

Feb. 8, 1955

M. C. McDONALD

2,701,518

WORM

Filed Oct. 23, 1950

2 Sheets-Sheet 1

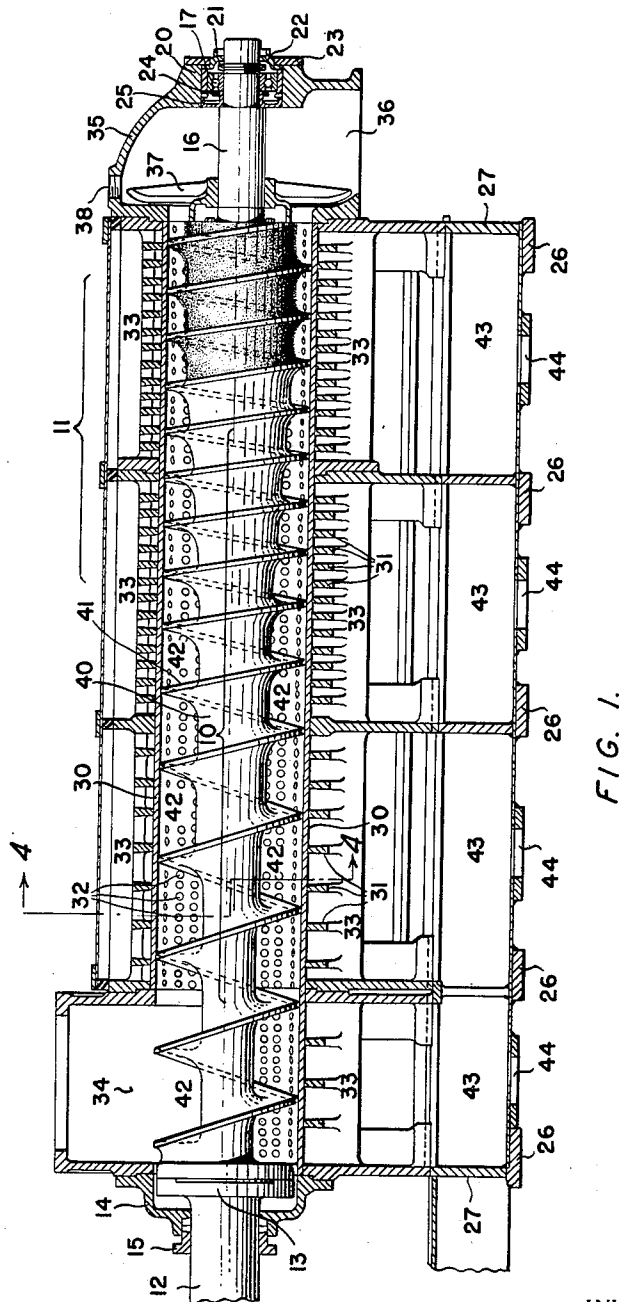


FIG. 1.

