

[54] **HEATING APPARATUS FOR PLASTIC EXTRUDERS**

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[51] Int. Cl. **F27d 11/04**

[58] Field of Search **13/23; 425/174.6;**
219/284, 291

[56] **References Cited**

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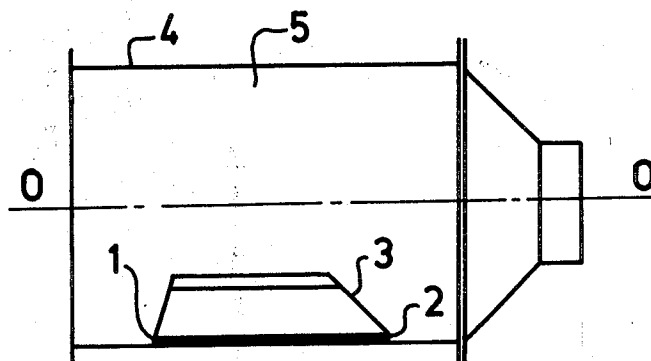
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[57] **ABSTRACT**

A heating unit comprising a chamber in which are located at least two electrodes. The electrodes each comprising a first portion matching and secured to the interior wall of the chamber and a second portion extending radially inward toward the central axis.

13 Claims, 8 Drawing Figures



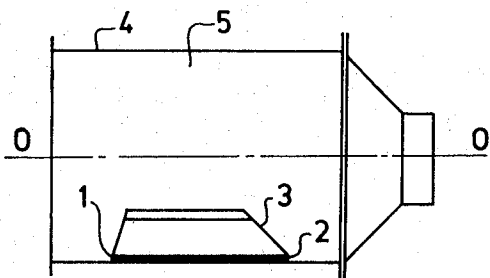


FIG. 1

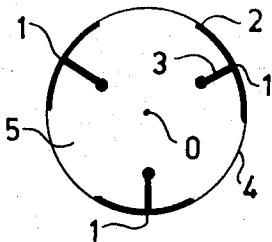


FIG. 2

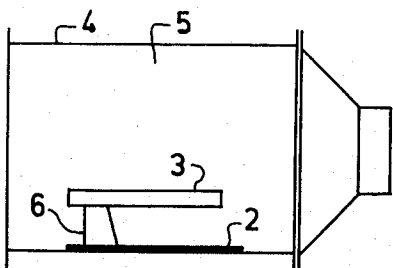


FIG. 3

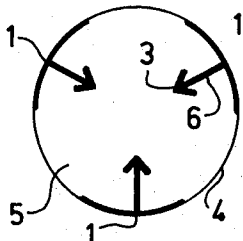


FIG. 4

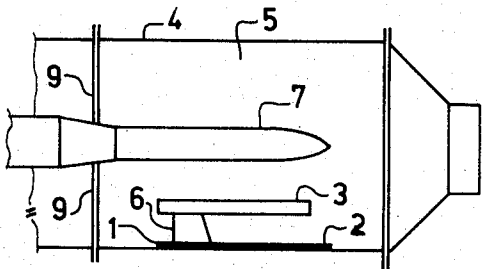


FIG. 5

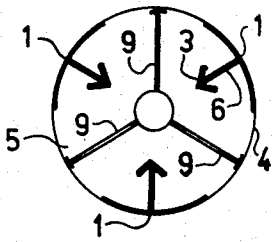


FIG. 6

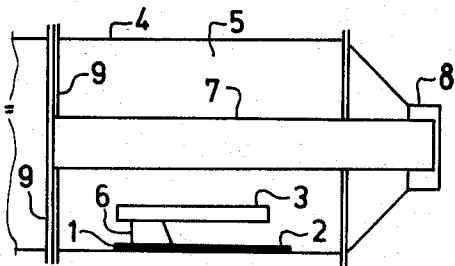


FIG. 7

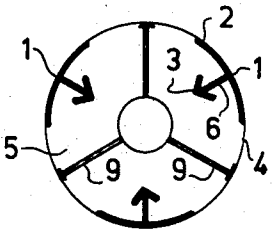


FIG. 8

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HEATING APPARATUS FOR PLASTIC EXTRUDERS

The present invention relates to apparatus for extruding plastic masses and in particular to apparatus for extruding clay or ceramic objects.

