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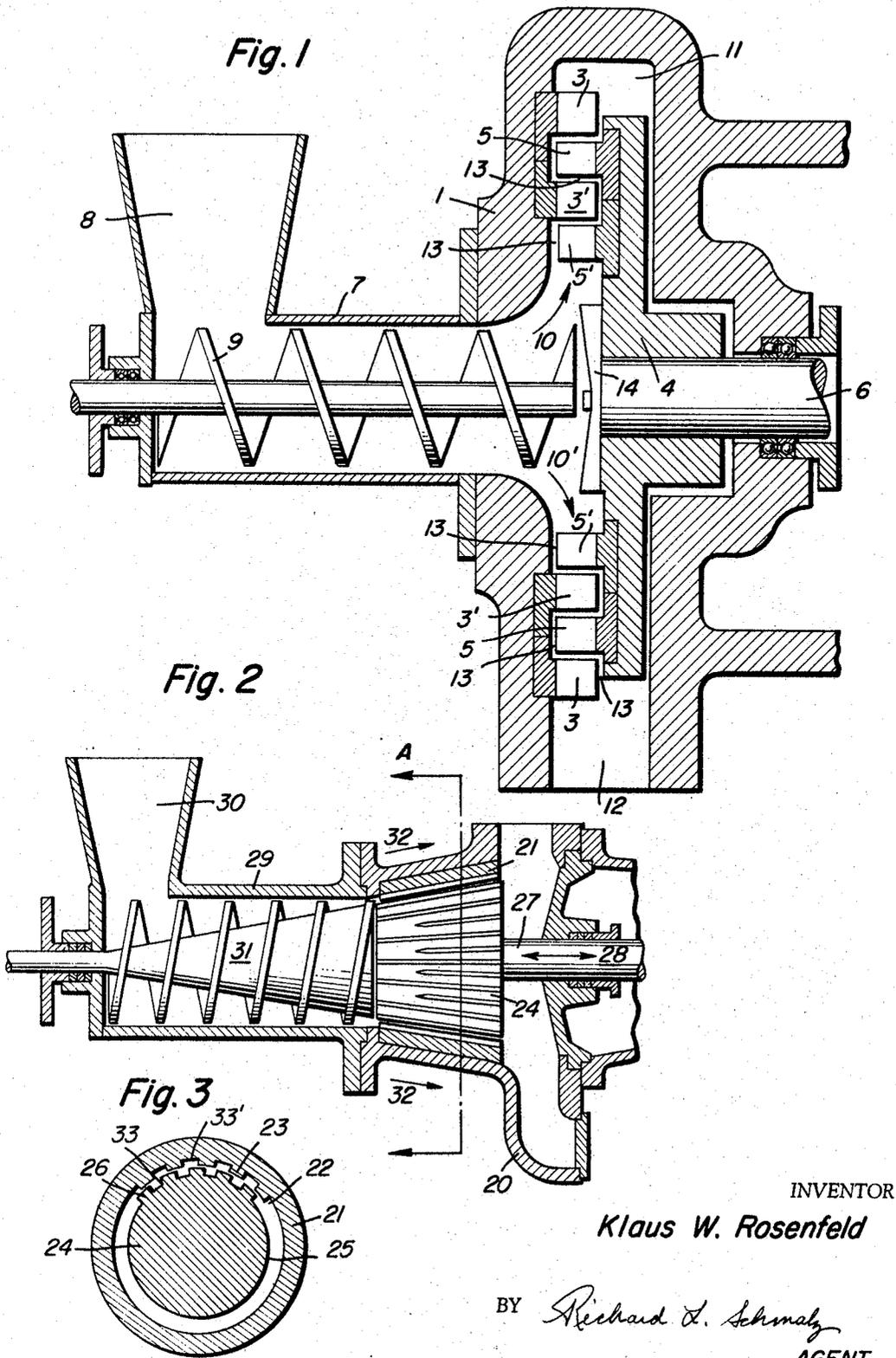
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METHOD FOR THE PREPARATION OF FIBROUS MATERIALS FOR
THE PRODUCTION OF PAPER AND CARDBOARD

