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Extruder

Abstract

An extruder configured to extrude a solid raw material containing moisture includes a barrel, a hopper coupled to one side of the barrel, a discharge port, a screw, vent disposed between the hopper and the discharge port to discharge vapor generated within the barrel; and a heater mounted on the barrel to heat the raw material. Raw material introduced into the barrel through the hopper is heated by the heater while being transferred within the barrel through the screw. A kneading zone, in which raw materials transferred by the screw threads are compressed, is formed on the screw. Since the raw material is melted within the barrel, a heating temperature of the heater and an axial rotation speed of the screw are controlled so that a sealing membrane that shields an inner transverse section of the barrel is formed from the liquid raw material in the kneading zone.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) The present application is a National Phase of International Application No. PCT/KR2020/010746 filed on Aug. 13, 2020, which claims the benefit of the priority of Korean Patent Application No. 10-2019-0152012, filed on Nov. 25, 2019, which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

(2) The present invention relates to an extruder that extrudes a solid raw material containing moisture and, more specifically, to an extruder having a zone in which a sealing membrane is formed from the raw material within a barrel to prevent backflow of moisture discharged from the raw material.

BACKGROUND ART

(3) In a process of manufacturing thermoplastic resin produced by emulsion polymerization, the manufactured thermoplastic resin is generally obtained in a latex state with a dispersion medium. Thus, raw materials contain a large amount of moisture.

(4) Accordingly, the process of manufacturing a thermoplastic resin comprises a dehydration and drying process for removing the moisture.

(5) As the known drying process, a method has been generally performed in which the moisture is evaporated by applying thermal energy to the dehydrated raw material while the raw material is moving or when stopped.

(6) Subsequently, an extruder illustrated in FIG. 1 is used, as needed, to heat and press the dried raw material, and thus, the dried raw material is obtained in a form of pellets.

(7) Referring to FIG. 1 that illustrates the internal configuration of an extruder according to the related art, the extruder is configured such that a hopper 2, through which a raw material is put, is installed on one side of a tubular barrel 1, and the raw material is discharged to a discharge port (a left outlet in the drawing) through an internal screw 5.

(8) The raw material injected through the hopper 2 is heated by a heater (not shown) mounted to the inside or outside of the barrel and pressed by the screw 5. Accordingly, water vapor generated from moisture remaining in the dried raw material is separated while the dried raw material is moved by the screw 5. The separated water vapor is discharged to the outside through a vent part 6 disposed away from the hopper 2.

(9) However, in this structure according to the related art, while the raw material passes through the screw 5, the water vapor generated inside the barrel 1 does not reach the vent part 6 but flows back to the hopper 2. The backflow of the water vapor has a negative effect on smooth input of the raw material, and extrusion performance is deteriorated.

(10) To this end, according to the related art, a check plate 4 for minimizing an effect of the backflow of water vapor and an introduction screw 3 for forcibly injecting the raw material into the barrel are additionally equipped in the hopper 2.

DISCLOSURE OF THE INVENTION

Technical Problem

(11) Thus, the object of the present invention is to provide an extruder capable of directly extruding a raw material that is dehydrated without a drying process and preventing water vapor, which is separated from the raw material, from flowing back to a hopper, thereby improving extrusion efficiency.

Technical Solution

(12) To achieve the above-described object, the present invention provides an extruder configured to extrude a solid raw material containing moisture, the extruder comprising: a barrel having a hollow tubular shape in a longitudinal direction, wherein a hopper into which a raw material is put is coupled to one side of the barrel, and a discharge port through which a dehydrated raw material is discharged is provided on the other side of the barrel; a rod-shaped screw provided with screw threads on an outer circumferential surface thereof so that the screw is mounted within the barrel to transfer a raw material put into the hopper to the discharge port while axially rotating in one direction; a vent part disposed at one point between the hopper and the discharge port to discharge vapor generated within the barrel to the outside; and a heater part mounted on the barrel to heat the raw material, wherein the raw material introduced into the barrel through the hopper is gradually heated by the heater part while being transferred within the barrel through the screw, a kneading zone, in which raw materials transferred by the screw threads are compressed, is formed on the screw, and since the raw material is melted within the barrel so that at least a portion of the raw material is phase-changed into a liquid state, a heating temperature of the heater part and an axial rotation speed of the screw are controlled so that a sealing membrane that shields an inner transverse section of the barrel is formed from the phase-changed raw material (in a liquid state or in a state in which solid and liquid are mixed) in the kneading zone.

