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DUPLICATE

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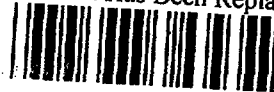
Plasticizing Apparatus and Plasticizing

Method Employing Same

This invention relates to a plasticizing apparatus in which the degree of vacuum in a cylinder may be increased to increase the throughput of molded articles and to improve the quality thereof and a plasticizing method employing such apparatus.

With the currently employed uniaxial or multiaxial plasticizing apparatus for molding of a plastic material, a vent hole is formed in the cylinder for degassing the inside of the cylinder via such vent hole to remove air, volatile matter or water contained in a space between the plastic material and the inner wall surface of the cylinder or within the plastic material to improve the quality of molded articles.

For effective degassing, it is necessary to seal the cylinder ahead of the vent hole to prevent air from being intruded from the outside into the inside of the cylinder during degassing. If such sealing is not made properly, it may occur that



air be intruded from the outside of the cylinder at a supply side of the plastic material, or the material in the cylinder be sucked via the vent hole, with the result that degassing of the material can not be carried out effectively.

In order to effect such sealing of the vent hole, it has been practiced with a known plasticizing apparatus shown in Fig. 12 to provide a compression section formed by shallow screw flutes ahead of a vent hole 102 of a screw 101 to cause the material to be charged at the compression section into a cylinder 103 as the material is transported to assure sealing of a vent region ahead of the vent hole 102.

There is also known an extruder disclosed in the gazette of JP Patent KOKOKU Publication No. 27912/1970, according to which a separate movable valving unit fitted with a thrust valve which may be opened or closed under the thrusting force is provided in a feeder for stopping up an exit opening of a hopper by the thrust valve to effect the sealing of the cylinder with respect to the supply side of the feed material.

On the other hand, with the conventional plasticizing method, a constant quantity of the feed material is supplied from the hopper into the cylinder without regard to the rotational speed of the screw in the plasticizing apparatus.

The above-described conventional plasticizing apparatus suffers from the following drawbacks.

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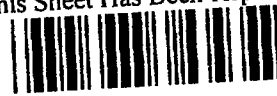


That is, if the compression section is provided in the screw as sealing means for the feed material supply side, the total length of the screw is increased by an amount equal to the length of the compression section to increase the size and costs of the apparatus.

If the separate movable valving unit is provided in the feeder, the feeder is complicated in structure and becomes costly.

With the conventional plasticizing method, in which a constant amount of the feed material is supplied into the cylinder without regard to the rotational speed of the screw, supply of the feed material can not cope with the throughput of the molded articles if, with the plasticizing apparatus employing a multiaxial screw, the rotational speed of the screw is changed, with the result that surplus or deficit of the feed material is incurred. Above all, if the rotational speed of the screw is increased, the material in the cylinder falls into shortage to lower the quality of the molded articles.

In view of the above-described status of the prior art, it would be desirable to be able to provide an apparatus for plasticization whereby the sealing in the cylinder may be achieved effectively with reduction in the size and costs of the apparatus, and a method for plasticization whereby the material to be plasticized may



be supplied in a suitable quantity conforming to the number of revolutions of the screw to increase the throughput and improve the quality of the molded articles.

Accordingly, the present invention provides a plasticizing apparatus comprising a plasticizing cylinder and a feed screw mounted within the plasticizing cylinder, characterized in that a rotary valve for supplying a powdery or particulate material to be plasticized into the cylinder is mounted in a hermetically sealed relation with respect to and in continuation to the cylinder. An air suction pump may be provided between the rotary valve and the cylinder or an air vent hole may also be provided in the vicinity of a material supplying section of the cylinder.

The present invention also provides a plasticizing method comprising plasticizing a material as it is supplied by a rotary valve into the inside of a plasticizing cylinder having a feed screw mounted therein. The material may be supplied into the cylinder as the rotary valve is rotated continuously or intermittently. Alternatively, the rotational speed of the rotary valve is synchronized with that of the screw for supplying a moderate amount of the material correlated with the rotational speed of the rotary valve into the cylinder for plasticization.

In the present specification, the term air is to be understood as meaning a

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in general including air.

Since a rotary valve having high sealing properties is employed in the plasticizing apparatus of the present invention as material supplying means, the space within the cylinder may be sealed reliably without the necessity of employing special screws or sealing means, while the degree of vacuum within the cylinder may be improved by providing various degassing means.