One of the main functions of apparatus of this type is to provide an even and uniform heating of the plastic material during its extrusion. In general this is performed by the distribution and shape of one or more electrodes within a heater unit. Conventionally the heater body is hollow and cylindrical or conical in shape and is located, either as an integral or separable member, between the worm or press chamber and the forming or shaping die out of which the plastic mass is extruded. The electrodes are connected to conventional sources of current and transform the hollow body into a heating chamber for the plastic.

In the prior devices the electrodes have been connected to a source of uniphase A.C. current, with one of the electrodes being in the form of a ring located on the inside surface of the hollow body and the other electrode in the form of a conductive mandrel located along the axis of the heating chamber. In extruders for small size objects the unevenness in heating the plastic mass is balanced and the heat uniformly distributed by the intensive mixing of the material as it is being forcefully extruded through the narrow orifice of the nozzle, the cross section of which is between 100 and 1000 times smaller than the cross section of the heating chamber. This situation is, however, different for the extrusion of pieces of large shapes and sizes, as for instance bricks or high voltage insulators, since the unevenness of the heating process within the heating chamber can not be balanced by the mixing of the mass in the die. In this latter instance the die orifice is at most only ten times smaller than the cross section of the heating chamber. In these larger extruders it has been necessary to use a three phase current source for the electrodes. Therefore the devices must contain three or a multiple of three electrodes. Notwithstanding the use of an increased current source the distribution of individual electrodes about the circumference of the heating space has not resulted in an even distribution of the heat, particularly along its central axis. Convex electrodes, that is, curved to conform with the shape of the body, have been tried, resulting in a more even distribution of electric current field, but they do not achieve a more even distribution of the heating temperature. The heat along the central axis is higher than the outside. The convex electrodes are furthermore not convenient because they reduce the transflux cross section and retard the movement of the plastic mass around the electrodes, although the movement of the mass along the central axis is faster.

It is an object of the present invention to provide extruding apparatus of the type described which creates a more even and uniform distribution of heat within the entire cross section of the plastic mass.

It is another object of the present invention to provide extruding apparatus of the type described in which large pieces and objects may be formed.

It is yet another object of the present invention to provide extruding apparatus in which uniform mixing of the heat mass may be obtained with the use of large die orifices.

These objects, others and numerous advantages will be apparent from the following disclosure of the preferred embodiment of the present invention.

SUMMARY OF THE INVENTION

According to the present invention apparatus for heating the plastic mass in extrusion devices is provided comprising a chamber having a longitudinal axis in which at least two electrodes are located. Each electrode comprises a first portion secured insulatingly to the inner wall of the body and a second portion extending radially toward the central axis. The two portions are at least conductively connected to form a unitary electrode body and are of such size and configuration to evenly distribute the heat without reduction of the transflux cross section of the body.

Preferably the electrodes are connected to a three phase current source in wye or delta networks. The inner portion may be provided with a curved or convex configuration while the outer portion is curved to match the arc or configuration of the body. A mandrel or shaft may also be located along the central axis and may be connected into the current source network.

Full details of the present invention will be seen in the attached drawing and in the following description.

BRIEF DESCRIPTION OF DRAWING

In the drawing:

FIG. 1 is an axial cross section of a heating apparatus according to the present invention,

FIG. 2 is transverse sectional view of the apparatus of FIG. 1,

FIGS. 3 and 4 are views similar to FIGS. 1 and 2 respectively showing a second embodiment of the present invention,

FIGS. 5 and 6 are views similar to FIGS. 1 and 2 respectively, showing a third embodiment, and

FIGS. 7 and 8 are views similar to FIGS. 1 and 2 showing yet a fourth embodiment.

Before turning to the description of the present invention it will be understood that the drawings show only the heating unit and chamber and associated apparatus. The remaining extruder apparatus such as the worm, screw or other compression means, the die, the sources of current, control means, etc., are omitted from the drawings for the sake of brevity. These non-illustrated mechanisms are well known and do not require description or showing here for the understanding of the present invention.