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2 Sheets-Sheet 1



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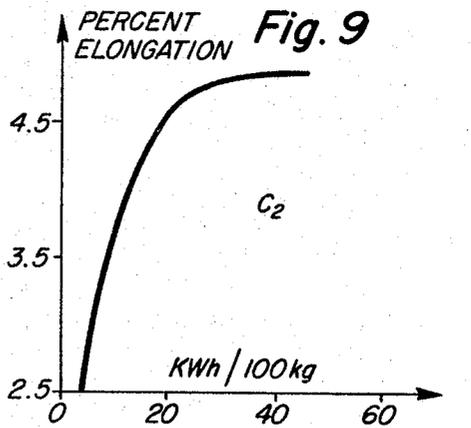
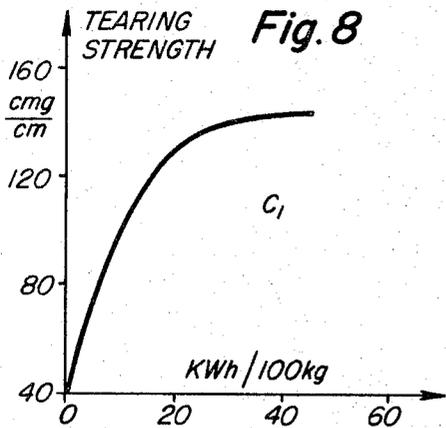
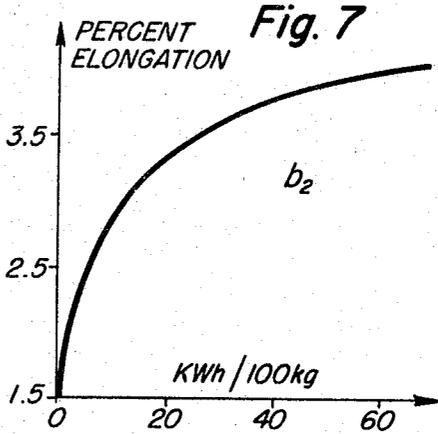
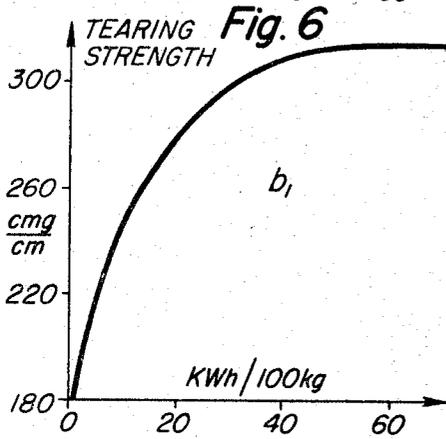
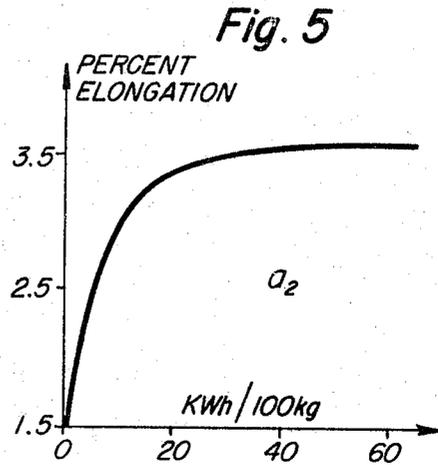
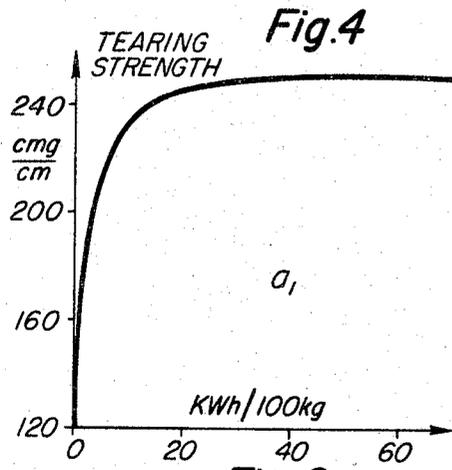
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METHOD FOR THE PREPARATION OF FIBROUS MATERIALS FOR THE PRODUCTION OF PAPER AND CARDBOARD

