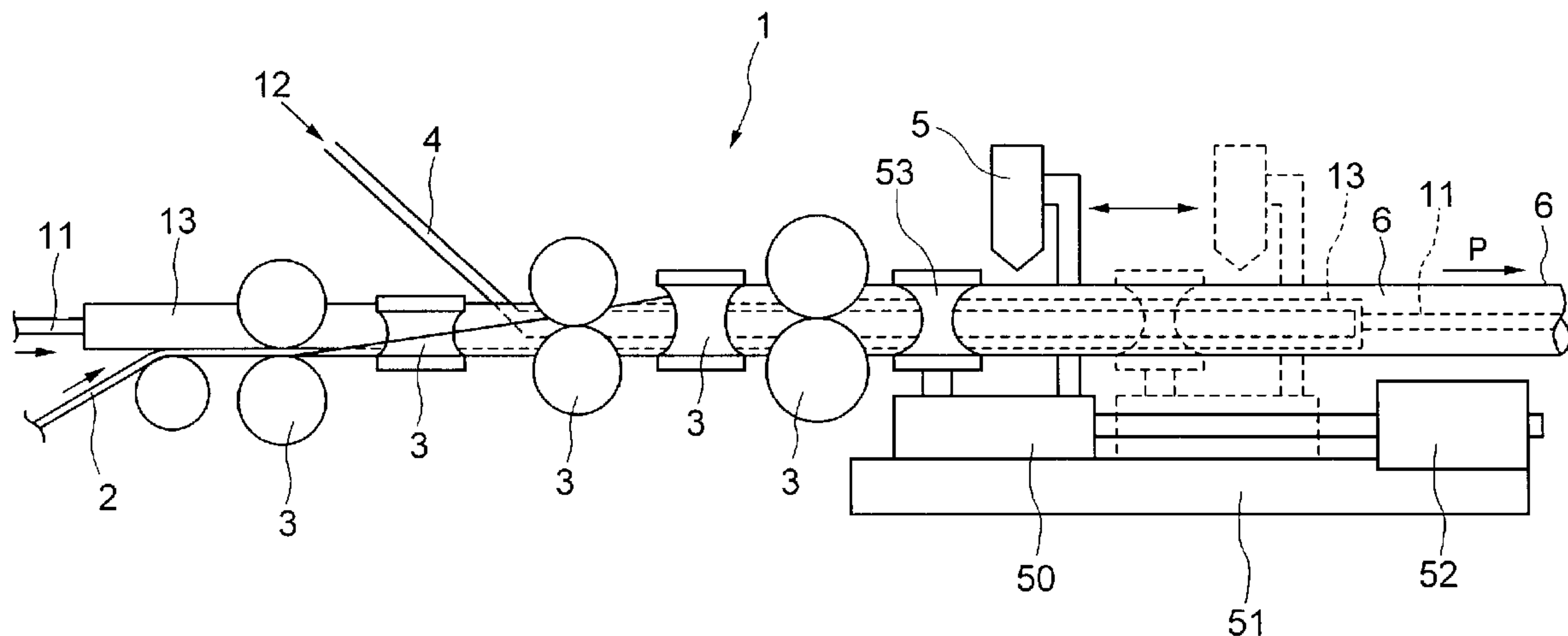




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(71) Demandeur/Applicant:
THE FURUKAWA ELECTRIC CO., LTD., JP
(72) Inventeurs/Inventors:
TAKEDA, JUNICHI, JP;
AIDA, YUKIKATSU, JP;
SEKIGUCHI, AKINOBU, JP
(74) Agent: RIDOUT & MAYBEE LLP

(54) Titre : DISPOSITIF ET PROCEDE DE FABRICATION DE CABLE DE FIBRES OPTIQUES COUVERT DE TUBE METALLIQUE
(54) Title: MANUFACTURING APPARATUS FOR METAL SHEATHED OPTICAL FIBER CABLE AND METHOD THEREOF



(57) **Abrégé/Abstract:**

A device and a method for manufacturing a metal tube-covered optical fiber cable; the method, comprising the step of, while manufacturing a metal tube (6) by forming a metal tape (2) in a tubular body and welding the joint of the metal tube (2), feeding an optical fiber (11) protected by a jacket substance into the metal tube (6) through a guide pipe (13) inserted in to the metal tube (6) so that the tip thereof is positioned ahead of a welded position, wherein a damage of the guide pipe (13) by welding heat is reduced to increase the service life of the optical fiber, and a welding torch (5) for welding the joint of the metal tape (2) is reciprocally moved along the joint for welding, whereby the welding heat can be prevented from being concentrated into one position on the guide pipe.