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2 Sheets-Sheet 2

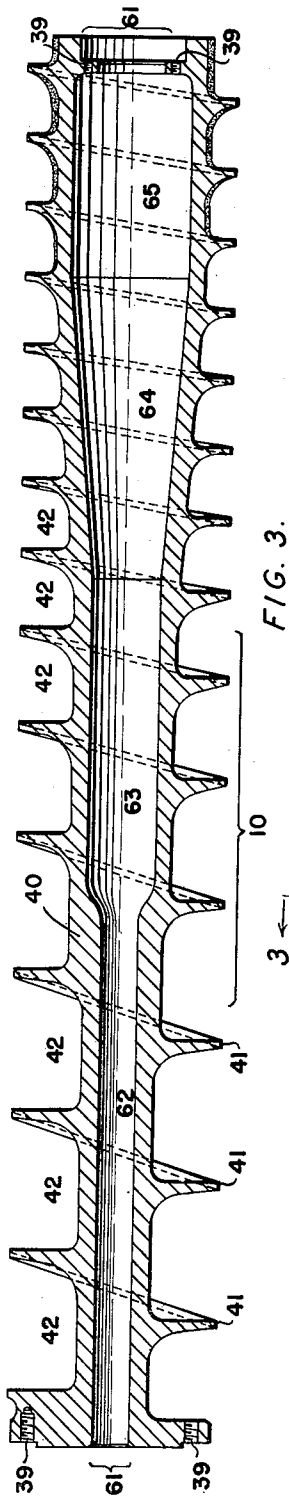
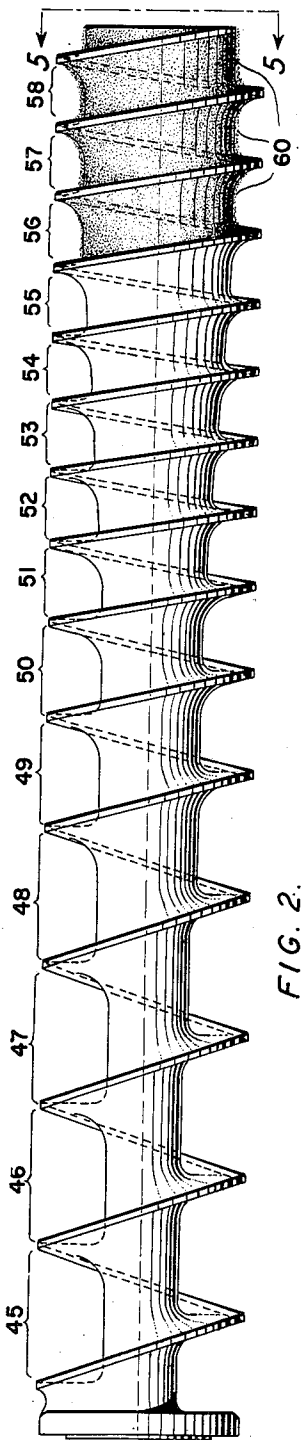


FIG. 3.

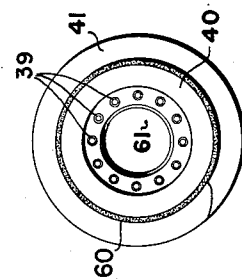


FIG. 5.

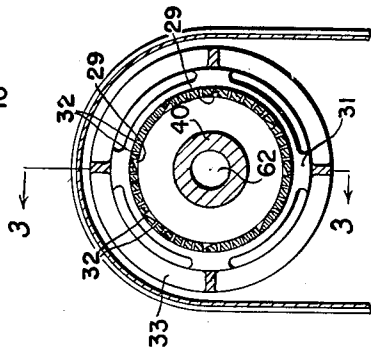


FIG. 4.

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2,701,518

WORM

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Application October 23, 1950, Serial No. 191,645

1 Claim. (Cl. 100—93)

This invention relates to a worm of a character particularly useful in processing pulped fibrous material. More particularly the invention concerns a worm constituting a component of a screw press or like apparatus, and having capacity for applying successive compressive forces in alternate directions to pulp fibres in effecting pressure washing of pulp. While the invention is applicable for pressure washing of any fibrous material, it is of particular advantage for pressure washing of paper pulp.

In my U. S. Patent No. 2,355,091, I disclose and claim a device including a worm mounted for rotation within a housing for treating and removing chemicals from cooked or digested pulp fibres. Such apparatus includes a rotatable worm having screw elements defining a continuous channel of progressively decreasing cross sectional area adapted to compress the advancing pulp fibres against a perforated plate and thereby to express the liquid from the fibres. In such apparatus the pulp is at all times subjected to combined axially and radially directed forces which create the pressure exerted against the perforate plate, and at a predetermined point the pressure is suddenly released by abruptly increasing the cross sectional area of the screw channel, thereby providing space adjacent the pulp cake and within the channel for introduction of further treating fluid to the fibres. Following the relaxation of pressure and introduction of liquid the pulp fibres are held in position and the areas of the screw channels are further diminished, forcing the added liquid through the cake.