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2 Sheets-Sheet 2



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METHOD FOR THE PREPARATION OF FIBROUS MATERIALS FOR THE PRODUCTION OF PAPER AND CARDBOARD

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 6 Claims. (Cl. 241—15)

This invention relates to a method for the preparation of fibrous materials for the production of paper and cardboard by refining. The refining process can be carried out in an apparatus known as a deflaker or in a disc refiner or cone-shaped refiner, etc. Such methods of refining are known and their object is primarily to loosen up the fibril structure of the native cellulose fibers, thereby providing a larger specific surface for the accumulation of water so that the sheet-strength of the paper can be formed, after the formation of the wet fiber network.

A known method of this type uses a fibrous pulp-water suspension with a solids content of between 1 and 7%. This suspension is passed once or several times through a cone refiner, a disc refiner, a roll refiner or a Hollander. The fiber particles are torn apart on their way through the refiner, resulting partly in a loosening of the fibril structure, but also in a shortening of the individual fibers. Under certain circumstances, such a shortening of the individual fibers may be desirable, but in general, however, it is a harmful side reaction which should be eliminated in view of the resulting different physical properties of the formed and dewatered paper sheet, particularly the so-called tearing strength.

In another known method, the pulp suspension is dewatered to such an extent that it has solids content of more than 15%, preferably 20–30%. The high consistency material thus obtained is conducted by means of a screw conveyer through an apparatus known as a deflaker and is subjected to intensive refining. It was found that the fiber is not significantly shortened by this treatment, and that the fibril structure and the fiber surface are merely loosened and opened, which leads to an increased amount of water being imbibed on the polysaccharide molecules of the fiber.

A "deflaker" is to be understood to mean an apparatus which has a disc with teeth arranged concentrically thereon, which rotates relative to a second disc on which the teeth are likewise arranged concentrically. The arrangement is such that the teeth of the first-mentioned disc protrude into the gaps of the teeth of the last-mentioned disc. The pulp to be processed flows from a central opening and moves alternately through the tooth gaps of the teeth of the two discs in the direction from inside to outside.

It has now been found that in order to obtain an optimum swelling state of the fiber without shortening it, the type of refiner used is not as important as is the distance between the working elements of the refiner and their circumferential speed. According to the present invention, the method for the preparation of fibrous materials for the production of paper and cardboard comprises the passing of wet pulp with a solids content of more than 15%, preferably 20 to 30%, once or several times through a refiner, for example, a deflaker, a disc refiner, etc. The method according to this invention is characterized in that the mutual distance of the working or refining elements of the refiner is substantially equal to half the mean fiber length and that the circumferential speed of the rotating working elements is 40 to 120 m./sec., preferably 50 to 90 m./sec.

It has been found that with high consistency refining, only minor hydraulic energy losses occur, whereas with low consistency refining, the circumferential speed of the working elements is limited due to uneconomically high hydraulic energy losses. A high circumferential speed, however, is an essential prerequisite for the desired refining effects to fibers according to this invention.

If the above conditions are met, a thickened fiber pulp can be successfully processed through a deflaker, a cone, a refiner, a disc refiner or through several other known refiners. Tests have shown that the fiber is not shortened or is shortened only to a very minor extent, and that practically the entire refining work is used for fibrillation and thus for increasing the water-accumulating surface of the fibers.

