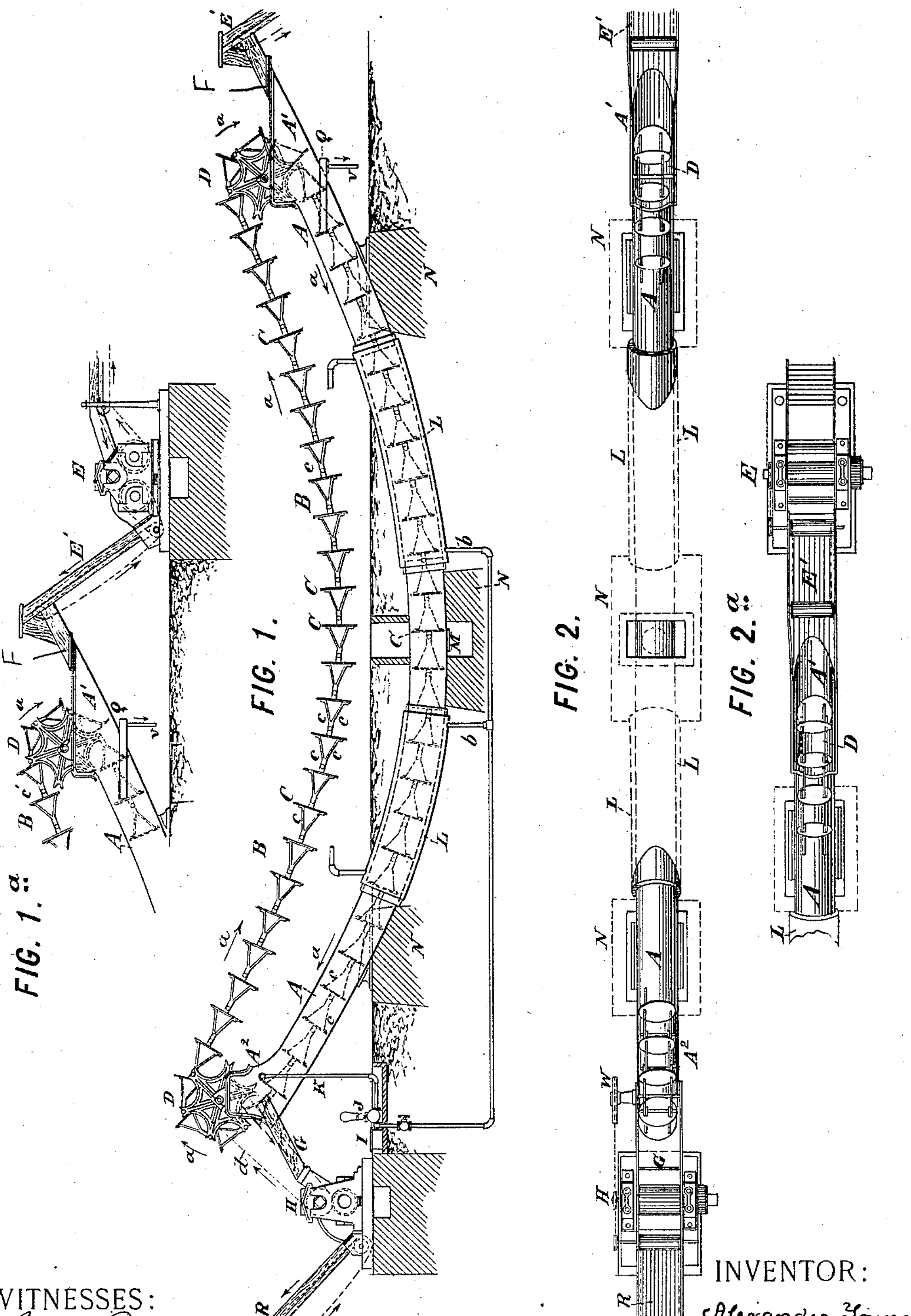
(No Model.) 4 Sheets—Sheet 1.

A. YOUNG.
DIFFUSION APPARATUS.

No. 418,262. Patented Dec. 31, 1889.



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INVENTOR:
Alexander Young,
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FIG. 3.