The present invention is directed to an entirely different worm construction whereby pulp fibre compression is attained by exerting forces on the pulp fibres alternately and in different directions, and in which the pressure on the fibres is progressively caused to increase and is not permitted to be relaxed during the period in which liquid is being expressed or squeezed from the cake. By reason of this invention a twisted or curled pulp fibre of superior quality is produced with speed and economy. When such pulp is processed to form paper, this paper has the advantage of high tensile strength.

It is accordingly an object of the present invention to provide a worm for use in processing fibrous material and simultaneously treating the fibres to produce pulp or magma of high quality. It is a further object of the invention to provide continuously operating pressure washing means for producing a pressure washed pulp having excellent qualities for use in producing paper. Still another object is to provide a continuous mechanism adapted for connection to existing paper mill equipment, such as digesters or the like, to pressure-wash continuously the pulp produced therein and to form a pulp having curled or twisted fibres.

Other objects and advantages of the invention, including the simplicity and economy of the same and its adaptability to a wide variety of uses, will appear in further detail hereinafter.

In summary, the present invention concerns a worm for use in conjunction with a tubular perforate housing or the like, adapted to be mounted for rotation within the housing for forcing the pulp against the housing thereby expressing liquid from the pulp, said worm having a core and screw elements constructed and arranged to exert successive forces on the pulp in different directions while continuously increasing the pressure thereon, thereby twisting or curling the pulp fibres as they are processed.

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Of the drawings:

Fig. 1 represents a side elevation of a screw press including a housing and a preferred embodiment of the worm of the invention, the housing being shown in section and the worm in full elevation;

Fig. 2 represents a side elevation of the worm;

Fig. 3 represents a side sectional view of the worm, taken as indicated by the lines and arrows III—III which appear in Fig. 4;

Fig. 4 represents a sectional view of the worm and housing, with parts broken away, taken as indicated by the lines and arrows IV—IV, which appear in Fig. 1; and

Fig. 5 represents an end view of the worm, taken as indicated by the lines and arrows V—V which appear in Fig. 2.

It is to be understood that the embodiment of the invention selected for illustration in the drawings represents one of many embodiments falling within the scope of the invention, and that the following description is a description of the precise structure shown in the drawings, and not of the invention in all the forms which it may assume.

Referring now particularly to Fig. 1 of the drawings, the worm 10 is rotatably mounted in the housing 11 and may be assumed to be rotated continuously by suitable drive means, not shown. Such drive means are operatively connected to drive shaft 12 which has a flange 13 secured to the end of the worm 10. Drive shaft 12 extends into the housing 11 through stuffing box 14 and stuffing box gland 15. At its other end the worm 10 is non-rotatably attached to tail shaft 16 which is rotatably mounted in housing 10 bearing 17, bearing cage 20, lock nut 21, bearing cover 22, and retaining ring 23. The mount for tail shaft 16 also includes the packing 24 and flanged ring 25.

The housing 11 includes the base pieces 26 and ribs 27 which are desirably formed integrally with, and serve to support, the cylindrical press plate 30. A plurality of brace rings 31 surround the press plate 30 and are formed integrally with the casing of housing 11.

The press plate 30 is perforated or provided with a large number of small apertures 32 which open into the outer casing 33. Press plate 30 may also be provided with a plurality of longitudinally extending keyways 29 into which caked stock or pulp is compressed, thereby forming pulp keys which serve to prevent the caked stock from rotating with the worm 10.

The housing 11 has an inlet 34 constructed and arranged to receive pulp from the digesters or other pulp producing or processing equipment, and is also provided with discharge canopy 35 and outlet 36 which conduct the magma, or dehydrated pulp produced, to subsequent processing equipment. The bladed spider wheel 37 is non-rotatably mounted on tail shaft 16 and revolves with the worm 10 to assist in discharging the magma from the screw press. Discharge canopy 35 is provided with threaded opening 38 for introduction or withdrawal of liquid as desired.

