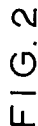


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MASTICATOR FOR PLASTIC MATERIALS

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MASTICATOR FOR PLASTIC MATERIALS

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My present invention relates to an attachment for masticating a moldable (e.g. thermoplastic) material prior to its delivery to a shaping device such as an extrusion press or an injection-molding machine.

Masticators commonly used for the pretreatment of such moldable material employ one or more worms to transport and plastify the raw granules at elevated temperatures by exerting high axial pressure on the mass. In some instances these worms are also reciprocated in axial direction to act as injection pistons.

Because the high degree of compression often required in these masticators, particularly with materials of high viscosity, may subject the worms to extreme axial pressures which cannot be fully sustained by their mountings and lead to a rapid wear of the parts, it has already been proposed to impart to the compression force a radial component which can be more readily withstood by the cylindrical worm housing. Difficulties have been encountered, however, in implementing this proposal in a practical and economical manner.

The general object of my invention is to provide a masticator of the type just described with simple and dependable means for exerting a progressively increasing radial pressure upon a charge of moldable material to be plastified.

A feature of my invention resides in the provision, within a generally cylindrical housing, of one or more worms each carrying a helicoidal principal thread (or set of threads) of constant radius, with a constant or a varying pitch, serving to advance the charge of moldable material along the worm axis, interleaved with at least one auxiliary helicoidal thread of like pitch and progressively increasing radius. The latter thread, whose function it is to subject the advancing charge to a steadily increasing radial pressure whereby the material is progressively compacted within the narrowing space between adjacent principal-thread turns, advantageously starts at the level of the base of the principal thread next to it and gradually rises to the height of the outer radius thereof. It will generally be convenient to limit the rise of the auxiliary thread to an intermediate longitudinal section of the worm, thereby providing a substantially pressure-free region near the inlet of the housing and a region of substantially constant compaction just ahead of its discharge end; this latter measure particularly facilitates the ejection of the compacted material through the outlet nozzle of the masticator and minimizes the risk of local overheating that would otherwise arise from the complexity of the flow conditions at that end. Thus, in the terminal zone of the masticator the principal and auxiliary threads are of the same height so that the worm effectively operates there as a multiple-thread feed screw for the compacted charge carried between its turns within the surrounding housing.

The rise of the auxiliary thread may vary with the material to be compacted, in order to conform substantially to the rate of shrinkage of such material under heat and pressure. Also, the angle of slope of the auxiliary thread (i.e. the angle included between its own tangent and that of the principal thread) should at all points be less than the angle of friction between the plas-

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tic mass and the worm and housing surfaces in contact therewith.

Generally, two or more worms in mesh with one another will be employed in a masticator embodying the invention, although (particularly in the case of a reciprocating injection plunger) a single worm may be used. The invention further provides, in the case of a multiple-worm assembly, for the formation of a helicoidal groove of progressively increasing depth in the turns of principal thread of one worm facing the turns of auxiliary thread on an adjoining worm in mesh therewith. Thus, in accordance with a more specific feature of my invention, each worm has a principal thread which is progressively separated by the aforementioned groove into two helicoidal ridges so as to form two interleaved threads of like pitch and height in a region remote from the inlet end of the housing, each groove matingly accommodating an auxiliary thread of the aforescribed character on at least one adjoining worm. The threads may be rectangular or trapezoidal in upprofile, or of other conventional configuration.

Although the invention will be described hereinafter with particular reference to a masticator having adjacent worms rotating in opposite directions and provided with threads of relatively inverted pitch, it is to be understood that the principles of the present disclosure are also applicable to systems in which two or more worms of like pitch are in mesh with one another and rotate in the same direction. The intimate mixing of the particles and the resulting homogeneity of the mixture with a minimum of axial stresses will be realized in either instance.

In the accompanying drawing:

FIG. 1 shows a longitudinal sectional view through a masticator housing with a pair of meshing worms according to the invention; and

FIG. 2 is a cross-sectional view taken generally on line 2-2 of FIG. 1 but showing the projections of the auxiliary threads of the worms upon a transverse plane.

The masticator shown in the drawing comprises a pair of meshing worms with threads of opposite pitch, including a worm L with left-handed threads and a worm R with right-handed threads. These worms are driven with opposite sense of rotation by a mechanism here shown to comprise a pair of interengaging gears 11, 12 cooperating with a driving pinion 13 on the shaft of a motor not illustrated. A housing 14 is formed with two generally cylindrical cavities 15, 16 which merge into a substantially figure-eight-shaped cross-section.

Worm L is formed with a principal helical thread L2 whose turns of substantially rectangular profile are separated by a helical gap L1 of the same width as these turns. Worm R is similarly formed with a principal helical thread R2 defining a gap R1 complementary to, respectively, the gap L1 and the thread L2 of worm L in close mesh therewith. The housing 14 is longitudinally divided into an inlet zone I, provided with a hopper 17 for the introduction of the granulated material to be plastified; an intermediate zone II, in which the elastic material is compacted at an elevated temperature produced, for example, by a heating coil 18; and an outlet zone III, in which the plastified mass is allowed to flow without appreciable additional compaction toward a discharge nozzle 19.

