May 14, 1935. P. HOOKER ET AL 2,000,953

MEANS FOR REACTING SEMIFLUID MATERIALS

Filed Oct. 30, 1933 2 Sheets-Sheet 1

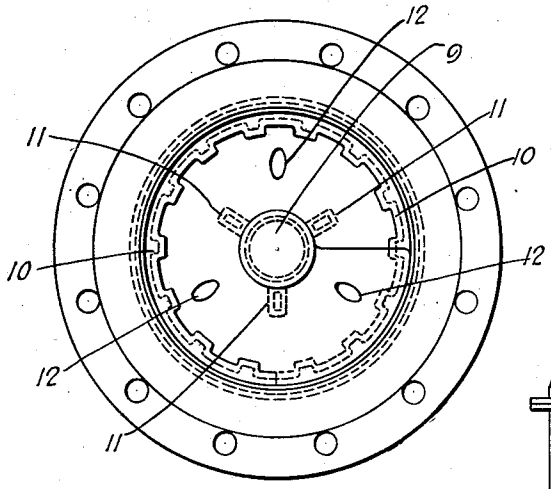

Fig. 5

Fig. 1

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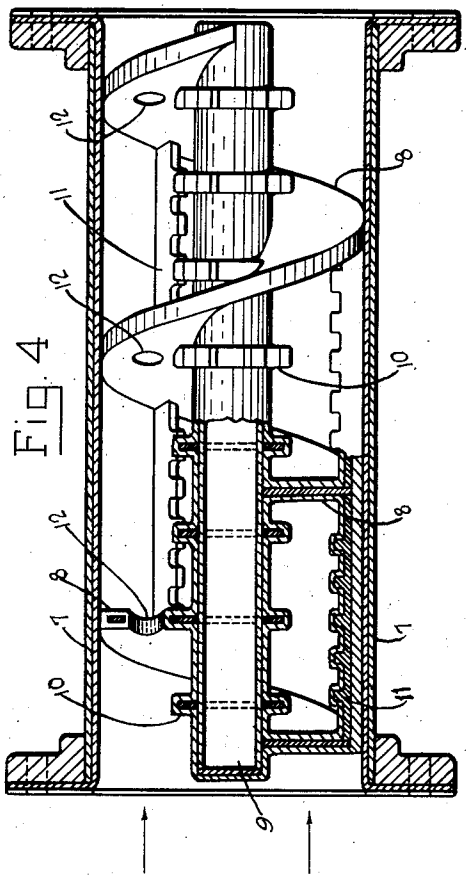