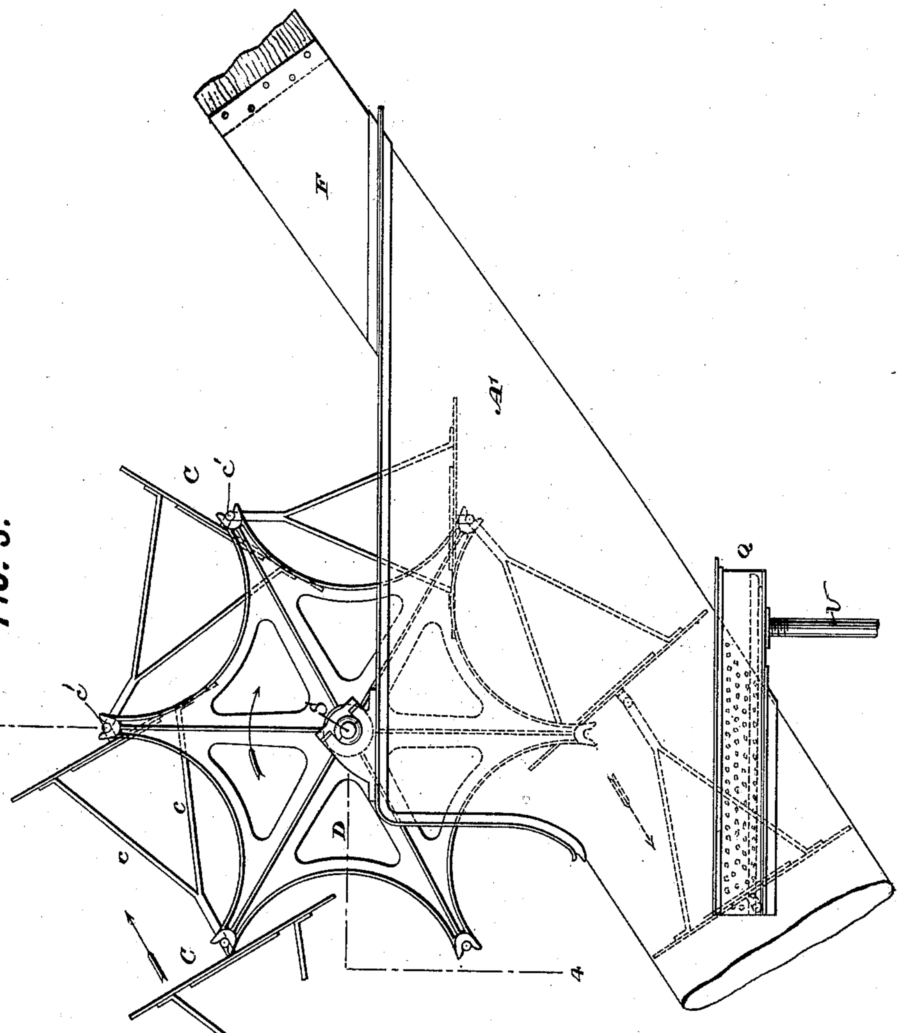
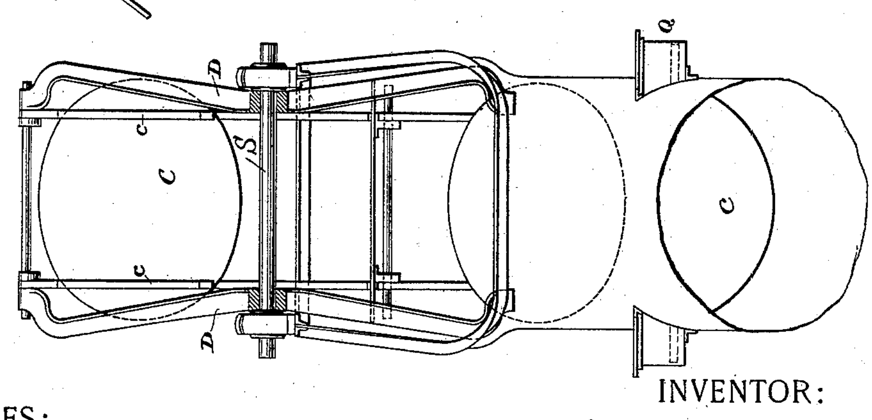


FIG. 4.



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(No Model.) 4 Sheets—Sheet 3.