Besides, with the plasticizing method of the present invention, employing the above-mentioned plasticizing apparatus, a moderate amount of the material may be supplied at all times into the plasticizing cylinder, while the air included in the space between the material and the inner walling of the cylinder or within the material itself may be eliminated to raise the bulk density of the material.

With the above-described plasticizing apparatus of the present invention, the degree of vacuum within the cylinder may be improved while the apparatus may be reduced in size.

In addition, it becomes possible with the plasticizing method of the present invention to supply a moderate amount of the material into the plasticizing cylinder to increase the throughput and improve the quality of the molded articles.



By way of example only, embodiments of the invention will be described in greater detail with reference to the accompanying drawings of which:

Fig. 1. is a longitudinal cross-section showing a plasticizing apparatus employing a uniaxial screw according to a first embodiment of the present invention.

Fig. 2 is a longitudinal cross-section showing a plasticizing apparatus employing a uniaxial screw according to a second embodiment of the present invention.

Fig. 3 is a longitudinal cross-section showing a plasticizing apparatus employing a multiaxial screw according to a third embodiment of the present invention.

Fig. 4 is a partial cross-sectional view showing a plasticizing apparatus according to a fourth embodiment of the present invention.

Fig. 5 is a partial cross-sectional view showing a plasticizing apparatus according to a fifth embodiment of the present invention.

Fig. 6 is a partial cross-sectional view showing a plasticizing apparatus according to a sixth embodiment of the present invention.

Fig. 7 is a partial cross-sectional view showing a plasticizing apparatus according to a seventh embodiment of the present invention.

Fig. 8 is a partial cross-sectional view showing a plasticizing apparatus according to an eighth embodiment of the present invention.

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Fig. 9 is a partial cross-sectional view showing a plasticizing apparatus according to a ninth embodiment of the present invention.

Fig. 10 is a partial cross-sectional view showing a plasticizing apparatus according to a tenth embodiment of the present invention.

Fig. 11 is a partial cross-sectional view showing a plasticizing apparatus according to an eleventh embodiment of the present invention.

Fig. 12 is a longitudinal cross-sectional view showing a conventional plasticizing apparatus.

Referring to the drawings, certain preferred embodiments of the plasticizing method and apparatus according to the present invention will be explained in detail. It should be noted that these embodiments are given only for the sake of illustration and are not intended for limiting the invention.

A uniaxial screw type plasticizing apparatus according to a first embodiment of the present invention is first explained.

Fig. 1 shows, in a longitudinal cross-section, a plasticizing apparatus of the present first embodiment.

A rotary valve 2 is connected to an exit side of a hopper 1.

The exit side of rotary valve 2 is connected to a plasticizing cylinder 4 in



a hermetically sealed manner via a connecting tube 3. The rotary valve 2 is run in rotation by a driving motor 2a for supplying the material contained in the hopper 1 into the inside of cylinder 4.

A feed screw 5 driven by a driving unit 7 is mounted within a hollow interior of the plasticizing cylinder 4.

In the vicinity of a material supply section connecting to the connecting tube 3 and, in the present embodiment, in a portion of the plasticizing cylinder 4 in the vicinity of a root part 5a of the screw 5, there is formed one or more air vent holes 4a for sucking air contained in cylinder 4. At least a part of the air vent hole(s) 4a may be of a porous structure.

A rotary seal 6 is provided in the vicinity of the root part 5a of the screw 5 for preventing air from flowing from the driving unit 7.

The driving unit 7 is provided with a sensor 9 for detecting the number of revolutions of the screw 5 and a controller 10 responsive to a signal from the sensor 9 to control the number of revolutions of the motor 2a for the rotary valve 2. Details of the sensor 4 and the controller 10 will be explained later in connection with a concrete example of the plasticizing method embodying the present invention.

A heater 8 is provided around the peripheral surface of the cylinder 4 for heating the cylinder 4 for melting the material as it is transported through the

Index 4.
Fig. 2
plastic

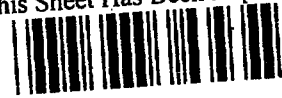


Fig. 2 shows, in a longitudinal cross-section, a uniaxial screw type plasticizing apparatus according to a second embodiment of the present invention.

