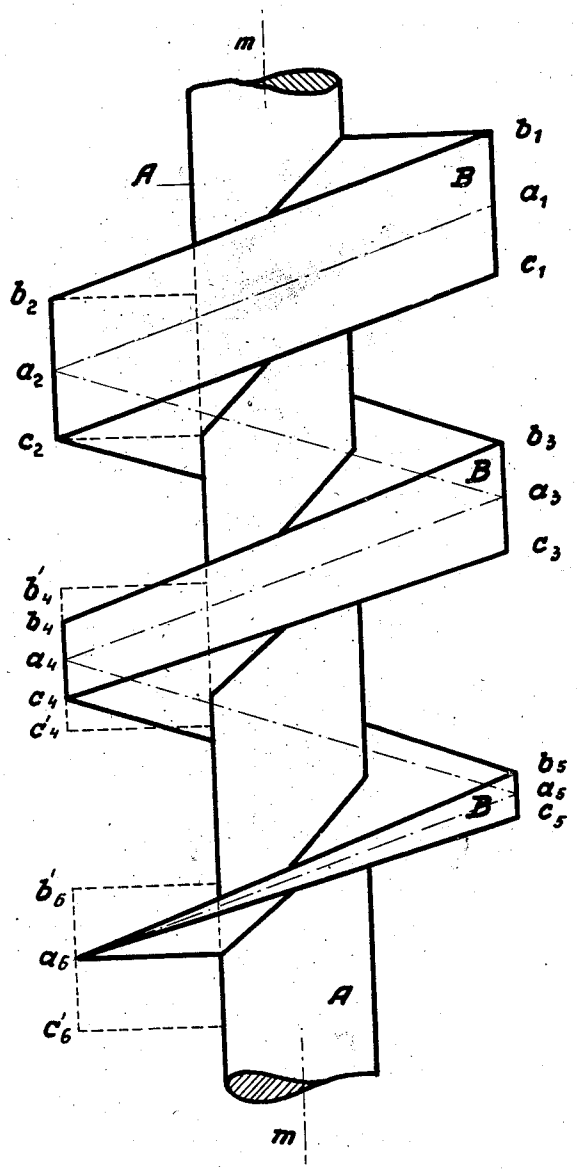
Nov. 8, 1938. S. KIESSKALT ET AL 2,136,264

KNEADING APPARATUS

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Fig. 1



INVENTORS:
Siegfried Kiesskalt,
Hans Dampke,
Ernst Weingaertner,
Karl Wimbacher,
By Potter, Pierce & Scheffler, ATTORNEYS.