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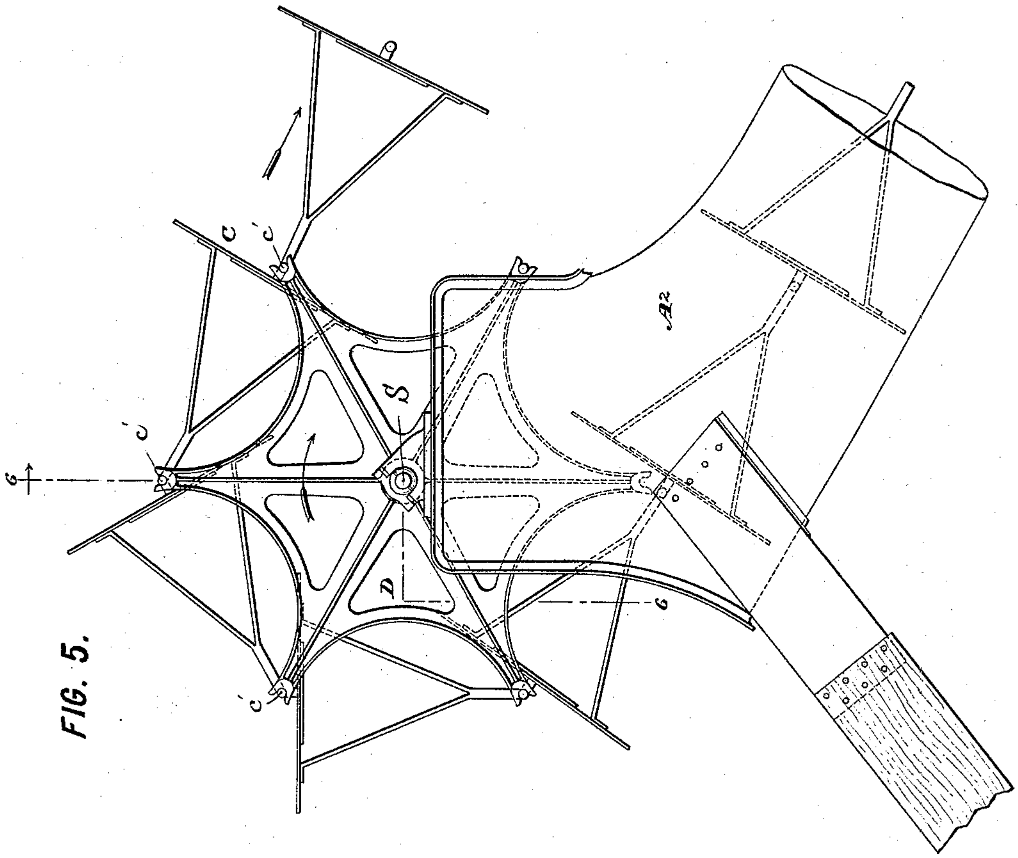

FIG. 5.

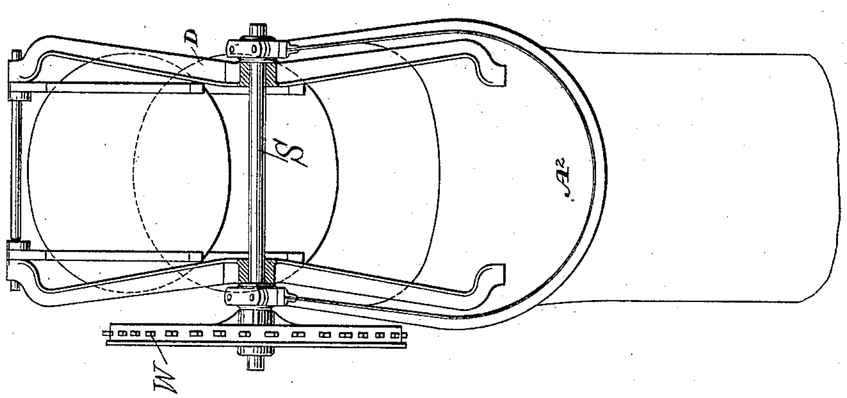

FIG. 6.

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(No Model.)

4 Sheets—Sheet 4.

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DIFFUSION APPARATUS.

No. 418,262.

Patented Dec. 31, 1889.

FIG. 7.