With the present plasticizing apparatus, a suction tube of a suction pump 11 is connected to a part of a connecting pipe 3 interconnecting the rotary valve 2 and the cylinder 4. It is by this suction pump 11 that air is sucked from a space between the inner wall surface of the connecting tube 3 and the material contained in the connecting tube 3 and from within the material. In the present embodiment, the air vent hole 4a formed in the vicinity of the material supply section of the cylinder 4 may be eliminated. That is, with the present embodiment, it is possible to remove air from a space between the material and the inner wall surface of the connecting tube 3 and from within the material itself at a stage prior to supply of the material into the cylinder 4.

Fig. 3 shows, in a longitudinal cross-section, a biaxial screw type plasticizing apparatus according to the third embodiment of the present invention.

With the present plasticizing apparatus, screws 5, 5, of which only one is illustrated, are mounted in a meshing state within cylinder 4.

A vent port 4b for sucking air included in the cylinder 4 or volatile matter or water etc. generated from the material to outside is formed at an upper region of



the cylinder 4. In the present embodiment, the vent hole 4a may be dispensed with.

With the above-described first to third embodiments, since the inside and the outside of the cylinder 4 are perpetually sealed from each other by the rotary valve 2, it becomes possible to prevent air from being intruded during degassing into the cylinder from the material supply side.

Thus it becomes possible to discharge air by suction by suction pump 11 and to discharge air, volatile matter and moisture etc. by the vent hole 4a and/or the vent port 4b to improve degassing of the material contained in the cylinder 4.

Besides, by employing the rotatory valve, the material may be supplied in desired amounts in a desired supply mode such as a continuous or intermittent supply mode. An amount of the material correlated with the screw rotation may be supplied by synchronizing the screw rotation with the rotary valve rotation.

With the above-described embodiments, the space within the cylinder 4 may be sealed effectively without the necessity of providing the compression section in the screw or providing a movable valving device of a complicated structure in the feeder as in the conventional plasticizing apparatus.

Thus it becomes possible to reduce the total length of the screw to reduce the size and costs of the entire apparatus, as well as to simplify the feeder structure.

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With the above-described first to third embodiments, the material is supplied into the cylinder by the sole rotary valve. For improving the sealing of the material supply side, it is also possible to provide a plurality of stacked rotary valves or to provide a shut-off valve at an upper part of the rotary valve for supplying the material into the cylinder.

Preferred embodiments of this type are hereinafter explained.

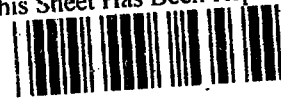
Fig. 4 shows, by a partial cross-sectional view, a plasticizing apparatus according to the fourth embodiment of the present invention.

With the present plasticizing apparatus, two rotary valves 21, 22 are stacked and connected to each other in a hermetically sealed manner between hopper 1 and connecting tube 3.

In the present embodiment, having the rotary valves 21, 22 stacked one above the other, the sealing between the inside and the outside of the cylinder 4 may be improved further to assure a more effective degassing of the material and the space between the cylinder and the material.

Meanwhile, the present embodiment may be applied to both the uniaxial screw apparatus and to the multi axial screw apparatus, subject to corresponding modifications.

Fig. 5 shows, by a partial cross-sectional view, a plasticizing apparatus



according to the fifth embodiment of the present invention.

With the present plasticizing apparatus, two rotary valves 21, 22 are connected to each other in a hermetically sealed manner by a connecting tube 30, and a suction tube of a suction pump 31 similar to that of the second embodiment is connected to the connecting tube 30 for discharging air to outside under suction via connecting tube 30.

With the present fourth embodiment, it becomes possible to discharge air from the space between the material and the inner wall surface of the connecting tube 30 and from within the material before the material is supplied to the inside of the cylinder 4.

Fig. 6 shows, by a partial cross-sectional view, a plasticizing apparatus according to the sixth embodiment of the present invention.

With the present plasticizing apparatus, two rotary valves 21, 22 are connected to each other in a hermetically sealed manner with a material storage section 40 in-between, and a suction tube of a suction pump 41 similar to that of the second embodiment is connected to the storage section 40 for discharging air to outside.

With the present embodiment, the material supplied from hopper 1 is stored once in the storage section 40 and degassed for a predetermined period by suction

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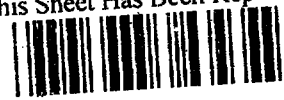
In the present embodiment, an air vent section 4a is formed in the following manner. That is, the walling of the cylinder in the vicinity of the material supply section is of a double cylinder structure comprised of a heating cylinder 4c as an outer cylinder and an air-permeable cylinder 4d as an inner cylinder, and the air is discharged from within the cylinder 4 to outside by suction by a suction pump 42.