(13) The kneading zone is disposed between the vent part and the hopper.

(14) A distance between the kneading zone and the vent part is less than three times a diameter of the barrel. Also, a distance between the kneading zone and the hopper is greater than five times a diameter of the barrel.

(15) The screw comprises: a first forward zone in which the screw threads are provided to transfer the raw material, which is put from the hopper, toward the discharge port when rotating axially; the kneading zone in which the screw threads are provided to compress the raw material, which is transferred from the first forward zone, when rotating axially; and a second forward zone in which the screw threads are provided to transfer the raw material, which passes through the kneading zone, toward the discharge port when rotating axially.

(16) The kneading zone may comprise a neutral zone in which the screw threads are provided on the outer circumferential surface of the rod shape to induce the raw material to rotate at the same place. Also, the kneading zone may comprise a reverse zone in which the screw threads are provided on the outer circumferential surface of the rod shape to transfer the raw material in a direction opposite to the direction in which the raw material is transferred by the screw threads provided in the first forward zone. Also, the kneading zone may be constituted by connecting the neutral zone, in which the screw threads are provided on the outer circumferential surface of the rod shape to induce the raw material to rotate at the same place, to the reverse zone, in which the screw threads are provided on the outer circumferential surface of the rod shape to transfer the raw material in the direction opposite to the direction in which the raw material is transferred by the screw threads provided in the first forward zone, wherein the neutral zone is connected to the first forward zone, and the reverse zone is connected to the second forward zone.

(17) In addition, the screw may further comprise a sub-kneading zone in which the screw threads are provided to recompress the raw material, which is transferred from the second forward zone, when rotating axially.

(18) A distance between the sub-kneading zone and the vent part is greater than three times a

diameter of the barrel.

(19) Also, the screw further may comprise a third forward zone in which the screw threads are provided to transfer the raw material, which passes through the sub-kneading zone, toward the discharge port when rotating axially, and a sub-vent part configured to discharge impurities contained in the raw material to the outside may be provided in the barrel within a range in which the third forward zone is formed.

(20) A distance between the sub-kneading zone and the sub-vent part is less than three times a diameter of the barrel.

(21) Also, the extruder may further comprise a pulverizer configured to pulverize the dried raw material that is discharged from the discharge port of the barrel.

Advantageous Effects

(22) In the extruder having the structure described above according to the present invention, the sealing membrane is formed in the kneading zone while the raw material is being extruded inside the barrel, and thus, the backflow of the water vapor to the hopper may be prevented or minimized.

(23) The kneading zone may comprise one of the neutral zone or the reverse zone or the combination thereof and thus may be selectively utilized depending on the state or properties of the raw material.

(24) In addition, the screw according to the present invention may further comprise the sub-kneading zone, and thus, it is possible to form the additional sealing membranes, thereby more efficiently preventing the backflow of the water vapor.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a see-through view illustrating the internal configuration of an extruder according to the related art.

(2) FIG. 2 is a see-through view illustrating the internal configuration of an extruder according to the present invention.

(3) FIG. 3 is an enlarged view of a section in which a kneading zone of FIG. 2 is provided.

(4) FIG. 4A through 4C are views illustrating embodiments of screw threads applicable to the kneading zone of the present invention.

(5) FIG. 5 is a view showing transverse sections before and after a sealing membrane is formed in the kneading zone.

(6) FIG. 6 is a view showing a distance relative to a diameter D of a barrel in the extruder of the present invention.

MODE FOR CARRYING OUT THE INVENTION

(7) Hereinafter, the present invention will be described in detail with reference to the accompanying drawings so that the present invention can be easily carried out by a person skill in the art to which the present invention pertains. However, the present invention may be embodied in several different forms, and not be limited to the embodiments set forth herein.

(8) A part unrelated to the description will be omitted so as to clearly describe the present invention, and the same reference symbols are affixed to identical or similar elements throughout the specification.