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Fig. 2

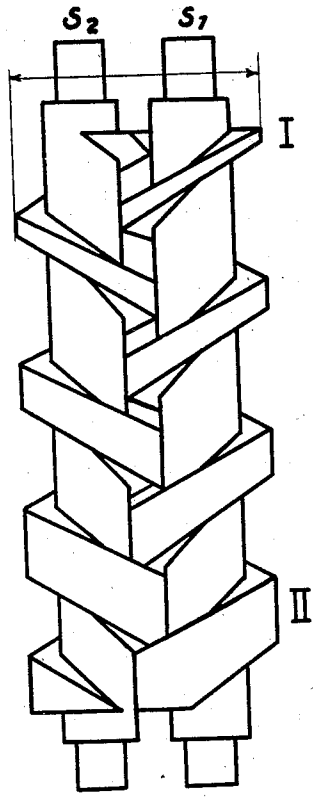


Fig. 3

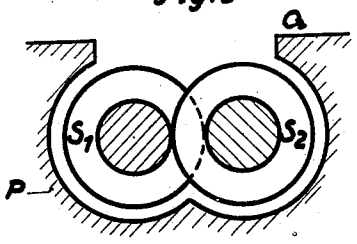


Fig. 4

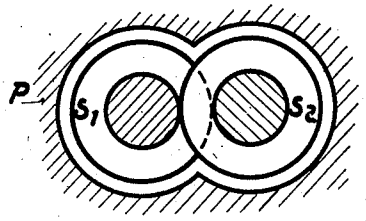
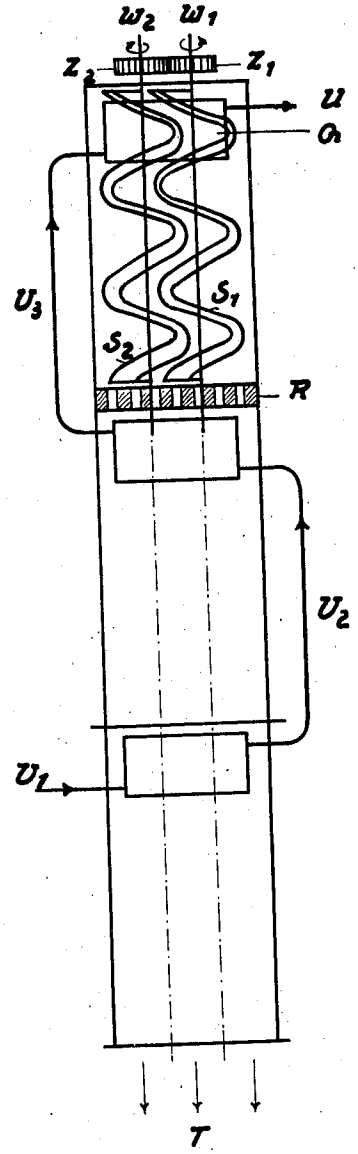


Fig. 5



INVENTORS:
Siegfried Kiesskalt,
Hans Dampke,
Ernst Weingaertner,
Karl Winbacher,
By Potter, Pierce & Scheffler, ATTORNEYS.

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KNEADING APPARATUS

Siegfried Kiesskalt, Hans Tampke, Ernst Weingaertner, and Karl Winnacker, Frankfort-on-the-Main, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany

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5 Claims. (Cl. 259—104)

The present invention relates to an improved apparatus for preparatory processes, such as mixing or kneading.

Certain preparatory processes are applied to masses which are in a plastic condition, for instance, plastic masses of the ceramic and rubber industries and masses occurring in the known processes of making dispersions of coal and oil free from ash, so-called "flowing coal", and the like. These processes involve kneading, mixing and, in part, washing operations, the masses having in most cases to be subdivided once or several times during the operation in order to create a large surface. Besides a continuous passage, the possibility of a treatment in stages and application of the counter-current principle are desirable.

The present invention provides an apparatus which may be used with advantage in such preparatory processes. This apparatus comprises a right-handed worm and a left-handed worm arranged so that their threads intermesh. The thread of each worm is in axial direction narrow at one end relatively to the pitch of the worm and increases in cross-section towards the other end until the intermeshing threads engage so closely that in combination with a casing surrounding the worms at this end they constitute a valveless pump. This means that at the end of the worm the cross-section of the thread remains constant during at least one turn. Owing to the increasing cross-section of the threads, there is provided a passage whose cross-section decreases in the axial direction of the worms from one end (the inlet end) of the apparatus to the other end (the outlet end). Several such pairs of worms may be connected in series with intercalation of perforated press plates. The apparatus may also be provided with means which allow a counter-current operation with treating liquids. For this purpose there may be provided means for introducing treating liquid into the casing adjacent to the discharge outlets and means for discharging treating liquid adjacent to the inlet end of the casing whereby the material being treated and the treating liquid pass through the casing in counter-current to each other.

The apparatus of this invention, therefore, may be an organic combination of twin screw conveyors and valveless pumps with passages of changing volume.

The accompanying drawings diagrammatically illustrate the invention.

Fig. 1 is a right-handed worm, the corresponding left-handed worm having the same profile structure.

Fig. 2 is a right-handed worm and a left-handed worm arranged axially.