An auxiliary thread L3, of a width here shown to be about one-third that of gap L1, begins to rise within this gap at the junction A-A between zones I and II and gradually approaches the full height of principal thread L2 which it reaches at the junction B-B of zones II and III. The presence of thread L3 divides the gap L1 into two helical grooves L1', L1''; simultaneously, a helical groove L4 progressively cuts into the face of thread L2

until it reaches the depth of gap L1 at the junction B—B, this groove thus dividing the land of thread L2 into two helical ridges L2', L2''. As here shown, groove L4 has substantially the same width as grooves L1', L1'', i.e. about one-third the width of thread L2, whereby in the terminal zone III the worm L is formed with three interleaved and equispaced threads L2', L2'', L3 separated by complementary grooves L1', L1'', L4.

The configuration of worm R is identical with and mirror-symmetrical to that of worm L, the principal thread R2 being split by a groove R4 into two helical ridges R2', R2'' while the gap R1 is divided by an auxiliary thread R3 into two grooves R1', R1''. It will be apparent that threads L3, R3 are complementary to grooves R4, L4, respectively, and that consequently the grooves R1', R1'' matingly receive the ridges L2', L2'' while the grooves L1', L1'' similarly coast with the ridges R2', R2''.

The close contact between the several ridges and grooves causes the plastic material to advance continuously from hopper 17 toward nozzle 19 while being compacted against the inner wall surface of housing 14 by the rising auxiliary threads L3 and R3. As shown in FIG. 2, the projections of thread L3 and groove R4 (as also those of thread R3 and groove L4) are mating spirals 21, 22; with the worms L and R rotating in the direction of the arrows, some of the compressed mass 20 from the clearance left by thread L3 will spill over into the groove R4 where it will be advanced with a relatively retarded motion, the net result being an increased densification of the charge at a rate determined by the angle of slope of the spiral 21 included between the tangent 23 to the spiral and the tangent 24 to the outer circumference of the worm or the cylindrical housing concentric therewith. This angle may vary according to a linear or non-linear law depending upon the nature of the plastic material, but in any event should be less than the angle of friction of this material as mentioned above. In the actual embodiment illustrated the curves 21 and 22 are Archimedean spirals.

My invention is, of course, not limited to the specific embodiment herein disclosed but may be modified in various respects without departing from the spirit and scope of the appended claims.

I claim:

1. A masticator for the plastification of moldable material, comprising a housing with at least two merging, substantially cylindrical cavities, said housing having an input end and an output end, a pair of rotatable worms in close mesh with each other, each worm fitting closely inside a respective cavity, each worm having at least one principal helicoidal thread of substantially constant radius and at least one auxiliary thread interleaved with said principal thread intermediate the turns thereof and spaced therefrom, said auxiliary thread rising progressively from a minimum radius to a maximum radius, each worm being further provided with a helicoidal groove cutting progressively deeper into the land of its principal thread while complementarily receiving the auxiliary thread of the other worm, and drive means for rotating said worm in a sense advancing a charge of moldable

material from said input end to said output end while compacting said charge between said auxiliary thread and said housing.

2. A masticator for the plastification of moldable material, comprising a housing with at least two merging, substantially cylindrical cavities, said housing having an input end and an output end, a pair of rotatable worms in close mesh with each other, each worm fitting closely inside a respective cavity, each worm having at least one principal helicoidal thread of substantially constant radius and at least one auxiliary thread interleaved with said principal thread intermediate the turns thereof and spaced therefrom, said auxiliary thread rising progressively from a minimum radius at the base of said principal thread to a maximum radius equaling that of said principal thread, between a first location beyond said input end and a second location ahead of said output end while maintaining the same maximum radius between said second location and said output end, each worm being further provided with a helicoidal groove cutting progressively deeper into the land of its principal thread while complementarily receiving the auxiliary thread of the other worm, and drive means for rotating said worm in a sense advancing a charge of moldable material from said input end to said output end while compacting said charge between said auxiliary thread and said housing.

3. A masticator according to claim 2 wherein said principal thread has turns of a width equaling the spacing therebetween, said auxiliary thread having a width substantially equal to one-third of said spacing and forming between itself and adjacent turns of said principal thread a pair of helicoidal grooves of like width.

4. A masticator according to claim 2 wherein said auxiliary thread has a slope angle which at all points is less than the angle of friction between said moldable material and the surfaces of said housing and said worms in contact therewith.

5. A masticator according to claim 2, further comprising heating means at said housing for maintaining said material at an elevated temperature at least between said first and second locations.

6. A masticator according to claim 2 wherein the threads of said worms are of opposite pitch, said drive means being adapted and arranged to rotate said worms in opposite directions.

References Cited in the file of this patent

UNITED STATES PATENTS

1,886,592	Royle	Nov. 8, 1932
2,119,162	Hartner	May 31, 1938
2,686,336	Kleinlin et al.	Aug. 17, 1954
2,807,833	Schanz	Oct. 1, 1957
2,872,703	Gambrill et al.	Feb. 10, 1959

FOREIGN PATENTS

519,574	Belgium	May 15, 1953
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OTHER REFERENCES

Monsanto Bulletin No. 1029, copyright 1956.