DESCRIPTION OF INVENTION

In all four of the illustrated embodiments a plurality of electrodes 1 comprising an external portion 2 and an interior portion 3 are located within the hollow space formed by a body 4 having an axial central axis O. The body 4 may be cylindrical or conical although as seen, it is generally cylindrical and has a leading conical tapered discharge end portion in which an orifice 8 is formed for discharge of material. The body 4 is adapted to be secured between the non-illustrated worm or compression means and the shape forming die and its interior defines a heating space or chamber 5 wherein the plastic material acted upon by the electrodes and constituting a portion of the electrical resistance circuit is elevated in temperature to attain its proper extrusion plasticity. The interior surface of the body is preferably coated with electrically insulating material or at least

such material is interposed between the internal portion 2 of the electrode and the surface of the body 4.

The external portion 2 of the electrode is insulatingly secured to the internal surface of body 4 and the internal portion 3 extends radially inward toward the central axis. The two portions 2 and 3 are both mechanically and electrically connected, preferably being integrally and/or unitarily formed of suitable electrode conductive material. The external part 2 is matched to the shape of that portion of the body 4 at which it is located. That is, it is transversely curved to the arc of the body and extends over a substantial portion thereof rather than having merely a point or line configuration and attachment. For example, when placed in a cylindrical body the external portion 2 comprises a cylindrical segment and when placed in a conical body it comprises a conically curved section. This provides a generally even distribution of power along the cross-sectional periphery of the body and the greatest transflux cross-sectional movement can be achieved. The surface of the internal portion 3 is for optimum results kept at least equivalent to a fifth of the surface of the external portion 2 and extends radially into the body 4 to a depth of at least a third of the radius of the body measured from its interior surface. This provides for an even and uniform distribution of heat toward the central axis and balances the heat provided at the cross-sectional periphery.

The individual embodiments differ from each other as follows:

In the arrangement seen in FIGS. 1 and 2 the internal portion 3 forms a radial rib which may have a terminal head at its inner end. This rib is integrally connected to the external portion 2. Preferably, the two portions are formed unitarily from the same piece of material although they may be separately formed and then mechanically and electrically connected. The electrodes are arranged triangularly in a delta network to a source of three phase current.

In the arrangement according to FIGS. 3 and 4 the internal portion 3 is in the form of an elongated longitudinally directed plate or strip, the longitudinal direction extending parallel to the axis of the body 4. The profile of the internal portion 3 is curved in cross section convexly with respect to the central axis and is connected to the external portion 2 by a radial strut or supporting piece 6 of small cross section perpendicular to its longitudinal axis. This construction creates only a minimum reduction in the transflux cross section of the heating chamber. It is noted that the curve of the inner portion 3 flares away from the center of the heating chamber being opposite in general form to the arc of the body. Rather than a convex curve the inner portion may be bent along its center to form an inverted V- or U-shape. As in the preceding embodiment the portions 2 and 3 and the strut 6 may be formed from one piece of material or they may be separately made. The electrodes are also connected in a triangular delta network to the current source.

In the arrangement of FIGS. 5 and 6 the electrodes 1 may have the same shape as those in either of FIGS. 1 and 2 or FIGS. 3 and 4, but here a conductive mandrel 7, either as a solid rod or hollow tubular shaft, is located cantilevered along the central axis. The mandrel 7 is held by a plurality of holding brackets 9 radially extending to the interior surface of the body 4. The electrodes 1 may be connected in a wye or spider net-

work to a source of three phase current while the mandrel 7 is connected to the node or common point of the circuit arrangement. In this manner the electrodes 1 and the mandrel 7 both act as heating source. It will be noted that the mandrel 7 extends from within the non-illustrated compression chamber partially through the heating space terminating in a conical or bullet nose end short of the discharge cone and opening 8.