Fig. 4

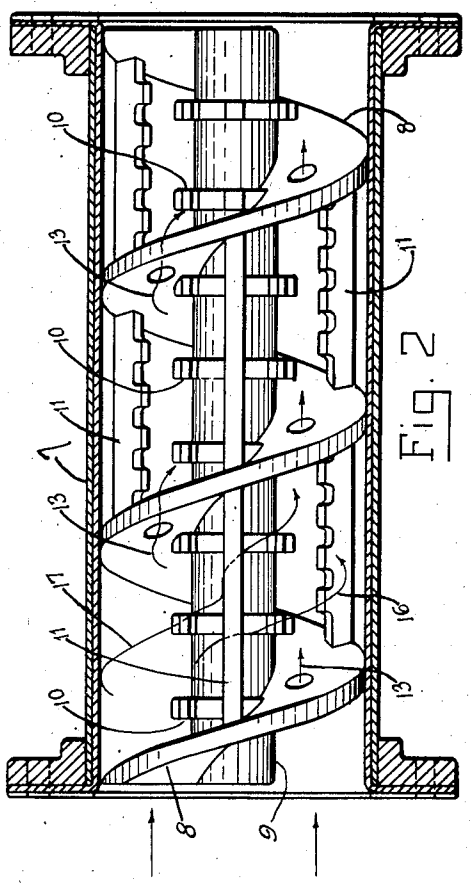

Fig. 2

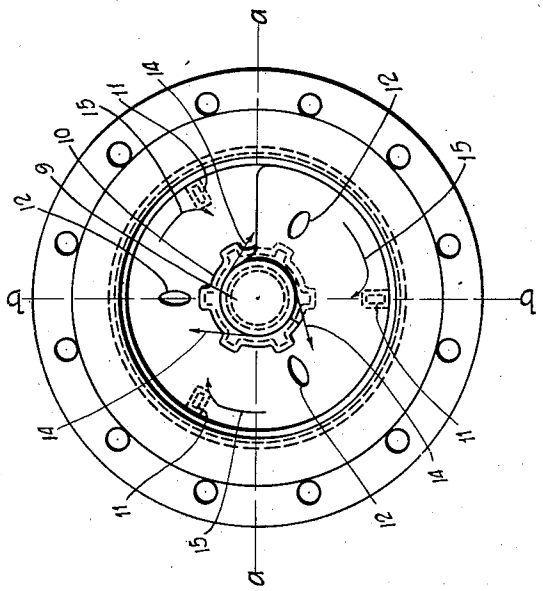

Fig. 3

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MEANS FOR REACTING SEMIFLUID MATERIALS

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Application October 30, 1933, Serial No. 695,876

6 Claims. (Cl. 259—4)

Our invention relates to means for reacting materials, one or more of which may be plastic or in semi-fluid suspension and one or more liquid or gaseous. More particularly, our invention relates to means for mixing chemical reagents, such as chlorine, with plastic or fibrous materials, such as paper pulp in water suspension.

The mixing of gases with semi-fluid materials is by no means a simple matter. This is especially true when the reaction is rapid, as when chlorine is reacted with paper pulp, since the mixing must be promptly effected to avoid over-chlorination of a portion of the pulp before the remainder comes into contact with the chlorine. The difficulty is increased by the fact that wet chlorine is highly corrosive to metals.

In co-pending application Serial No. 547,755 there is disclosed an apparatus for reacting chlorine with paper pulp in a closed system under pressure. The present invention is an improvement in detail upon that apparatus.

Figure 1 is a diagram of the apparatus of this invention showing the mixing device in its relation to the remainder of the apparatus.

Figure 2 is an elevation of the mixing device with outer shell sectioned along the line *a—a* of Figure 3, the inner structure remaining intact.

Figure 3 is an end view of the mixing device looking in the direction of the arrows in Figure 4.

Figure 4 an elevation of the mixing device partly in section along line *b—b* of Figure 3 and partly with outer shell removed and inner structure intact.

Figure 5 is an end elevation of a modification of our invention.

Referring to Figure 1, a pump (not shown) maintains a continuous flow of pulp through the system comprising the mixer **2**, retention tower **3** and a second mixer **4**. **5** is the inlet for chlorine and **6** a second inlet for milk of lime arranged in accordance with the process of the co-pending application before mentioned.

Figures 2, 3 and 4 illustrate in detail the mixer, i. e., parts **2** and **4** of Figure 1. The mixer consists of a section of flanged pipe **7** which in this case is rubber lined, into which is fitted the helix **8**. This helix is wound around and welded to a central shaft **9** provided with collars **10** of which there are several for each convolution of the helix. The helix **8** is also provided with longitudinal members **11**, of which, in this illustration, there are three, spaced 120 degrees apart, cutting through the outer rim of the helix and welded to it. The convolutions of the helix **8** are provided with holes **12** spaced as shown. The collars **10** are notched around their circumferences and the members **11** are similarly notched along their inner faces. The helix **8**, shaft **9**, collars **10** and members **11** are rubber-covered the rubber covering being carried through the holes **12**. The assembly comprising the helix **8**, etc., is secured inside the pipe **7** by cementing together their respective rubber coverings. The purpose of the rubber covering is, of course, to protect the metal against the wet chlorine.

The operation of this device is as follows:

Suspensions of paper pulp in water, containing two to four percent of fibre, while they may be pumped, behave in some respects as plastic material. When a liquid is pumped through a pipe, the inner core moves faster than the outer layers and there is a natural mixing. When a pulp suspension is pumped through a pipe there is much less of this mixing. The stream moves through the pipe more as a rope pushed or pulled through a conduit. The outer layer remains the outer layer and the inner core remains the inner core for appreciable distances. If chlorine is injected into such a stream it will not diffuse readily, unless means are employed to cause transposition of layers. This can easily be proven by observing the bleaching action of the chlorine upon the fibre, which will appear streaked if not well mixed.