With such construction, it becomes possible to discharge air effectively from the space between the inner wall surface of the cylinder and from within the material itself as well as to raise the bulk density of the material further.

Meanwhile, the apparatus shown in Fig. 6, having the suction tube of the suction pump 41 connected to the storage section 40, may be satisfactorily employed as the plasticizing apparatus, even if the air vent section 4a of the double cylindrical construction is omitted.

Fig. 7 shows, by a partial cross-sectional view, a plasticizing apparatus according to the seventh embodiment of the present invention.

The plasticizing apparatus of the present seventh embodiment includes a material supply channel 60 having its inlet connected to a hopper 50 in a



hermetically sealed manner, while having its outlet side connected to the cylinder 4 in a hermetically sealed manner. Three rotary valves 23, 24 and 25, run in rotation by a single driving motor 20a, are arranged in tandem on the same rotary axis, while a screw feeder 70, driven by a driving motor 70a, is mounted as a material extrusion means into the cylinder 4, in the vicinity of the material supply channel 60.

With the present embodiment, having the three rotary valves 23 to 25 arranged in tandem and by having the screw feeder 70 mounted as the material extruding means, it becomes possible to raise the degree of vacuum within the cylinder 4 and to assure effective degassing from the space between the inner wall surface of the cylinder and the material and from within the material itself as well as to increase the material supply quantity.

Meanwhile, if the heat emitted by heater 8 provided at the discharge side of the cylinder 8 as shown in Figs. 1 to 3 is transmitted via cylinder 4 to rotary valves 23 to 25, it may occur that the material in the supply channel 60 be melted to lower the sealing properties of the rotary valves 23 to 25. Thus, with the present embodiment, a cooling section 80 for circulating a cooling medium 81, such as water, around the peripheral surface of the supply side of the cylinder 4, is provided for preventing the heat evolved by the heater 8 from being transmitted to the rotary



ives 23 to 25 to maintain the sealing properties of the rotary valves 23 to 25.

It is noted that such cooling section 80 may be provided on the cylinder 4 of the plasticizing apparatus according to the first to sixth embodiments described previously.

Fig. 8 shows, by a partial cross-sectional view, a plasticizing apparatus according to the eighth embodiment of the present invention.

With the present plasticizing apparatus, a ball valve 26 as a shut-off valve and a rotary valve 22 are provided in a directly stacked relation and in a hermetically sealed manner relative to each other between the hopper 1 and the connecting tube 3. The ball valve 26 is rotated intermittently by 90° by motor 27 driven under a driving signal from controller 10 for alternately supplying and interrupting the material repeatedly.

The plasticizing apparatus of the present embodiment, in which the ball valve 26 and the rotary valve 27 are stacked one upon the other, is suited above all to the supply of a pulverulent material because the sealing between the outside and the inside of the cylinder 4 may be improved to achieve effective degassing from the space between the inner wall of the cylinder 4 and the material and from within the material.

Meanwhile, the present embodiment may be applied to both the uniaxial screw



type plasticizing apparatus and the multi axial screw type plasticizing apparatus, subject to corresponding modifications.

Fig. 9 shows, by a partial cross-sectional view, a plasticizing apparatus according to the ninth embodiment of the present invention.

With the present plasticizing apparatus, a ball valve 26 as a shut-off valve and a rotary valve 22 are connected to each other in a hermetically sealed relation via a connecting tube 30 to which is connected a suction tube of a suction pump 31 similar to that of the second embodiment described above for discharging air to outside under suction via the connecting tube 30.

With the present embodiment, it becomes possible to discharge the air from the space between the inner wall surface of the connecting tube and the material and from within the material before the material is supplied into the cylinder 4.

Fig. 10 shows, by a partial cross-sectional view, a plasticizing apparatus according to the tenth embodiment of the present invention.

With the present plasticizing apparatus, a ball valve 26 and a rotary valve 22 are connected to each other in a hermetically sealed relation with a material storage section 40 in-between and a suction pipe of a suction pump 41 similar to that of the above-described second embodiment is connected to the storage section 40 to discharge air under suction effects out of the storage section 40.



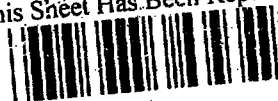
As the shut-off valve 26, a butterfly valve or a slide valve may be employed besides the ball valve.

