May 22, 1934. G. H. CARNAHAN 1,959,902

METHOD OF DISINTEGRATING CELLULOSIC MATERIAL

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Fig. 1.

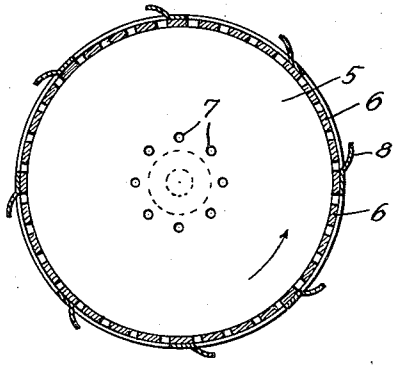

Fig. 2.

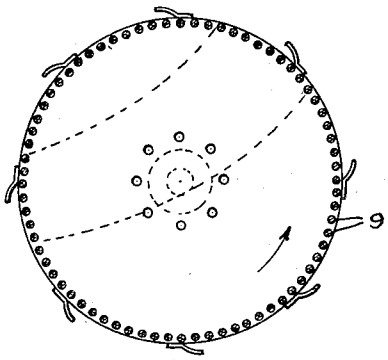

Fig. 4.

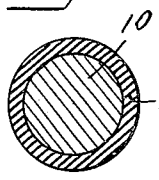

Fig. 5.

Fig. 6.

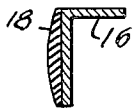

Fig. 3.

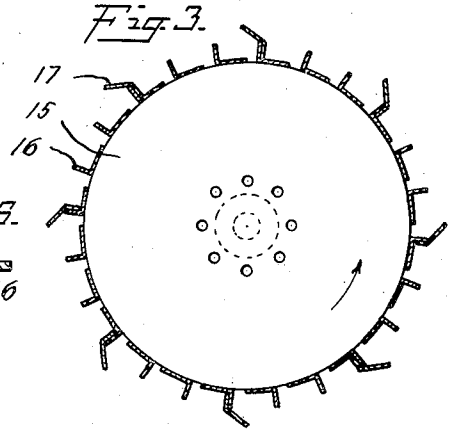

Fig. 7.

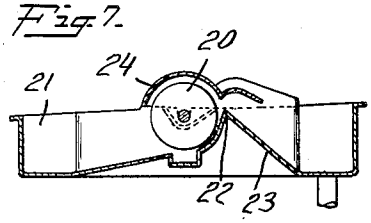

Fig. 9.

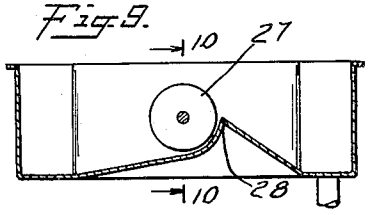

Fig. 10.

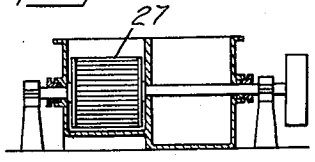

Fig. 8.

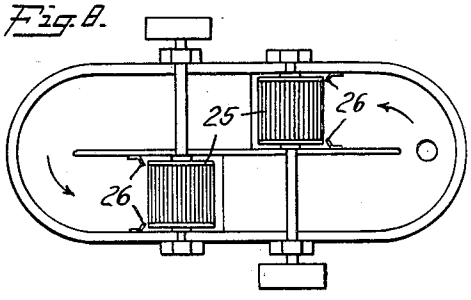

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Fig. 11.