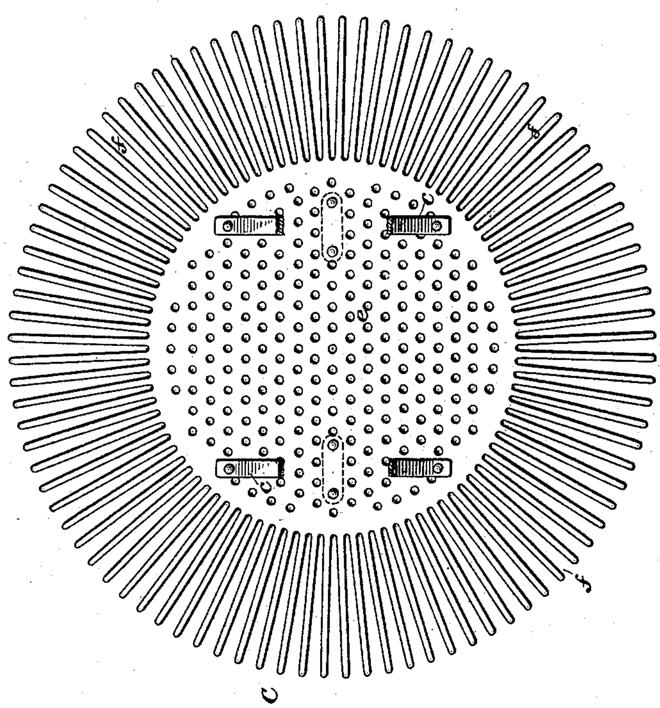
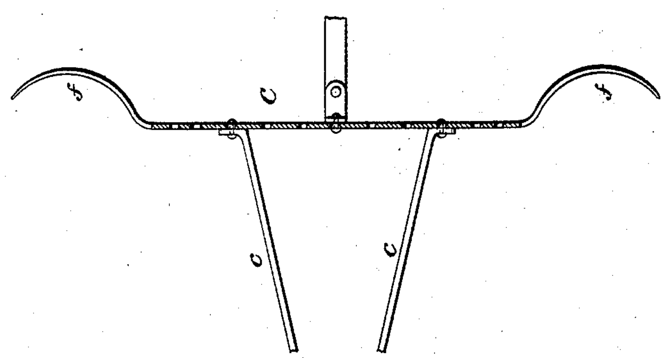


FIG. 8.



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N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

ALEXANDER YOUNG, OF HONOLULU, OAHU, HAWAIIAN ISLANDS.

DIFFUSION APPARATUS.

SPECIFICATION forming part of Letters Patent No. 418,262, dated December 31, 1889.

Application filed July 30, 1889. Serial No. 319,172. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER YOUNG, a subject of the King of Hawaii, residing in Honolulu, on the island of Oahu, Hawaiian Islands, have invented certain new and useful Improvements in Diffusion Apparatus, of which the following is a specification.

This invention relates to the extraction of soluble matters by diffusion from solids containing them, such as sugar-cane, sorghum, beets, bagasse from cane roller-mills, &c. All such substances containing soluble matters will be hereinafter designated "solids."

The object of my invention is to obtain all the advantages of diffusion automatically and continuously without entailing the losses and inconveniences consequent upon the cell-battery method of working.

In carrying out this invention I make use of a tube of suitable length and diameter, which I fill with the solids and cause the latter to travel through the tube from one end to the other by either a continuous or an intermittent movement. The solids are filled in at the entering end of the tube and are removed from the emerging end of the tube. The diffusion-liquid is introduced at the end of the tube from which the solids emerge, and is caused to flow through the tube in the opposite direction to that in which the solids are moved, being drawn off at the end at which the solids enter. Thus the liquid encounters first the nearly spent or exhausted solids which have been nearly or quite depleted of soluble matters, and as it progresses through the tube it is brought in contact successively with solids more and more rich in soluble matters and absorbs continually more of such matters, becoming itself richer, until, finally, when it is drawn off, it is in contact with the fresh solids, from which none of the soluble matters have been extracted.

The movement of the solids through the tube is effected by means of a succession of perforated followers, disks, or pistons, which are arranged at suitable distances apart to leave spaces for the desired quantity or mass of solids between them, and are of such size and shape as to freely fit within the tube, suitable mechanical means being provided for moving them through the tube from one end to the other by either a continuous or intermittent movement. The means for thus moving them consists of connecting them to one another by articulated connections, thereby constituting an endless chain. This chain is carried over sprocket-wheels at the opposite ends of the tube, power being suitably applied to one or both of these wheels to impart progressive motion to the chain. The chain is so arranged that it is extended between the sprocket-wheels in approximately horizontal direction and with sufficient slack to cause it to depend between them in catenary curves of suitable dip. The diffusion-tube is in such case made of a catenary curve conforming to the curve of the lower bight of the chain, and is arranged to inclose this portion of the chain. One advantage of this is that the bight of the chain may travel through the tube, hanging in its natural curve, whereby undue friction of the followers against the walls of the tube is avoided.