With the above-described fourth to tenth embodiments, in which material supply means into the cylinder 4 is achieved by an arrangement comprised of a plurality of rotary valves 21 and 22 or 23 to 25, stacked together, or an arrangement comprised of the rotary valve 22 and the shut-off valve 26, it becomes possible to improve the sealing of the cylinder 4 further and to achieve more effective degassing from the space between the material and the inner wall surface of the cylinder and from within the material.

Besides, if the suction pump 31 or suction pumps 41, 42 are additionally employed, it becomes possible to discharge air from the space between the material and the inner wall surface and from within the material more reliably in conjunction with the above-mentioned effects in improving the sealing.

Fig. 11 shows, by a partial cross-sectional view, a plasticizing apparatus according to the eleventh embodiment of the present invention.

With the present plasticizing apparatus, a void space having a length equal to $1/3$ to 3 times the diameter of the screw is formed ahead of the foremost part of the screw 5 for accumulating the molten material therein. By such construction, the molten material is allowed to dwell in the void space so as to be equalized in its



molten state to reduce melting fluctuations. As a result thereof, fluctuations in the pressure in the material as it is extruded from the plasticizing apparatus may be diminished to assure a uniform quality of the extruded molten material.

The plasticizing method which may be realized with the above-described first to eleventh embodiments may be applied to both the uniaxial screw apparatus and to the multi axial screw apparatus.

The plasticizing method which may be realized with the above-described first to eleventh embodiments is hereinafter explained.

With the plasticizing method of the present invention, the rotary valve(s) may be rotated continuously or intermittently for supplying desired amounts of the material into the cylinder for plasticization, or the rotary valve(s) may be rotated in synchronism with the rotational velocity of the screw for supplying the material in amounts correlated with the rotational speed of the screw for plasticization.

Referring to Figs. 1 and 2, the latter case in which the rotational speed of the rotary valve 2 is synchronized with the rotational speed of the screw 5 to feed and plasticize the material is explained.

The screw 5 and the rotary valve 2 are synchronized in operation by the sensor 9 and the controller 10 provided in the driving unit 7. That is, the sensor 9 senses the number of revolutions of the screw 5 to output a corresponding signal to



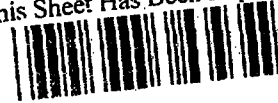
roller 10 which then runs the driving motor 2a in rotation based on a signal from sensor 9 to run the rotary valve 2 in rotation with the number of revolutions conforming to the number of revolutions of the screw 5.

This synchronizes the rotational speed of the screw 5 with that of the rotary valve 2, so that, if the number of revolutions of the screw 5 is changed, the number of revolutions of the rotary valve 2 is correspondingly changed to enable a moderate amount of the material correlated with the rotational speed of the rotary valve 2 to be perpetually supplied into the cylinder 4.

Besides, since the inside of the cylinder 4 is sealed by rotary valve 2, the air from a space between the material and the inner wall surface of the cylinder and from within the material itself may be effectively discharged under suction via the air vent hole 4a in the cylinder 4, while air is also allowed to flow through the cylinder 4, if the plasticizing method is carried out using the plasticizing apparatus of the first embodiment described above, such air flow causing the material to be sucked effectively into the cylinder 4. This raises the bulk density of the material in the cylinder 4 while assuring positive and smooth supply of the material and eliminating fluctuations in the quantity of the discharged material.

If the present plasticizing method is to be carried out using the plasticizing apparatus according to the second embodiment, the bulk density of the material may

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apparatus may



be raised by discharging air from a space between the material and the inner wall surface of the connecting tube and from within the material itself at a stage prior to supply of the material into the cylinder.

If the present plasticizing method is to be carried out using the plasticizing apparatus according to the third embodiment, any foreign matter, such as air, volatile matter or water etc. may be effectively discharged via the vent port 4b formed at the upper part of the cylinder 4 for effectively degassing the foreign matter from inside the cylinder 4 for raising the bulk density of the material.

Besides, if the present plasticizing method is to be carried out using the plasticizing apparatus according to the fourth to tenth embodiments, the bulk density of the material transported in the cylinder 4 may be increased by virtue of the high sealing realized at the supply side of the apparatus.

With the above-described plasticizing method of the present invention, a moderate amount of the material correlated with the rotary speed of the screw may be supplied into the cylinder and the material transported in the cylinder may be maintained in the high bulk density state on account of the high sealing properties of the rotary valve. Besides, any foreign matter contained in the material or in the space between the material and the inner walling of the apparatus may be eliminated to enable increased throughput and improved quality of molded articles.