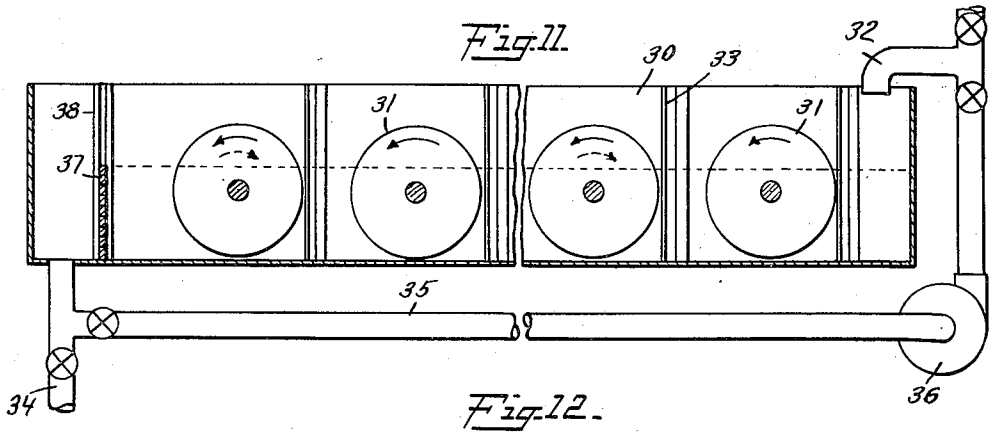


Fig. 12.

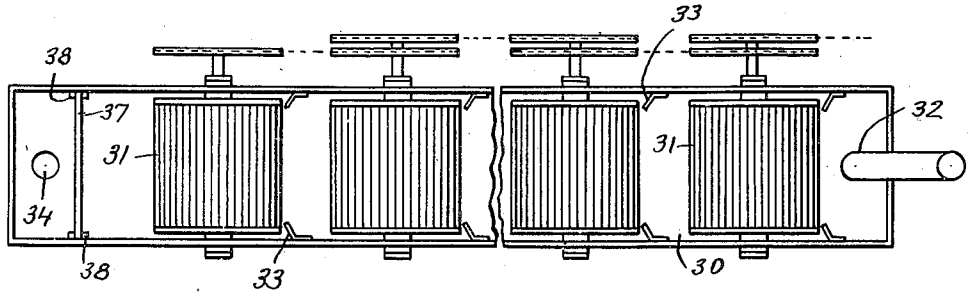


Fig. 13.

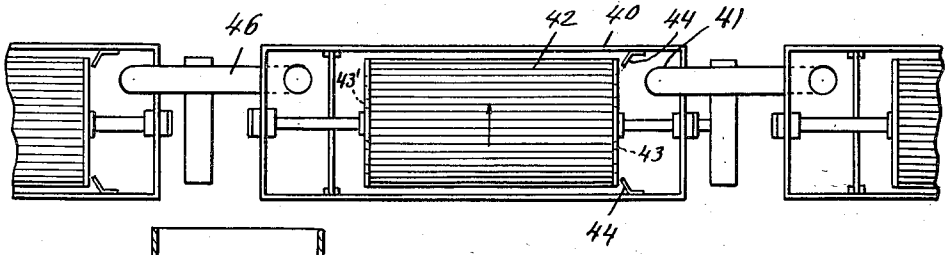
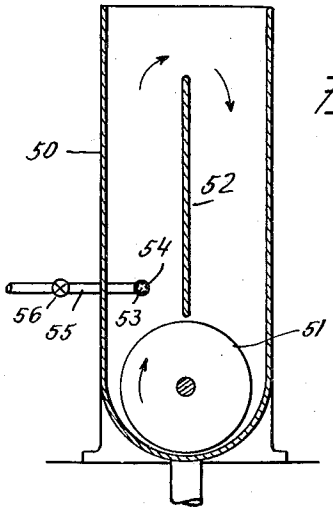


Fig. 14.



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UNITED STATES PATENT OFFICE

1,959,902

METHOD OF DISINTEGRATING CELLULOSIC MATERIAL

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Application October 28, 1931, Serial No. 571,515

2 Claims. (Cl. 92—20)

This invention relates to an improved method for grinding, beating, etc., and is an improvement on present methods of rod mill and ball mill grinding and beating operations, etc.

Heretofore the common types of rod mills and ball mills intended for the grinding or beating of wet material suspended in or admixed with water, have been of the water-tight type of construction. That is, the rod mill or ball mill has been of cylindrical or similar shape and has contained the charge of rods or balls and also the charge of material to be ground, or beaten, or otherwise disintegrated, admixed with the water in which the material has been suspended. The feed to the ball mill or rod mill has ordinarily been at one end and the discharge at the other, and the entire charge of balls or rods and of the material being ground or otherwise disintegrated or treated has been supported by the rod mill or ball mill itself.