In the co-pending application above referred to there is illustrated a mixing device employing a helix in a pipe and having pins projecting from the central shaft. The function of these pins is to cause mixing by eddies. In the present device, the pins are replaced by the collars **10** and members **11**, the function of which is to act as baffles and cause definite transposition of layers, so that what was the outer layer at the entrance to the device leaves it as the central core layer and vice versa. This is effected as follows:

Referring to Figure 2, it will be noticed that the flow of the pulp is illustrated by arrows. This pulp moves as a large rope of rectangular cross section, or would do so if it were not for the baffles. Thus the layer that starts out next the central shaft **9** meets with resistance from the collars **10** successively tending to deflect it backwards and tangentially outward, as illustrated by the arrows **14**, Figure 3, and the layer that starts out next the outer shell meets with resistance from the members **11** successively, tending to deflect it forwards and inward as illustrated by the arrow **15**, Figure 3. There is thus produced a clockwise torsional movement or rotation of the rope of material. The movement of the inner layer is illustrated by the arrow **16**, Figure 2.

It will be seen that this follows a helical path close to the shaft 9 until it strikes the collar, then is deflected outward and resumes its helical path at a point about half way to the outer shell. The movement of the outer layer is similarly illustrated by the arrow 17. It will be seen that this, starting along a helical path next the outer shell, strikes one of the members 11 and is deflected inward, finally resuming its helical path at a point about half way in toward the shaft 9.

It is not possible to illustrate the exact path of a fibre for any considerable distance, owing to its complexity. However, the fact that the inner layers are being continually forced outward and the outer layers continually forced inward as illustrated will be self evident, and this cannot fail to result in transposition of layers.

The notches in the baffles break up the layers still further.

The holes 12 permit some of the material to take a shorter path as illustrated by the arrows 13 and thus cause a transposition in the direction of flow. It has been found that this device gives excellent mixing and that the material issuing from it shows almost perfectly uniform color and freedom from streaks.

Referring to Figure 5:

In this modification the longitudinal members 11 are placed next the shaft 9 and the collars 10 are replaced by rings fitted against the outer shell. In other words, the longitudinal and transverse baffles are transposed in position. It will be obvious that this arrangement is the equivalent of that previously shown and described, and the effect upon the moving stream of material similar, except that the rotation is in the opposite direction; that it to say, the outer layer is deflected inward and backward and the inner layer outward and forward, producing a counter-clockwise rotation.

It will be observed that this device is free from moving parts and adapted to operate under a pressure.

What we claim is:

1. In a system for contacting a reagent with a stream of semi-fluid material flowing in a closed cylindrical conduit, a mixing device comprising a helical baffle wound around a shaft and coaxially disposed within said conduit, in combination with a plurality of collars upon said shaft and a plurality of longitudinal ribs upon the inner face of said conduit, said collars and ribs projecting into the path of flow defined by said helical baffle, whereby inner layers of said material are continuously moved outward and outer layers are continuously moved inward.

2. In a system for contacting a reagent with a stream of semi-fluid material flowing in a cylindrical conduit, a mixing device comprising fixed means defining a helical path of flow through said conduit, in combination with a plurality of straight longitudinal ribs and flat circular transverse baffle plates within said conduit, projecting into said path and causing transposition of layers of said material.

3. In a system for reacting a gas with a stream of semi-fluid material flowing in a cylindrical conduit, a mixing device comprising fixed means defining a helical path of flow through said conduit, in combination with a plurality of straight longitudinal ribs and flat circular transverse baffle plates within said conduit projecting into said path and causing transposition of layers of said material.

4. In a system for reacting chlorine with a suspension of paper pulp flowing in a cylindrical conduit, a mixing device comprising fixed means defining a helical path of flow through said conduit, in combination with a plurality of straight longitudinal ribs and flat circular transverse baffle plates within said conduit projecting into said path of flow and causing transposition of layers of said material.

5. In a system for contacting a reagent with a stream of semi-fluid material flowing in a closed cylindrical conduit, a mixing device comprising a fixed helical baffle co-axially disposed within said conduit in combination with a plurality of straight longitudinal ribs and flat circular transverse baffle plates within said conduit projecting into the path of flow defined by said helical baffle and causing transposition of layers of said material.

6. In a system for contacting a reagent with a stream of semi-fluid material flowing in a closed cylindrical conduit, a mixing device comprising a fixed helical baffle co-axially disposed within said conduit, in combination with a plurality of transverse and longitudinal baffles within said conduit projecting into the path of flow defined by said helical baffle, the edges of said transverse and helical baffles being serrated.

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