The end of the tube from which the exhausted solids emerge is arranged somewhat higher (in practice eight to ten feet, more or less) than the end where the solids enter, and the diffusion-liquid being introduced at this higher end a sufficient hydrostatic pressure is attained to cause the liquid to flow gently through the mass of solids in an opposite direction to the travel of the series of moving compartments or spaces between the followers containing the solids. The followers are advanced at such a speed as will submit the solids to an immersion of such duration as may be required to effect the perfect extraction of the saccharine or other soluble matter contained in the solids to be diffused. The movement is so speeded that time is allowed for all of the liquid which may be liberated by gravitation to drain off from the solids back into the tube, thus saving what is usually lost in cell-battery diffusion when each cell thereof is emptied of exhausted solids.

The construction of the diffusion-tube in a curve with its ends higher than its middle portion has the further advantage that the tube is filled with a column of liquid, the vertical height of which is preferably in practice not less than thirty feet, so that the whole of the mass in passing through the lower portion of the tube will be submitted to a pressure of about fifteen pounds per square inch, which pressure is balanced in all directions, so that there is no tendency to pack the solids closely together, and thereby obstruct the flow of the diffusion-liquid. On the contrary, the entire contents of the tube are maintained in continual agitation by the movement of the followers, and all of the solid particles are in free contact with the liquid, whereby the extraction of the soluble matters, under the law of exosmosis, is effected freely and rapidly. A further important advantage is that from the time the solids enter the tube and are immersed till they emerge at the discharge end of the tube they are not subjected to the detrimental action of the air.

To maintain the contents of the tube at any desired temperature, steam-jackets are formed around the tube at intervals and fitted with pipes by which steam in supplied to them.

In the accompanying drawings, Figure 1 is a side elevation of the apparatus, on a small scale, representing the diffusion-tube as working in connection with sugar-cane roller-mills for dealing with bagasse. Fig. 1^a is a similar elevation of the end portion of the apparatus, showing the end at which the bagasse enters. Fig. 2 is a plan view of Fig. 1, and Fig. 2^a a plan of the end portion of the apparatus shown in Fig. 1^a. Fig. 3 is a side elevation, on a larger scale, of the entering end of the diffusion-tube with the followers, chain, and sprocket-wheel in position. Fig. 4 is an end elevation looking from the left in Fig. 3, the sprocket-wheels being shown in vertical diametrical section. Figs. 5 and 6 are views answering, respectively, to Figs. 3 and 4, and showing the discharge end of the diffusion-tube. Fig. 7 is a face view of the preferred construction of the follower, and Fig. 8 is a diametrical transverse section thereof.

Referring to Figs. 1 and 2, A designates the diffusion-tube, which, in the construction here shown, is extended in a generally horizontal direction, and formed in a curve corresponding to the catenary of a chain suspended in the axis of the tube. Thus the middle portion of the tube is at a considerably lower level than its ends. The end A' of the tube is its receiving end, at which the solids to be diffused enter, and the end A^2 is the delivering end from which the solids are discharged. The delivering end is carried to a somewhat higher level than the receiving end, as shown. At or beyond the respective ends of the tube are mounted suitable sprocket-wheels or spiders D D, carried on shafts S S, as clearly shown in Figs. 3 to 6. Over these wheels is carried an endless chain B, one bight of which passes through the tube A, and the other, and preferably the upper bight, passes freely exterior to the tube, and preferably over its top, as shown. This chain carries at suitable intervals followers C C, which consist of perforated or otherwise foraminous or open-work disks or pistons loosely fitting within the tube A and capable of freely moving through it. Preferably the chain B is constructed of diagonal braces *c c*, carried from the successive followers and pivotally connected at c' to the next successive follower, these braces thus constituting the links of the chain and serving to hold the followers C C in planes perpendicular to the direction of extension of the chain. The chain travels in the direction of the arrows *a a*.

The solids to be operated upon are introduced at the end A' of the tube by any suitable means. In the case of sliced sugar-cane, sorghum, or beets, the material will be delivered from the cutters into this end of the tube, either directly or through the medium of elevators, in any usual manner. In case bagasse is the solid to be diffused it is delivered from the roller-mill into the end A' of the tube. In Fig. 1^a the roller-mill is shown at E, and the elevator E' is shown for lifting the bagasse as it comes from the mill and delivering it to a chute F, which conducts it into the receiving end of the diffusion-tube. It is carried thence downward by gravity and fills the spaces between the followers C C as they successively advance.

At the discharge end A^2 of the tube is provided a chute G for conducting the exhausted solids away from the tube. As these solids will contain a considerable quantity of liquid, it is desirable that this should be squeezed out of them by the action of some suitable known form of press or squeezer.