The present invention provides an improved method of operating a ball mill or rod mill which is not a water-tight container, but which is made of a cage-like construction and which is mounted and arranged to operate submerged in the material to be disintegrated, beaten or otherwise treated.

Instead of making the ball mill or rod mill in the form of a water-tight cylinder or similar container, with inlet and outlet at its ends, I make the cylinder or similar container for the rods or balls in the form of a cage through which the liquid materials can readily pass, and I submerge the cage in a tank or receptacle containing the materials to be disintegrated or ground or beaten. Thereby the weight of the liquid material to be ground or otherwise treated does not require to be supported by the supports of the revolving cage, and even the weight of the rods or balls is less than they would otherwise be because they operate submerged in the liquid, and the cage is only required to support the weight of the rods or balls less the weight of a corresponding volume of the liquid displaced thereby. The cages can accordingly be made of much lighter construction, with resulting simplification and cheapening of the construction, and other advantages, such as those hereinafter pointed out.

The charge or body or circulating stream of the material to be ground or disintegrated or otherwise treated is contained in a tank or receptacle or trough in which the cage-like structure is arranged and adapted to revolve. The arrangement is such that the cage-like structure is either completely immersed in the liquid body or is at least immersed to the level to which the rods or balls are raised, so that the rods or balls operate submerged, without being lifted into the air and dropped back into the liquid body. In this way, aeration of the material being treated can be prevented, and the grinding or disintegrating action confined beneath the surface of the liquid body.

The present invention is of more or less general application to the grinding, disintegration, beating, etc. of various materials which require such treatment while suspended in or immersed in a liquid medium such as water. For grinding mineral materials, or hard materials, hard surfaced grinding elements such as metal rods or balls, or flint pebbles, etc., will be employed; but it is particularly advantageous for such purposes as the beating of pulp, etc., to employ rubber covered grinding elements, and particularly rubber covered metal balls with metal centers made of heavy metals or alloys such as lead or lead alloys, so that the balls will have a weight several times that of the water displaced thereby.

The present invention is of special value and application in the treatment of paper pulp, as a substitute for the ordinary beating operation, or as a special treatment for hydrating the pulp, or for disintegrating partly cooked woods to produce pulp therefrom. In the beating and hydration of pulp, the raising of the pulp into the air so that air enters the pulp is objectionable, and it is desirable that the hydration of the pulp should be accomplished while the pulp is completely immersed beneath the surface of the water. The present invention makes possible the beating or hydration of paper pulp while maintaining the pulp completely immersed in the water, so that neither the pulp nor the grinding elements are raised into the air and fall back into the pulp body. The tank or receptacle containing the material to be disintegrated or otherwise treated may have different shapes and sizes. For batch operation, a single tank or receptacle can be employed, with the cage member containing the grinding elements suitably supported therein. For continuous operation, such a tank can be provided with a continuous feed and a continuous discharge; and a series of tanks can be employed for a progressive and step-wise treatment of the material, with flow from one tank to the next.

So also, the invention can be carried out in apparatus of the type of the ordinary beaters, commonly employed for beating paper pulp, by eliminating the ordinary beater roll, and by placing one or more submerged cage-like members with grinding elements therein, and providing for the circulation of the pulp to be beaten into and out

of such cage-like members. A plurality of such cage-like members, with grinding elements therein, can be arranged in the beater, and pulp circulating through the beater can be subjected to a series of such beating or hydrating treatments. Special means may be provided for circulating the pulp, or the rotating cage-like members themselves may be provided with means for insuring that the pulp will be admitted into the interior of such members, and discharged therefrom.

The cage-like members which contain and support the grinding elements may vary in their construction. In some cases they may advantageously be made of a series of rods or bars arranged in the general form of a cylinder, and suitably supported at their ends by end or head members which form the ends of the cylindrical cages. Instead of using bars, a series of metal plates can be employed; or other construction can be used which will permit the free flow of the liquid material therethrough into and out of the charge of balls or rods contained in the cage-like member. In conjunction with the construction of such member, provision may also be made for promoting the introduction of the liquid material, such as scoops or projections which promote the inflow of the material at various parts of its rotation.