(9) Also, terms or words used in this specification and claims should not be restrictively interpreted as ordinary meanings or dictionary-based meanings, but should be interpreted as meanings and concepts conforming to the scope of the present invention on the basis of the principle that an inventor can properly define the concept of a term to describe and explain his or her invention in the best ways.

(10) The present invention relates to an extruder for extruding a solid raw material containing

moisture, and hereinafter, the extruder according to the present invention will be described in more detail with reference to the accompanying drawings.

(11) Referring to FIG. 2 illustrating the internal configuration of an extruder according to the present invention, the extruder according to the present invention comprises a barrel **10**, a screw **30** mounted inside the barrel **10**, a vent part **40** through which water vapor inside the barrel **10** is discharged to the outside, and a heater part **60** for heating the barrel **10**. Also, a sealing membrane is formed from a melted resin within the barrel **10**.

(12) The barrel **10** has a hollow tubular shape in the longitudinal direction. A hopper **20**, through which a raw material is put, is coupled to one side of the barrel **10**, and a discharge port **11** for discharging a dehydrated raw material is provided on the other side thereof.

(13) It is desirable that the barrel **10** is made of metal having excellent chemical resistance to prevent corrosion due to volatile substances and water vapor discharged from the raw material, or is manufactured such that the inner surface thereof is coated with a protective material. The barrel **10** is manufactured to have rigidity enough to withstand heat and pressure generated from the inside.

(14) The screw **30** has a bar shape and a structure in which screw threads M (**31**, **32**, **33**) are provided on the outer circumferential surface thereof. Also, the screw **30** transfers the raw material, which is put from the hopper **20**, toward a discharge port **11** while being mounted inside the barrel **10** and axially rotating in one direction.

(15) Here, the screw threads M having a spiral shape are provided on the outer circumferential surface of the screw **30** in the longitudinal direction. A region, in which the screw threads M are formed in a direction to move the raw material toward the discharge port, is divided into forward zones (sections **F1**, **F2**, and **F3**). Also, a region, in which the screw threads are formed to only rotate the raw material without moving the raw material or to move the raw material in a reverse direction (that is, to move the raw material from the discharge port of the barrel toward the hopper), is defined as a kneading zone **30A**.

(16) Referring to FIG. 3 illustrating an enlarged view of a section **K1** in which the kneading zone **30A** of FIG. 2 is provided and FIG. 4A through 4C illustrating shapes of the screw threads applicable to the kneading zone **30A**, the screw threads provided in the kneading zone **30A** are configured to compress the raw material rather than transfer the raw material. (The upper figure of FIG. 3 is a state in which a case is coupled to the exterior of the screw threads and the lower figure is a state in which the case is removed. Thus, hereinafter, the description will be made with reference to the lower figure.) The kneading zone **30A** comprises a neutral zone in which neutral screw threads **32** are provided on the outer circumferential surface of the rod shape to induce the raw material to rotate at the same place and/or a reverse zone in which reverse screw threads **33** are provided on the outer circumferential surface of the rod shape to transfer the raw material in the opposite direction. That is, the present invention provides embodiment 1, 2, and 3 having, respectively, a configuration in which only the neutral zone is provided in the kneading zone, a configuration in which only the reverse zone is provided in the kneading zone, and a configuration in which the neutral zone and the reverse zone are combined.

(17) As illustrated in FIG. 4C, the neutral screw threads **32** provided in the neutral zone may not have a form in which screw threads are connected to each other in a spiral shape, but have an individually separated form (that is, a form in which annular screw threads are connected to each other at intervals). When the raw material reaches the neutral screw threads **32** having the above-described form, force applied to the raw material creates the rotation at the same place rather than transfer.

(18) Also, as illustrated in FIG. 3 and FIG. 4B, the reverse screw threads **33** defined in the reverse zone are provided in a direction opposite to that of the screw threads provided in the forward zone. The reverse screw threads **33** having the above-described form generates force for transferring the raw material in the opposite direction when the raw material reaches.

(19) Alternatively, as illustrated in FIG. 4A, there may be the configuration in which the neutral zone and the reverse zone are combined.

(20) When the raw material reaches the kneading zone **30A** in which the neutral zone and/or the reverse zone are provided, the raw material is pressed as agglomerating together with raw material continuously supplied from the forward zone on a rear side.