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The plasticizing method and apparatus according to the present invention are highly effective especially in the case of a biaxial screw type molding system in which the screws have deep flutes and the material is allowed to be present only at lower portions of the cylinder.

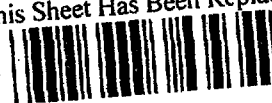
It should be noted that the plasticizing method and apparatus according to the present invention are not limited to the above-described embodiments.

For example, the plasticizing apparatus according to the present invention is not limited to the uniaxial or biaxial type system, but may be adapted for any multi-axial screw system having more than two screws. In these cases, the vent port 4b may be provided at the upper portion of the cylinder 4 as in the plasticizing apparatus of the second embodiment for effectively degassing impurities contained in the cylinder 4. Such vent port may naturally be provided within a uniaxial screw type plasticizing apparatus.

In addition, the present plasticizing method and apparatus may be extensively applied for plasticizing a variety of materials, such as powdery or particulate material.



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CLAIMS

1. A plasticizing apparatus comprising a plasticizing cylinder and a feed screw mounted within said plasticizing cylinder, characterized in that a rotary valve for supplying a material to be plasticized into said cylinder is mounted in a hermetically sealed relation with respect to said cylinder in continuation to said cylinder.
2. The plasticizing apparatus as claimed in claim 1 comprising a suction pump between said rotary valve and the cylinder for discharging air to outside by suction.
3. The plasticizing apparatus as claimed in claim 1 comprising an air vent section in the vicinity of a material supply section of said cylinder.
4. The plasticizing apparatus as claimed in any of claims 1 to 3 comprising a multi-axial screws within said cylinder and a vent hole at an upper part of said cylinder.
5. The plasticizing apparatus as claimed in any of claims 1 to 4 comprising a plurality of rotary valves in a stacked relation to one another.
6. The plasticizing apparatus as claimed in claim 5 comprising a plurality of rotary valves connected to one another via a connecting tube and a suction pump for discharging air from the connecting tube to outside under suction, said suction pump being mounted on the connecting tube.

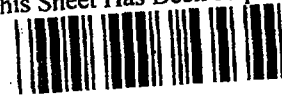
The plasticizing
rotary valve



- feed screw
7. The plasticizing apparatus as claimed in claim 5 comprising a plurality of rotary valves connected to one another via a material storage section and a suction pump for discharging air from the material storage section to outside under suction, said suction pump being mounted on the material storage section.
 8. The plasticizing apparatus as claimed in claim 5 comprising a plurality of rotary valves in tandem on the same rotary axis, said rotary valves being run in rotation by a single driving motor for supplying the material into the cylinder.
 9. The plasticizing apparatus as claimed in any of claims 1 to 4 comprising a shut-off valve connected at an upper part of the rotary valve.
 10. The plasticizing apparatus as claimed in claim 9 comprising a shut-off valve connected at an upper part of the rotary valve via a connecting tube in a hermetically sealed relation, and a suction pump mounted on said connecting tube for discharging air to outside under suction from the connecting tube.
 11. The plasticizing apparatus as claimed in claim 9 comprising a shut-off valve connected at an upper part of the rotary valve via a material storage section in a hermetically sealed relation and a suction pump mounted on said material storage section for discharging air to outside under suction from the material storage section.
 12. The plasticizing apparatus as claimed in claim 1 comprising a void space ahead



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of the foremost part of the screw, said void space having a length equal to $1/3$ to 3 times the diameter of the screw.

13. A method of plasticizing a material utilising apparatus as claimed in any one of claims 1 to 12, said material being supplied by the rotary valve into the inside of the plasticizing cylinder having a feed screw mounted therein, the method comprising supplying said material into the inside of said cylinder for plasticization as said rotary valve is rotated continuously or intermittently.

14. A method of plasticizing a material as claimed in any one claims 1 to 12, said material being supplied by the rotary valve into the inside of the plasticizing cylinder having a feed screw mounted therein, the method comprising synchronizing the rotational speed of said rotary valve with the rotational speed of said screw for supplying the material in an amount correlated with the rotational speed of said screw.

15. A plasticizing apparatus substantially as described with reference to and as illustrated by Figs. 1 to 11 of the accompanying drawings.

16. A method of plasticizing a material substantially as described with reference to Figs. 1 to 11 of the accompanying drawings.

ACT
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A rotary val.
apparatus