In Figs. 1 and 2 I have shown a two-roller mill H, to which the spent bagasse or other solid is fed as it is discharged from the diffusion-tube, after which the bagasse is removed by the conveyer R. The expressed liquid from this press or roller-mill is conducted to a tank I, in which, in the case of saccharine juice, it may be boiled, cleaned, and limed, and may be utilized by feeding it to the tube with the diffusion-water.

The diffusion-water or other liquid is introduced into the end A^2 of the diffusion-tube through a pipe K or otherwise, this pipe being fed from a pump J. At the opposite end of the diffusion-tube it is formed with perforations for draining off the enriched liquid or juice, which is caught in a tray Q, fitted around the tubes, as shown in Figs. 3 and 4, from which a pipe V leads, through which the juice is carried off to the boiling-house to be concentrated.

Steam-jackets L L, of suitable number and size, are arranged around the diffusion-tube A for the purpose of heating the diffusion-liquid in the tube to any desired temperature. The drainage-pipes *b b* from these jackets lead to the pump J, so that the water of condensation can be pumped into the tube with the diffusion-water in order to avoid any waste of heat.

The tube A is supported upon masonry foundations N N N, as shown, or in any other suitable way. The lowest part of the tube is provided with a washout or drainage opening M, which may be constructed in any manner known to engineers in the construction of structures of this general character.

Motion is given to the chain B by means of a chain or belt *d* from the roller-mill H to a sprocket-wheel or pulley W on the shaft S of the sprocket-wheels D D at the discharge end of the tube. But little power is required to move the chain, for the reason that the solids in the tube are of very nearly the same specific gravity as the liquid, so that everything is afloat and the weight of the solids is not borne by the chain.

Referring to Figs. 7 and 8, the followers C C are constructed preferably of a disk *e* of metal, preferably steel, perforated at suitable intervals and formed at its outer portion with radial prongs or teeth *f f*. This construction is for the purpose of reducing friction where the followers come into contact with the interior of the tube, imparting elasticity to the followers, and preventing any jamming of the solids between the followers and the walls of the tube.

To operate this apparatus, it is first necessary to fill the tube with water at a suitable temperature to such an extent that when the chain has had its compartments loaded the whole length of the tube the liquid will be almost high enough to flow out at the perforated part Q. When this is done, the chain is set in motion at the desired speed and a constant supply of the solids prepared for diffusion furnished through chute F, from which they descend by gravitation into the mouth A′ of the tube, where they are immersed in the liquid and carried along through the whole length of the tube by the traveling followers till they reach the discharge end A^2, where they drop into the feeder of two-roller mill H and are pressed dry for fuel. As soon as the exhausted solids appear at the discharge end the diffusion-water, through pipe K, is turned on and allowed to flow in such quantity as may be required to produce the proper density of concentrated juice at the other end of the tube, where it flows off through the perforated section of the tube at the tray Q. As the diffusion-liquid enters the tube at the end where the exhausted chips or bagasse are discharged and the liquid is drawn off or flows through a perforated section of the tube at or near the opposite end, it is apparent that the diffusion will be gradual and constant throughout the entire length of the tube, the liquid gradually gaining in density as it approaches the end where the solids to be diffused enter and where the liquid itself is constantly flowing off.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. A diffusion apparatus consisting of a curved tube having its ends higher than its middle portion and formed in approximately a catenary curve, combined with an endless chain, followers carried by said chain and movable through said tube, and sprocket-wheels at or beyond the opposite ends of the tube for carrying said chain, said chain being arranged to hang in a curve coincident with the catenary curve of the tube, whereby the movement of the followers through the tube is facilitated.

2. A diffusion apparatus consisting of a curved tube formed in approximately a catenary curve with its ends at different levels, a liquid-inlet at its higher end and a liquid-outlet at its lower end, in combination with an endless chain, followers carried by said chain and movable through said tube, and sprocket-wheels at or beyond the opposite ends of the tube for carrying said chain, said chain being arranged to hang in a curve coincident with the catenary curve of the tube, whereby the movement of the followers through the tube is facilitated.

3. The combination, with a diffusion-tube, of a chain, and followers carried thereby and movable within the tube, and consisting each of a central perforated disk formed or provided with prongs or teeth projecting radially outward from such disk to the periphery of the follower.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ALEXANDER YOUNG.

Witnesses:

WM. HORACE WRIGHT,

JONA. AUSTIN.