(21) Here, in the present invention, the screw **30** may have sections **F1**, **F2**, and **F3** in which a plurality of forward zones are provided and sections **K1** and **K2** in which a plurality of kneading zones are provided. That is, as illustrated in FIG. 2, there is provided a structure in which a first forward zone (section **F1**), a kneading zone (section **K1**), a second forward zone (section **F2**), a sub-kneading zone (section **K2**), and a third forward zone (section **F3**) are arranged in the order from the hopper **20**.

(22) Forward screw threads **31** are provided in the first forward zone to transfer the raw material, which is put from the hopper **20**, toward the discharge port **11** when rotating axially, and the neutral screw threads **32** or the reverse screw threads **33** are provided in the kneading zone **30A** to compress the raw material, which is transferred from the first forward zone, when the screw **30** rotates axially. Also, the neutral screw threads **32** or the reverse screw threads **33** are provided in the sub-kneading zone **30B** similar to the kneading zone **30A**, and the forward screw threads are provided in the second forward zone and the third forward zone similar to the first forward zone.

(23) In addition, the vent part **40** is mounted to the barrel **10** so that steam (and separated gas, etc.) is discharged after the raw material passes through the kneading zone **30A** from the hopper **20**. The vent part **40** may have a simple tubular shape that is open upward from the barrel **10**, but an openable and closable valve, an exhaust device that forcibly discharges water vapor, and a safety vent that opens only at a certain pressure or higher may be coupled thereto.

(24) Also, the heater part **60** for generating heat is coupled to the outer surface of the barrel **10** (or inside thereof). The heater part **60** may be a device that converts electrical energy into thermal energy or a device that receives a heat source from the outside to heat the barrel.

(25) A plurality of heater parts **60** are mounted over the entirety of the barrel, and temperatures of the heater parts **60** may be individually controlled. Accordingly, the barrel **10** is configured such that a temperature control is possible for each of the sections (the forward zones and the kneading zones).

(26) In the extruder having the above-described structure according to the present invention, when the raw material stored in the hopper **20** is supplied into the barrel **10**, the raw material is transferred through the screw **30** inside the barrel **10** and heated (and cooled) to a target temperature by the heater part **60**.

(27) Here, when the raw material passes through the first forward zone and reaches the kneading zone **30A**, the raw material is pressed in a heated state by raw materials continuously supplied from a rear side and by the rotation force of the screw **30**.

(28) Accordingly, the heated and pressed raw material is melt in the kneading zone **30A** (or before reaching the kneading zone), and at least a portion or almost all of the raw material is phase-changed into a liquid state.

(29) That is, while being phase-changed from a solid state to a highly viscous liquid state, the raw material, which has been heated and pressed in the kneading zone **30A**, is forced to be spread radially due to centrifugal force created in the kneading zone **30A**.

(30) Accordingly, as illustrated in FIG. 5 showing transverse sections before and after a sealing membrane is formed in the kneading zone **30A**, a solid raw material, water vapor separated from the raw material, etc. in a front portion of the kneading zone **30A** (close to the hopper) are spread into the space between the screw **30** and the barrel **10**. Also, as heat and pressure are continuously applied, most of the solid raw material in a rear portion of the kneading zone **30A** (close to the discharge port) is melted into a liquid state. Here, a sealing membrane, which shields the transverse section of the barrel **10**, is formed from the melted raw material by centrifugal force.

(31) Here, the thickness and the formation position of the sealing membrane may vary depending on the rotation speed of the screw **30**, the heating temperature of the heater part **60**, and the configuration of the screw threads provided in the kneading zone **30A**. Also, in the barrel **10**, the sealing membrane is formed in a changeable state rather than in a fixed state.

(32) That is, the sealing membrane is formed as a liquid film, and as a raw material is continuously supplied, the raw material, which has formed the sealing membrane first, passes through the kneading zone **30A** and is then discharged toward the second forward zone. Then, a raw material supplied later is changed into a liquid state and maintains the sealing membrane while supplementing the raw material discharged earlier.

(33) Depending on the state and amount of the raw material that is put to consistently maintain the sealing membrane, the heating temperature of the heater part **60** and the axial rotation speed of the screw are controlled.