It has also been found that it is not advisable, in carrying out the method according to this invention, to increase at random the refining work expended per 100 kg. air dry material. There is no further significant improvement of the physical properties of the treated fibers if the total work expended per 100 kg. air dry fibrous substance exceeds 40 kwh. (kilowatt-hours). As a further development of this invention, the total work expended per 100 kg. fibrous substance (air dry) is therefore limited to 4 to 40 kwh., preferably 10 to 30 kwh.

For a better understanding of the method according to this invention, reference is made to the attached drawing, which shows by way of example two devices that are suitable for carrying out the method according to this invention.

FIG. 1 is a longitudinal section through a deflaker.

FIG. 2 is a longitudinal section through a cone refiner.

FIG. 3 is a cross section along line A—A of the cone refiner represented in FIG. 2.

FIGS. 4–9 are a series of graphs in which tearing strength and elongation are plotted against refining work expended.

With reference to FIG. 1, several concentrically arranged gear teeth 3 and 3' are arranged in and rigidly connected to a stationary housing 1. A rotatable mounted plate or disc 4 which likewise carries concentrically arranged teeth 5 and 5', is also located in the housing 1. The teeth 5 and 5' are so arranged that they protrude into the tooth gaps between the teeth 3 and 3'. Disc 4 is rotated by means of a shaft 6.

Centrally attached to the housing 1 is a feeding device 7 with a hopper 8 through which the material to be refined is charged. The material is carried by a screw conveyer 9 into the refiner and moves in the direction of the arrows 10 and 10' into the region of the rotating refining elements, in the present case, the rotary teeth 5 and 5'. In order to prevent accumulations at the end of the screw conveyer of the material to be refined, a pump-impeller vane 14 is attached to the end of the drive shaft 6, and the vane 14 accelerates the material radially, thereby forcing it to the refining elements. Due to the unrefined material being delivered by the screw conveyer 9 and to the centrifugal force created by the impeller vane 14, the refined material accumulates in the annular chamber 11, after passing through the refining elements, and is finally discharged through the duct 12.

Devices of this kind are known. According to the present invention, they are used for refining cellulose or paper pulp-water suspensions with a solids content of more than 15% in such a way that the clearance 13 of the working or refining elements 3, 3' and 5, 5' is about equal to half the mean fiber length, and the circumferential speed with which the rotary working elements 5 and 5' rotate is about 40 to 120 m./sec., preferably 50 to 90 m./sec.

"Mean fiber length" is understood to the arithmetic average of the individual fiber lengths. If we had a fiber substance with a uniform fiber length of 3 mm., half the mean fiber length would be 1.5 mm. In a fiber mixture of 50% fibers of 3 mm. and 50% fibers of 2 mm. length, the "mean fiber length" is 2.5 mm. and, consequently, half the mean fiber length is 1.25 mm.

According to the present invention, the circumferential speed of the rotary working elements is so regulated that the outer elements do not exceed the maximum circumferential speed nor the inner elements the minimum circumferential speed.

FIG. 2 shows a longitudinal section through a so-called cone refiner. In a stationary housing 20 is arranged a hollow cone 21 which carries on its inner side 22 (see FIG. 3) knives 23 which extend over the entire length of the hollow cone.

Inside the device is a rotary cone 24 which is equipped on its outer side 25 with knives 26 which extend likewise over the entire length of the cone 24. The inner cone 24 is connected with a drive shaft 27 which rotates the cone 24. By displacing the drive shaft 27 and thus the cone 24 in the direction of the arrow 28, it is possible to adjust the clearance of the working or refining elements 23 and 26. According to this invention, this distance is so regulated that it corresponds to half the mean fiber length of the cellulose or paper pulp to be refined. In the cone refiner, too, the circumferential speed of the rotary working elements should be 40 to 120 m./sec., preferably 50 to 90 m./sec. In order to introduce the fiber pulp, which has a high consistency due to its high solids content of over 15%, preferably 20 to 30%, into the device, a charging device 29 with a hopper 30 and screw conveyer 31 is attached to the housing 20. The pulp is moved by the screw conveyer 31 in the direction of the arrows 32. In order to prevent the mass from settling in the grooves between the knives or from moving there without getting between the refining elements, the grooves are closed to a large extent by plates 33 and 33'.