Fig. 3 is a section through these two worms at the inlet end and

Fig. 4 is a section near the outlet end,

Fig. 5 is an arrangement in series of several pairs of worms.

m—m is the axis of the worm A; a_1 a_2 a_3 a_4 a_5 a_6 is the helicoidal centre line of the worm threads of the constant pitch a_1 a_3 or a_2 a_4. The form illustrated may be supposed to be derived from a square-threaded worm with threads of rectangular profile, the initial width of the thread being equal to half the pitch. On the left hand side of the drawings the limits are indicated by broken lines b_4' c_4' b_6' c_6' following b_2 c_2. b_1 b_2 c_2 c_1 show half a thread which remains in the original form, as it is required in this form for the valveless pump-like closing at the pressure end. From b_2 c_2 onwards the upper and lower helicoidal surfaces have a wedge shaped form so that the final limitation of the profile shown on the left side is now b_2 c_2, b_4 c_4, a_6. The thread B which remains and diminishes from the upper part to the lower part is represented by the solid lines b_1 b_2 b_3 b_4 b_5 a_6 and c_1 c_2 c_3 c_4 c_5 a_6. Each of them has a constant pitch. Such worms may be made in a simple manner by tapering the threads with the aid of inclined milling cutter discs. The cross-section of the upper part of the threads (b_1, c_1, b_2, c_2) does no longer increase, that is to say the distance from b_1 to c_1 is equivalent to the distance from b_2 to c_2. If the cross-section of the thread is kept constant in this manner for at least one turn, several worms of this kind situated parallel to each other form valveless pumps at the parts where the threads have a constant cross-section.

As shown in Fig. 2 such a right-handed worm S_1 is now assembled with a left-handed worm S_2 made in exactly the same way. When the worm S_1 rotates counter-clockwise and the worm S_2 clockwise, it is apparent that the narrow threads act on the mass of material at the inlet end I of the device, chiefly as mixing worms, whereas the threads at the outlet end II act as a screw pump and thus exert considerable pressure. Consequently the casing P at the inlet I will generally be given the form of an open trough having a hopper Q (see Fig. 3) but at the outlet II it will have the form of a casing surrounding the worms (see Fig. 4). In order to better distinguish the single parts a small space is shown between the gears s_1 and s_2 and the casing P. This space does not really exist as otherwise the chambers between the threads of the worm would not be completely separated from each other and a valveless pump would not be formed with the casing. The operation of this pair of worms, according to the invention, is as follows:—

The quantity of the mass taken up by the screw threads in the region I is considerably

larger than that contained by the worms at the outlet II, which has the form of a pump. Consequently, only part of the mass taken up at I will enter the final threads at II; the other part is more and more forced back to I by the screw threads which do not engage closely at the inlet and is thereby kneaded. A circulation of a part of the mass is thus introduced in a direction parallel with and opposite to the conveying current determined by the dimensions of the end of the worm.

The assembly of the whole device is illustrated in Fig. 5. On the two continuous lines of shafting W_1 W_2, which are coupled by means of toothed wheels Z_1 Z_2, several successive pairs of worms S_1 S_2 are arranged, those of each pair being engaged in the manner indicated in Fig. 2. The drawings show, for instance, a three-stage construction, but it is also possible to use one pair only or more than three. Between each of the consecutive pairs of worms a press plate R is inserted which has openings of the desired cross section. The mass to be treated is pressed through these openings by the pump portion of the pair of worms and then enters between the conveyer portion of the following pair of worms. The mass introduced through the first hopper Q is treated, as represented in Fig. 5, in three stages and is pressed or pumped out of the apparatus by the last pair of worms at T. In the case shown there is provision for causing a treating liquid to travel in counter current to the material. The conduit v_1 is introduced near the discharge outlet of the next to last casing. From this part the conduit v_2 leads to the corresponding part of the preceding casing and from there a third conduit v_3 leads to the inlet end of the entire apparatus. Through these conduits v_1, v_2 and v_3 the liquid for treating is passed through the entire device whereby a part of the liquid during the kneading operation is taken along by the worms and conducted together with the mass to be kneaded whereas the excess of the liquid leaves the apparatus at U.