(34) The liquid raw material and the gas-state water vapor, which have passed through the kneading zone, are transferred to the second forward zone. Here, the liquid raw material is continuously transferred along the screw **30**, but the gas-state water vapor (and the gas generated during the phase change) is discharged to the outside through the vent part **40**. Here, the backflow of the water vapor to the hopper **20** is prevented by the sealing membrane formed in the kneading zone **30A**.

(35) Also, the raw material, which reaches the sub-kneading zone **30B**, forms a sealing membrane again in the sub-kneading zone **30B** and is then discharged to the discharge port **11** through the third forward zone. While being transferred through the third forward zone, impurities (residual monomers, etc.) contained in the raw material, gas generated during the phase change, surplus water vapor, and the like are discharged to the outside through a sub-vent part **50**.

(36) Here, the raw material discharged to the discharge port **11** of the barrel **10** is cooled after the water vapor, gas, and the like are separated therefrom, and then discharged in a form of a solid mass.

(37) The raw material discharged in the form of a solid mass is cut into pellets having a certain size by a pulverizer **70** that pulverizes a dehydrated (dried) raw material.

(38) Also, in the extruder of the present invention, it is desirable that distances between components are limited to improve the drying and dehydration performance.

(39) That is, as illustrated in FIG. **6** showing each distance relative to a diameter D of the barrel in the extruder of the present invention, it is desirable that, on the basis of the diameter D of the barrel **10**, a distance from the hopper **20** to the kneading zone **30A** is set to $5D$ to $10D$. Also, it is desirable that a distance between the kneading zone **30A** and the vent part **40** is set to $3D$ or less, a distance between the vent part **40** and the sub-kneading zone **30B** is set to $3D$ or more, and a distance between the sub-kneading zone **30B** and the sub-vent part **50** is set to $3D$ or less. However, these relative distances are not limited to the ranges described above and may change depending on the length and axial rotation speed of the screw **30**, a state of the raw material, an output of the heater part **60**, and the like.

(40) In the extruder having the structure described above according to the present invention, the sealing membrane is formed in the kneading zone **30A** while the raw material is being dehydrated inside the barrel **10**, and thus, the backflow of the water vapor to the hopper **20** may be prevented or minimized.

(41) The kneading zone **30A** may comprise one of the neutral zone or the reverse zone, or a combination thereof and thus may be selectively utilized depending on the state or properties of the raw material.

(42) Also, in the present invention, since the screw **30** may further comprise the sub-kneading zone **30B**, an additional sealing membrane may be formed. Thus, the water vapor may be discharged through the vent part **40** as much as possible while more efficiently preventing the backflow of water vapor.

(43) Also, in the extruder of the present invention, since the moisture contained in the raw material

is discharged through the vent part **40** simultaneously with the extrusion, it is possible to discharge impurities (residual monomers, etc.) contained in the raw material through the sub-vent part **50** as much as possible.

(44) Here, the extruder of the present invention may be an apparatus for extruding thermoplastic resin. This thermoplastic resin may be thermoplastic resin that may be palletized through the extruder and, as a specific example, may be a diene-based graft copolymer. As a more specific example, the diene-based graft copolymer may be an acrylonitrile butadiene styrene graft copolymer.

(45) The diene-based graft copolymer is generally manufactured through an emulsion polymerization method, and is obtained in a latex state in which colloidal particulates of the completely polymerized diene-based graft copolymer are dispersed in water that serves as a dispersion medium, that is, in a solid state containing moisture. Subsequently, the diene-based graft copolymer, which has been obtained in the latex state, is obtained in a form of dry powder through aggregation, dehydration, and dry steps. However, the diene-based graft copolymer obtained in the form of dry powder has a problem that the caking phenomenon occurs due to aggregation and coagulation between the dry powder when stored for a long period of time.

(46) However, the extruder of the present invention may effectively remove the moisture from the solid raw material containing moisture, simultaneously with the extrusion. Thus, in a case where the diene-based graft copolymer is extruded by using the extruder of the present invention, it is not necessary to dry the diene-based graft copolymer obtained in the latex state, and it is possible to directly extrude the dehydrated diene-based graft copolymer.

(47) Also, the diene-based graft copolymer extruded by using the extruder of the present invention has bulk density higher than that of the dry powder and thus may prevent the caking phenomenon from occurring when stored for a long period of time.