In a further development of the method according to the present invention, a total work of 4 to 40 kwh., preferably 10 to 30 kwh., per 100 kg. fibrous substance (air dry) is expended. It was found that a substantial improvement of the physical properties of the refined material is only possible in this range, and that a further increase of the expended refining work has no further technical effect. In order to demonstrate this, reference is made to FIGS. 4-9 where six graphs are shown in which, as an example of the physical properties, tearing strength and elongation are plotted versus the pure refining work expended. Both terms are measured by standard methods, tearing strength according to DIN 53,115 and elongation according to DIN 53,112.

The graphs of FIG. 4 and FIG. 5 represent the variations of the above mentioned properties for unbleached pine sulfite cellulose. The graphs of FIG. 6 and FIG. 7 were measured on unbleached fir sulfite cellulose and the graphs of FIG. 8 and FIG. 9 were measured on bleached beech sulfite cellulose.

It can be seen that the improvement of the physical properties is greatest when the expended refining work is below 30 kwh., and in some cases even below 15-20 kwh. Above 40 kwh., there is no substantial improvement, and any improvement to be expected is not in an economically justifiable proportion to the additional work expended.

Thorough tests have shown that these conditions also apply to other than the above mentioned celluloses, and

that they can also be observed in the development of other physical properties, for example tearing length and bursting strength.

I claim:

1. In the method for the preparation of fibrous materials for the production of paper and cardboard which involves introducing a high consistency suspension of fibers into a refiner and passing the fibrous suspension between opposing fiber refining elements of the refiner, the improvement which comprises setting the clearance between the fiber refining elements at a distance substantially equal to half the mean fiber length of the fibers in the suspension.

2. In the method for the preparation of fibrous materials for the production of paper and cardboard which involves introducing a suspension of fibers with a solids content of more than 15% into a refiner and passing the fibrous suspension between opposing and cooperating fiber refining elements of the refiner, the improvement which comprises setting the clearance between the fiber refining elements at a distance substantially equal to half the mean fiber length of the fibers in the suspension.

3. In the method for the preparation of fibrous materials for the production of paper and cardboard which involves refining a suspension of fibers with a solids content between 15 to 30% by introducing the fibrous suspension into a refiner and passing the fibrous suspension between a first set of rotating fiber refining elements and a second set of fiber refining elements which oppose and cooperate with said first set of fiber refining elements to fibrillate the fibers in suspension, the improvement which comprises setting the clearance between said first set and said second set of fiber refining elements at a distance substantially equal to half the mean fiber length of the fibers in the suspension, and maintaining said first set of fiber refining elements at a circumferential speed between 40 to 120 m./sec.

4. In the method for the preparation of fibrous materials for the production of paper and cardboard which involves refining a suspension of fibers with a solids content between 20 to 30% by introducing the fibrous suspension into a refiner and passing the fibrous suspension between stationary and rotary fiber refining elements to fibrillate the fibers in suspension, the improvement which comprises setting the clearance between the stationary and rotary fiber refining elements at a distance substantially equal to half the mean fiber length of the fibers in the suspension, and maintaining the rotary fiber refining elements at a circumferential speed between 50 to 90 m./sec.

5. In the method according to claim 3, the further improvement characterized in that a total refining work between 4 to 40 kilowatt-hours is expended per 100 kg. of air dried fibers.

6. In the method according to claim 3, the further improvement characterized in that a total refining work between 10 to 30 kilowatt-hours is expended per 100 kg. of air dried fibers.

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