The worm 10 has a continuous core 40 carrying bolt holes 39 for connection to shafts 12 and 16. Core 40 has a progressively increasing diameter and carries the integrally formed continuous spirally disposed screw flange 41 defining a continuous screw channel or groove 42 in the worm 10. By reason of increasing core diameter and decreasing axial screw flange spacing, the cross sectional area of the screw channel 42 decreases in accordance with a highly important and critical sequence, as will be further described hereinafter.

The aforementioned decrease of cross sectional screw channel area results in the coaction of worm 10 and press plate 30 to apply pressure to the pulp by reason of radially and axially directed forces thereby forcing the liquor or liquid outwardly through the apertures 32, and the pulp is thereby pressure-washed to form magma. By reason of cohesion of caked pulp fibres and small diameter of apertures 32, little or no passage of pulp fibres through apertures 32 is experienced. The liquid or liquor thus separated from the pulp drains from the press plate 30 for collection in chamber 43 of outer casing 33. Chamber 43 may be one undivided chamber or may be partitioned to collect the liquid in separate compartments

as desired. The collected liquid may be withdrawn through outlets 44 for re-use or otherwise.

Referring now to Figs. 2-5 of the drawings, it will be observed that the worm 10 selected for illustration consists of approximately fourteen integrally formed screw sections bearing the consecutive reference numbers 45-58.

Screw sections 45-47 have cores 40 of uniform relatively small cross section and have screw flange portions 41 spaced equally along the axis of screw 10. Accordingly the screw channels 42 of screw sections 45-47 have equal and uniform cross sectional areas. Such channels serve to receive the incoming pulp and to lock this pulp in position between the core 40 of worm 10 and the perforate press plates 30 of housing 11.

In section 48 it will be observed that the core diameter suddenly becomes substantially greater than the core diameter of the immediately preceding section 47. This suddenly decreases the cross sectional area of the screw channel 42 and results in the sudden exertion of a considerable force in a radial direction causing pressure upon the pulp advancing within the pulp pressure-washer housing. This pressure is transmitted through the pulp to press plates 30 and liquid is thereby expressed through the apertures 32.

In screw sections 48-51 the core diameter is uniform but greater than the core diameter of screw sections 45-47. However, in these four screw sections the screw flange portions 41 have progressively decreasing pitch whereby their axial spacing is progressively decreased. Thus the areas of the screw channels 42 of this set of screw sections 48-51 progressively decrease, solely by reason of decreased spacing between the screw flanges 41. The pulp is thereby compressed axially with further expression of liquid through apertures 32.

The next group of screw portions bear the reference numbers 52-55. In this group the axial spacing of the screw flanges 41 remains constant while the outside diameter of core 40 increases progressively. Thus the areas of screw channels 42 are progressively decreased, solely by reason of increased core diameter, and further liquid is driven through the perforate press plate 30 by reason of pressure resulting from radially directed force.

In screw portions 56-58 the screw flange portions 41 are at constant pitch and axial spacing, equal to the pitch and spacing of the screw flange portions in the immediately adjoining set 52-55. The outside diameters of the cores 40 proper are also constant, but these cores are covered with lagging 60 the thickness of which increases progressively from a minimum at section 56 to a maximum at section 58. The lagging 60 is typically a metal plate of the same metal as the worm. Further radially directed force is thus applied to the pulp.

It is to be particularly observed that the spacing of the screw flanges in screw portions 52-58 is uniform. Thus the only pressure applied to the pulp (which may then have a consistency of 20-22%) is directed outwardly from the core of the worm to force the liquor through the apertures in the housing. There is no reduction in the spacing of the screw flanges, which would tend to fracture or distort the cake as it had been located into the keyways of the barrel.

The worm 10 is hollow and provided with a central passage 61 which may carry fluid such as steam, hot liquor, or the like and may assist in maintaining the desired pulp temperature throughout the screw pressing operation. The central passage 61 has a relatively small bore in the section designated 62, and flares outwardly to provide a second section 63 of larger but substantially constant bore. Passage section 63 is subtended by an immediately adjacent passage section 64 of gradually increasing diameter, and passage section 65 of substantially constant diameter completes the central passage 61. The shape of the central passage 61 conforms generally to the outside diameter of core 40 thereby maintaining a substantially uniform core thickness in worm 10.