The rotation of the cage-like members will tend to keep the entire body of material contained in the receptacle or tank agitated, with the suspended particles maintained in suspension; but the agitating action of the cage-like members can be supplemented by other agitating or circulating members to insure agitation and circulation of the pulp or other material so as to insure that it will be brought into contact with the revolving cage-like members and subjected to the grinding or disintegrating or other action of the balls or rods contained therein.

The invention will be further illustrated and described in connection with the accompanying drawings in which several modifications of the apparatus of the invention are illustrated which are adapted to carry out the improved process of the invention; but it is intended and will be understood that the invention is illustrated thereby but is not limited thereto:

Fig. 1 shows one form of construction for the cage-like mill or beater of this invention;

Figs. 2 and 3 show modified types of construction;

Figs. 4 and 5 are enlarged details of grinding elements that may be employed;

Fig. 6 is a detail of Fig. 3;

Fig. 7 is a paper pulp Hollander using the beater of this invention;

Fig. 8 is a plan view of a modified form of Hollander;

Fig. 9 is an elevation of another modified form of Hollander showing a submerged beater;

Fig. 10 is a section on the line 10—10 of Fig. 9;

Fig. 11 is an elevation partly in section of a treating tank containing a plurality of beaters;

Fig. 12 is a plan view of the apparatus shown in Fig. 11;

Fig. 13 shows a series of treating tanks each containing a beater; and

Fig. 14 is a modified form of apparatus containing a beater.

The cage-like shell of the mill or beater of Fig. 1 is made up of circular end plates 5 held together by slats 6. The slats are fastened around the circumference of the end-plates and with slats two or three inches wide an opening of one inch, for example, is left between each two slats. The openings allow liquid to pass in and out of the mill while it is in operation, but these openings are so small that the grinding or disintegrating elements inside of the cage will not pass through the openings. Each of the head pieces is advantageously provided with a number of openings indicated at 7 which are also of such a size that the grinding elements will not pass through them. These openings allow liquid to flow in and out of the beater.

The cage-like beater shown in Fig. 1 contains lips or scoops 8 which are adapted to scoop up liquid and induce a flow of liquid through the mill while it is in operation. These lips or scoops are not an essential feature of the mill.

Fig. 2 shows a cage-like shell of a somewhat similar construction, but instead of the head plates being connected by slats, the head plates of the mill shown in Fig. 2 are connected by rods 9. The rods may be one inch in diameter, more or less, and they may be spaced one inch apart, more or less. When balls two inches in diameter are employed as the grinding elements, a space of one inch between the rods is satisfactory.

These cage-like shells may be constructed of wood or any suitable metal. Where metal shells are desired and the treatment involves the use of a corrosive liquid, a non-corrosive metal is employed. Wooden head pieces connected by metal rods or slats, or metallic head pieces connected by wooden rods or slats may be used.

Any suitable grinding elements may be employed and the structure of the shell of any mill or beater is suited to the type of grinding element used. Balls or rods or elements of irregular shape may be employed.

Fig. 4 is a detail of a ball suitable for use as a grinding element. The ball comprises a hard metal center 10 and a coating 11 of resilient material such as rubber.

Fig. 5 is a detail of a rod made up of a hard metal center 12 and a coating of rubber or other resilient material 13. By using such rubber covered grinding elements a different sort of squeezing or disintegrating action is produced on the material being treated.

Fig. 3 shows a mill of rigid construction suitable for use with heavy grinding elements and for subjecting materials to a severe grinding and pounding treatment. The head plates 15 are connected by angle irons 16. These angle irons may, for example, be 6'' x 4'' and where balls 3'' or more in diameter are used, a space of two inches or more may be left between adjacent angle irons. Scoops 17 similar to the scoop 8 of Fig. 1 are provided.