The effect of the worms provided with a flat or a broad passage may be enhanced by using not only threads with a converging or tapered profile, but by cutting the worms with a pitch which becomes smaller from the inlet end to the outlet end. Moreover, at the pumping end the threads may be given an additional profile in any known manner in order to improve the pumping action. Finally at the conveying end the worms may be perforated in order to improve the kneading action. The arrangement of the worms may also be used alone as a kneader with conveying action. The principal advantage of the invention over blade kneaders and mixing worms lies in the possibility of combining mixing, kneading by displacing action and mere pumping action in one and the same device.

We claim:—

1. A kneading apparatus comprising a casing, right-handed and left-handed worms arranged in the casing so that the threads of the worms intermesh, the threads of the worms being of constant pitch, the cross-sectional area of the threads of each worm gradually increasing from the inlet to the outlet end of the casing, whereby the threads of the worms are relatively widely separated at the inlet end and closely spaced at the outlet end, the worms and casing forming a valveless pump at the outlet end of the casing.

2. A kneading apparatus comprising a casing, a right-handed and a left-handed worm arranged axially in the casing so that the threads of the worms intermesh, the threads of the worms being of constant pitch, the cross-sectional area of the threads of each worm gradually increasing from the inlet end to the outlet end of the casing whereby the threads of the worms are relatively widely separated at the inlet end and closely spaced at the outlet end to provide a passage of decreasing volume from the inlet point to the outlet point, the worms and casing forming a valveless pump at the outlet end of the casing.

3. A kneading apparatus comprising a casing, several pairs of right-handed and left-handed worms arranged axially in series in the casing so that the threads of each pair of worms intermesh, the threads of the worms of each pair being of constant pitch, the cross-sectional area of the threads of each worm gradually increasing from the inlet end to the outlet end of the casing whereby the threads of the worms are relatively widely separated at the inlet end and closely spaced at the outlet end of each pair to provide a passage of decreasing volume from the inlet point to the outlet point, the worms and the casing forming a valveless pump at the outlet end of each pair of worms.

4. A kneading apparatus comprising a casing, several pairs of right-handed and left-handed worms arranged axially in series in the casing so that the threads of each pair of worms intermesh, perforated press plates interposed between each pair of worms, the threads of the worms of each pair being of constant pitch, the cross-sectional area of the thread of each worm gradually increasing from the inlet end to the outlet end of the casing whereby the threads of the worms are relatively widely separated at the inlet end and closely spaced at the outlet end of each pair to provide a passage of decreasing volume from the inlet point to the outlet point, the worms and casing forming a valveless pump at the outlet end of each pair of worms.

5. A kneading apparatus comprising a casing, several pairs of right-handed and left-handed worms arranged axially in series in the casing so that the threads of each pair of worms intermesh, an inlet for material to be treated at one end of the casing and a discharge outlet for treated material at the opposite end of the casing, perforated press plates interposed between each pair of worms, the threads of the worms of each pair being of constant pitch, the cross-sectional area of the thread of each worm gradually increasing from the inlet end to the outlet end of the casing whereby the threads of the worms are relatively widely separated at the inlet end and closely spaced at the outlet end of each pair to provide a passage of decreasing volume from the inlet point to the outlet point, the worms and casing forming a valveless pump at the outlet of each pair of worms and means for introducing treating liquid into said casing adjacent to said discharge outlets and means for discharging treating liquid adjacent to the inlet end of the casing whereby the material being treated and the treating liquid pass through the casing in counter-current to each other.

SIEGFRIED KIESSKALT.
HANS TAMPKE.
ERNST WEINGAERTNER.
KARL WINNACKER.