Thus it will be apparent that the worm 10 in accordance with this invention includes successive interconnected sections functioning in different but interdependent manners and in a definite and critical sequence, whereby the incoming pulp is first locked in position by the coaction of the core and screw flanges which exert only a very moderate pressure on the pulp in two directions at the same time, is then partially pressure-washed under pressure resulting from force suddenly exerted solely in a radial direction, is subsequently still further pressure-

washed by application of sidewise or axial force under the influence of the screw flanges 41, and is further pressure-washed solely by application of outwardly or radially directed core pressure. In this manner unusually rapid and complete pressure washing is attained with minimum fibre damage. Moreover the selective actions of the screw elements as previously set forth exert a curling or twisting effect on the pulp fibres whereby normally flat fibres tend to twist and to assume a more or less kinked shape. This has marked effect upon the character of the paper into which the fibres are eventually incorporated and materially increases its strength. The fibre twisting action appears to be amplified by reason of the rubbing action of the pulp under pressure on the metal surfaces of the screw and the perforated plates, under continuous application of increasing pressure in the manner previously indicated as the fibres progress through the screw press. The pressure is accordingly not permitted to be reduced at any point in the set screw pressing operation and is applied by exertion of forces alternately in radial and axial directions on the pulp.

Preferably, in accordance with the invention, the pitch angle of the worm is as blunt as possible and accordingly assures positive forward movement of the pulp slush with minimum application of power to the worm.

The construction of one preferred example of screw press in accordance with this invention will be further understood by reference to the relative dimensions set forth in the following illustrative table:

Worm Section	Axial flange spacing between this section and preceding section (inches)	Approximate core diameter (outside) (inches)	Cross sectional channel area (sq. inches)
45	12	6 1/32	61.62.
46	12	6 1/32	61.62.
47	12	6 1/32	61.62.
48	12	7 1/16	48.49.
49	11 3/4	8 1/32	38.145.
50	9 1/2	8 1/32	30.6.
51	8	8 1/32	24.1.
52	6 3/4	9 5/8	20.6.
53	6	10 1/2	18.2.
54	6	11 1/4	16.0.
55	6	12 1/8	13.76.
56	6	12 3/4 plus lagging	lagged.
57	6	do.	Do.
58	6	do.	Do.

It will be appreciated that the worm 10 as heretofore described is constructed for operation in combination with a wide variety of press plates or the like, and is effective in use with any means for permitting fluid flow while retaining or obstructing flow of fibrous material. While such means may desirably be in the form of a perforate press plate of uniform diameter, successful pressure washing of pulp may also be attained in conjunction with equivalent apparatus of non-uniform diameter.

It will further be apparent that numerous changes and modifications may be made in the form of the worm and press, including the manner in which the worm may be mounted and rotated, that reversals of parts or elements and substitution of equivalent mechanisms may be made, and that certain features of the invention may be used with or without the use of other features, all within the spirit and scope of the invention as defined in the appended claim.

Having thus described my invention, I claim:

70 A worm for a pulp dehydrator comprising a hollow axial shaft and a continuous flange forming a screw attached to said shaft, said worm comprising a first set of screw sections wherein the shaft diameter and axial spacing of flanges are substantially constant; a second set of screw sections wherein the shaft diameter is substantially constant but abruptly greater than in the first sections, the spacing between successive screw sections progressively decreasing in said second set of sections, a third set of screw sections wherein the shaft diameter increases progressively from section to section but the axial spacing of flanges is substantially uniform, and a fourth set of screw sections wherein both the axial spacing of flanges and shaft diameter are substantially uniform and a layer of lagging of progressively increasing thickness applied to the outer surface of said section, said worm subjecting

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said pulp to successively increasing pressures fluctuating as to rate of increase and direction.

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