(48) As described above, the extruder of the present invention may be more effective to obtain the thermoplastic resin, the diene-based graft copolymer as a specific example, and the acrylonitrile butadiene styrene graft copolymer as a further specific example.

(49) Although the present invention is described by specific embodiments and drawings, the present invention is not limited thereto, and various changes and modifications may be made by a person skilled in the art to which the present invention pertains within the technical idea of the present invention and equivalent scope of the appended claims.

DESCRIPTION OF THE SYMBOLS

(50) **10**: barrel **20**: hopper **30**: screw **40**: vent part **50**: sub-vent part **60**: heater part

Claims

1. A single-screw extruder configured to extrude a solid raw material containing moisture, the extruder comprising: a barrel having a hollow tubular shape in a longitudinal direction, wherein a hopper into which a raw material is put is coupled to one side of the barrel, and a discharge port through which a dehydrated raw material is discharged is provided on the other side of the barrel; a rod-shaped screw provided with screw threads on an outer circumferential surface thereof so that the screw is mounted within the barrel to transfer a raw material put into the hopper to the discharge port while axially rotating in one direction; a vent part disposed at one point between the hopper and the discharge port to discharge vapor generated within the barrel to the outside; and a heater part mounted on the barrel to heat the raw material, wherein the raw material introduced into the barrel through the hopper is gradually heated by the heater part while being transferred within the barrel through the screw, a kneading zone, in which raw materials transferred by the screw threads are compressed, is formed on the screw, and since the raw material is melted within the barrel so that at least a portion of the raw material is phase-changed into a liquid state, a heating temperature of the heater part and an axial rotation speed of the screw are controlled so that a

sealing membrane that shields an inner transverse section of the barrel is formed from the phase-changed raw material in the kneading zone, wherein the kneading zone is disposed between the vent part and the hopper, and wherein the screw comprises: a first forward zone in which the screw threads are provided to transfer the raw material, which is put from the hopper, toward the discharge port when rotating axially; the kneading zone in which the screw threads are provided to compress the raw material, which is transferred from the first forward zone, when rotating axially; a second forward zone in which the screw threads are provided to transfer the raw material, which passes through the kneading zone, toward the discharge port when rotating axially; and a sub-kneading zone in which the screw threads are provided to recompress the raw material, which is transferred from the second forward zone, when rotating axially, and wherein a distance between the sub-kneading zone and the vent part is greater than three times a diameter of the barrel.

2. The extruder of claim 1, wherein a distance between the kneading zone and the vent part is less than three times a diameter of the barrel.
3. The extruder of claim 1, wherein a distance between the kneading zone and the hopper is greater than five times a diameter of the barrel.
4. The extruder of claim 1, wherein the kneading zone comprises a neutral zone in which the screw threads are provided on the outer circumferential surface of the rod shape to induce the raw material to rotate at the same place.
5. The extruder of claim 1, wherein the kneading zone comprises a reverse zone in which the screw threads are provided on the outer circumferential surface of the rod shape to transfer the raw material in a direction opposite to the direction in which the raw material is transferred by the screw threads provided in the first forward zone.
6. The extruder of claim 1, wherein the kneading zone is constituted by connecting the neutral zone, in which the screw threads are provided on the outer circumferential surface of the rod shape to induce the raw material to rotate at the same place, to the reverse zone, in which the screw threads are provided on the outer circumferential surface of the rod shape to transfer the raw material in the direction opposite to the direction in which the raw material is transferred by the screw threads provided in the first forward zone, wherein the neutral zone is connected to the first forward zone, and the reverse zone is connected to the second forward zone.
7. The extruder of claim 1, wherein the screw further comprises a third forward zone in which the screw threads are provided to transfer the raw material, which passes through the sub-kneading zone, toward the discharge port when rotating axially, and a sub-vent part configured to discharge impurities contained in the raw material to the outside is provided in the barrel within a range in which the third forward zone is formed.
8. The extruder of claim 7, wherein a distance between the sub-kneading zone and the sub-vent part is less than three times a diameter of the barrel.
9. The extruder of claim 1, further comprising a pulverizer configured to pulverize the raw material discharged from the discharge port of the barrel.