The grinding and squeezing action produced by rubber covered elements produces a different effect from that produced by elements of the same shape and weight which have a non-yielding surface. When rubber covered grinding elements are employed as shown in Figs. 4 and 5, it may be desirable to cover the inner surfaces of the mill, at least the circumferential surfaces, with rubber. Fig. 6 shows a detail of an angle iron 16 which is covered with rubber 18. If the end plates of a mill constructed as in Fig. 3 are held together by angle irons covered with rubber, as in Fig. 6, and rubber covered grinding elements are employed, there is a squeezing and disintegrating action between the various elements and also between the elements and the shell of the still which is quite different from the pounding and grinding action of the usual ball or tube mills of hard,

rigid construction in which unyielding grinding elements are used. The action of rubber covered grinding elements in a mill with rubber covered surfaces produces a particularly beneficial action on paper pulp stock and the cage-like mills of this invention may be employed for treating paper pulp.

Fig. 7 shows a Hollander of a usual type in which the beater of this invention is employed instead of the usual type of beater. The beater 20 is composed of a cage-like shell and the inner surfaces of the circumference of the shell are advantageously covered with a resilient surface, such as rubber and rubber covered balls or tubes are advantageously used as grinding elements. The Hollander 21 is supplied with pulp in the usual way and as the pulp circulates through the Hollander it passes into the beater 20 and is there subjected to a beating and disintegrating action and is simultaneously hydrated. The beater is close-fitting, i. e. there is little space for the liquid to flow around the beater and make the circuit of the Hollander without passing into and through the beater and being subjected to beating and disintegration therein. As the beater rotates it carries treated pulp up and over the neck 22 on to the back-fall 23. The whole apparatus is advantageously covered as shown in part at 24.

Fig. 8 shows a plan view of a Hollander which contains two beaters 25. In front of each of the beaters are baffles or deflection plates 26 which tend to prevent short circuiting of the pulp by passage around the beater and through the Hollander without entering the beater and being subjected to the beating and disintegrating action which this is intended to provide.

Fig. 9 shows a Hollander with a beater 27 of the type contemplated by this invention and the beater is submerged in the pulp. As the pulp circulates through the Hollander it is subjected to the beating or disintegrating action of the beater 27 without being brought into contact with the atmosphere inside of the beater 27. The beater causes a flow of the pulp through the Hollander up over the neck 28. As the flow of pulp above the beater is away from the neck instead of toward it, due to the direction of rotation of the upper portion of the beater, there is no danger of the pulp short-circuiting above the submerged beater. The pulp circulates through the beater and is lifted by the beater up above the neck and it is subjected to a grinding and disintegrating action in the beater without being brought into contact with the atmosphere.

Fig. 11 shows a tank 30 which comprises a plurality of beaters 31. The pulp or other material to be treated enters the tank through the spout 32. The beaters may all be rotated in the same direction or adjacent beaters may be rotated in opposite directions, as indicated by the arrows. Baffles or deflection plates 33 are advantageously provided to direct the liquid into the beaters and prevent its being short-circuited around them. The pulp or other material is first subjected to treatment in one beater and then it passes through the next beater and is subjected to further treatment therein, and then passes to the other beaters in succession. By the time it is passed entirely through the tank 30, which may contain any number of beaters desired, it has been thoroughly treated and is drawn off through the line 34, or if further treatment is desired, a part or all of the material can be recirculated through the line 35 by means of the pump 36 and be reintroduced into the tank through the spout 32. The tank may be operated as a batch proposition or by gradually introducing pulp or other material through the spout 32 and gradually discharging it through the line 34, a continuous operation may be carried out with or without recirculation through the line 35.

The level of the material being treated is controlled by the weir 37. This is made up of slats placed in the grooves 38, and the height of the weir is controlled by the number of slats employed. By increasing the number of slats the beaters can be submerged or by reducing the number of slats the height of the liquor can be lessened. The height of the liquid in the tanks can be controlled as desired by increasing or decreasing the number of slats in the weir 37.

Fig. 13 shows a modified arrangement adapted for treating pulp or other material in a number of beaters in series. The material to be treated enters the tank 40 from the pipe 41. In the tank is a beater 42 which is positioned longitudinally in the tank. Some of the material enters the beater through the holes 43 in the end plate and some is discharged through the holes 43′ in the other end plate and also between the slats in the circumference of the beater. In a mill or beater used in this manner, it may be advantageous to provide many perforations in the end plates. Deflection plates 44 are provided to direct the liquid toward the openings in the head plate and to prevent its passing around the drum without being subjected to treatment therein. After being treated in the tank 40 the pulp is discharged through the pipe 46 into the next tank of the series where the treatment is repeated. Any desired number of tanks may be employed in the series. The same treatment may be repeated in each tank, or by heating or adding chemicals or otherwise influencing the treatment in any one or more of the tanks in the series, different treatments may be effected.