The arrangement according to FIGS. 7 and 8 is similar to that of FIGS. 5 and 6 except that the conductive mandrel 7 extends the full length of the chamber 5 through the discharge cone and into the opening 8, but does not necessarily extend from the compression chamber. It is preferably secured at its rear end to a reinforced bracket 9. The mandrel 7 here may preferably be a hollow tube open at its forward end, or it may be shaped as seen in the preceding FIGS. 5 and 6.

It will be seen that in each embodiment the electrode comprises two parts. The outer portion, located on the surface of the body, covers a substantial portion thereof, while the inner portion extends toward the central axis. The capacity and effect of the inner portion can be enhanced by convexly curving the portion away from the central axis thus producing a more even distribution of heat. Both parts are mechanically and electrically connected. Preferably, at least two electrodes are used, although when three electrodes 1 are employed, or their multiple, connection to a three phase current source in either delta or wye networks is easily possible. The electrodes are uniformly spaced about the transverse cross section of the body. Thus, almost no reduction in the transflux movement occurs although the heat source (i.e. electrodes) is shifted toward the center of the heating chamber.

The size of the electrodes, particularly in the width dimension, will vary with respect to the size of the body 4 or heating chamber 5. In addition it will be beneficial to vary the width of the electrode in any installation in the direction of the longitudinal axis of the body to adjust and accommodate for the changes in electrical resistance of the plastic mass. As the plastic mass moves forward from the compression chamber to the discharge opening 8 the heat and manipulation within the chamber 5 increases its plasticity thus modifying electrical resistance. As a consequence the electrode at the forward end need not be of the same size as at the rear-most end. Generally the size will be less as the resistance is less.

It will also be seen that the present invention provides for the uniform and even distribution of heat and the effective plasticizing of the material not withstanding the size of the plastic particles or the size of the die. The die may be very large but sufficient plasticity will be obtained from working of the material within the heating chamber and by the heat supplied from the electrodes.

Various other modifications, embodiments and changes can be made and it is intended therefore that the present disclosure be taken as illustrative only and not limiting of the present invention.

What is claimed:

1. In an extruder for clay, ceramic and the like materials, heating apparatus comprising a heating chamber formed from a hollow body having a central axis and an insulated interior surface, and at least two electrodes located within said body and connected to a source of current, each of said electrodes comprising an elon-

gated internal and external portion extending parallel to the central axis conductively connected with each other to form a unitary member, the external portion being insulatively secured to the interior surface of said body and the internal portion spaced from said surface and extending radially inward toward the central axis of said body.

2. The apparatus according to claim 1, wherein the internal portion of the electrode has the form of a rib connected to the external portion of the electrode.

3. The apparatus according to claim 1, wherein the internal portion of the electrode has the shape of an elongated plate or strip, the longitudinal direction of the latter being parallel with the axis of the body and being connected to the external one by means of a radial strut.

4. The apparatus according to claim 1 wherein the cross section transverse to longitudinal direction of the internal portion of the electrode is curved.

5. The apparatus according to claim 1, wherein the cross section transverse to longitudinal direction of the internal portion of the electrode is an inverted V-shape.

6. The apparatus according to claim 1, wherein the shape of the external part of the electrode is matched to the shape of that part of the internal surface of the body at which the external part of the electrode is located.

7. The apparatus according to claim 1, wherein the external part and internal portion of the electrode are

made of one piece.

8. The apparatus according to claim 1, wherein the surface of the internal portion of the electrode is at least equal to a fifth of the surface of the external portion of the electrode.

9. The apparatus according to claim 1, wherein the width of the electrodes in the direction of the central axis is varied in dependence on the change of the electrical resistance of the plastic mass as a result of change of temperature in its passage through the heating chamber.

10. The apparatus according to claim 1, wherein the internal portion of the electrode penetrates into the depth of at least one third of the radius of the body, measured from the internal surface.

11. The apparatus according to claim 1, wherein the electrodes are connected in delta to a three phase current source.

12. The apparatus according to claim 1, wherein the electrodes are connected in wye to a three phase current source, and a conductive mandrel is located to extend along the central axis of the body, said mandrel being connected to the node of the three phase current source.

13. The apparatus according to claim 12, wherein the conductive mandrel extends through the body to its orifice.

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