Fig. 14 shows an arrangement of apparatus for effecting positive circulation of the pulp, etc. by means of an air-lift device. In this apparatus, shown in transverse vertical section, the tank 50 has the rotatable cage 51 containing grinding elements near the bottom of the tank, with a partition 52 extending from the cage upwardly but terminating below the normal liquid level. An air-lift circulating device is provided on one side of the partition, made up of a perforated pipe 53 surrounded by a canvas covering 54 and supplied by compressed gas through supply pipe 55 having control valve 56 therein.

The arrangement is such that when compressed gas is supplied to the pipe 53 it escapes through the canvas covering 54 in the form of fine bubbles which rise through the liquid and cause an active circulation of liquid upwardly with the gas and over the top of the partitions 52 and down the other side. The cage 51 is located close to the bottom which is rounded to conform generally to the shape of the cage, and the partition 52 also extends close to the cage, so that there is little space left for the circulation of the pulp except through the perforated cage where the material contained in suspension is subjected to the grinding or disintegrating or hydrating action of the grinding elements. The grinding, etc. action within the rotating cage and due to the grinding elements therein, is exerted on material which is kept in circulation, so that different parts

of the material in suspension are progressively subjected to the grinding action.

The arrangement shown in Fig. 14 with the cage at the bottom of the tank, permits heavier or coarser or larger pieces or particles in suspension to be preferentially ground, since the heavier particles tend to settle more readily and to remain at the bottom where they are subjected to continued or repeated treatment, while the finer and lighter particles rise more readily with the rising and circulating liquid. A combined disintegration and classification of finer particles is thus possible, e. g. for grinding and classifying ores, minerals, etc.

The provision of an air-lift device for promoting circulation enables the material to be treated with gas or subjected to aeration where this is desired. The finely divided air will aerate the liquid through which it passes, and it may form a froth and promote removal of selected constituents by flotation. The air will escape at the top of the apparatus and the liquid passing down again for further disintegration in the rotating cage tube or ball mill will be free from entrained air, so that the aeration can be effected without interfering with the ball mill operation.

The apparatus of Fig. 14 is adapted for either batch or continuous operation. For batch operation, the same batch of material will be subjected to grinding or disintegration or hydration, etc. in a progressive manner, with circulation and recirculation of the material through the cage grinding mill. For continuous operation this action is supplemented by a continuous feed of fresh material and a continuous discharge of disintegrated or ground or hydrated material. With the inlet at one end and the discharge at the other, the material during its progress through the apparatus is repeatedly recirculated in a generally spiral or helical path, with repeated subjection to the action of the disintegrating elements during its repeated passages through the disintegrating body of such elements.

I claim:

1. The method of disintegrating cellulosic material which comprises maintaining a body of material to be disintegrated suspended in a liquid medium, maintaining disintegrating elements in said suspension of material, repeatedly lifting said disintegrating elements in said suspension and permitting them to fall back upon each other to cause a disintegration of the material, and maintaining the liquid medium in the disintegrating zone at a level above that at which the disintegrating elements are lifted, whereby splashing and the resulting aeration of the cellulosic material is avoided and the disintegrating takes place wholly beneath the surface of the liquid.

2. The method of disintegrating cellulosic material which comprises maintaining a body of material to be disintegrated suspended in a liquid medium, maintaining disintegrating elements having resilient surfaces in said suspension of material, repeatedly lifting said disintegrating elements in said suspension and permitting them to fall back upon each other to cause a disintegration of the material, and maintaining the liquid medium in the disintegrating zone at a level above that at which the disintegrating elements are lifted, whereby splashing and the resulting aeration of the cellulosic material is avoided and the disintegrating takes place wholly beneath the surface of the liquid.

GEORGE HOLMES CARNAHAN.