ABSTRACT

A manufacturing apparatus and a method for a metal sheathed optical fiber cable by forming a metal tape 2 into a tube, welding joint portions of the metal tape 2 to manufacture a metal tube 6, while inserting an optical fiber 11 protected by a viscous material into the metal tube 6 through a guide pipe 13 inserted into the metal tube 6 so that a front end of the pipe 13 is located at a position ahead of a welding position, and thereby reducing damage on the guide pipe 13 due to welding heat and enabling an increased life.

A welding torch 5 welds joint portions of the metal tape 2 while reciprocating along the joint portion. It is thereby possible to prevent the welding heat from focusing on a single portion of the guide pipe.

Selected drawing Fig. 2

Specification

Manufacturing apparatus for metal sheathed optical fiber cable and method thereof

Technical field

The present invention relates to a manufacturing apparatus for manufacturing metal sheathed optical fiber cables, for example, used in optical-fiber combined overhead ground wires, and more particularly, to a manufacturing apparatus and method for forming a metal tube from a metal tape, inserting an optical fiber into the formed metal tube, filling gaps between the optical fiber and metal tube with a viscous material, and thus manufacturing metal sheathed optical fiber cables.

Related art

A metal sheathed optical fiber cable is manufactured by forming a metal tape into a tube, welding joint portions of the metal tape, and thereby manufacturing a metal tube, while inserting an optical fiber into the metal tube through a guide pipe inserted into the metal tube so that a front end of the guide pipe is located at a position ahead of a welding position (for example, as described in Japanese Laid-Open Patent Publication No.4-350808 (1992)). Such an optical fiber cable is manufactured, for example, using an apparatus as shown in Fig. 1. In a manufacturing apparatus 1, a metal tape 2, for example, stainless steel tape is formed into a tube using a plurality of forming rolls 3, joint portions on opposite ends of the metal tape 2 are welded using a welder 5, and thus a metal tube 6 is formed. While forming the metal tube 6, an optical fiber 11 and a viscous material 12, for example, liquid synthetic resin are introduced inside the metal tube 6 using a guide pipe 4, and thereby an optical fiber cable is manufactured.

The guide pipe used as described above protects optical fibers from damage due to welding heat in welding the tape by Tig welding, for example. Further, the guide pipe is often used to feed a waterproofing viscous material, as well as the optical fiber, inside the metal tube.

As shown in Fig. 1, the optical fiber 11 is supplied through guide pipes 4 and 7, and the viscous material 12 is supplied from a tank 9 using a pump 10 to the guide pipe 4 through a supply pipe 8. The guide pipe 4 extends ahead (in the direction of feeding the optical fiber) of a position where the metal tube 6 is welded, and protects optical fibers and viscous material from damage due to heat caused by the welding.

In a conventional apparatus, since a joint of the metal tape that is running to form a tube is welded using a welding torch disposed at a fixed position, a portion of the guide pipe exactly under the welding torch tends to cause damage by heat. Then, it may happen that the heat bores a hole in the guide pipe, whereby the sheath of the optical fiber inside the pipe melts by the heat and/or the viscous material boils and flows outside. Even if the welding heat does not cause a hole, there arises a case that the guide pipe transforms by the heat and a distance between the metal tape and guide pipe changes, thereby providing the welding with inconveniences.

In view of the foregoing, a first object of the present invention is to provide a manufacturing apparatus for a metal sheathed optical fiber cable to overcome the above problems. The viscous material filled into gaps between the optical fiber and metal tube fixes the optical fiber in the metal tube, and protects the optical fiber from water and from side pressure.

The aforementioned viscous material has a high viscosity, and cannot be supplied by a predetermined pressure at the time of starting manufacturing. When the pump 10 is started to work, the viscous material does not flow from the guide pipe 4 into the metal tube 6 immediately after the pump 10 is actuated, and gradually moves inside the metal tube 6 from the guide pipe 4 after a time elapses. Then, the viscous material starts flowing stably from the guide pipe 4 to the metal pipe 6 at a set flow rate R_s (for example, 40g/min.) after two or more minutes, for example, elapses after starting the pump 10.

As described above, since it takes a time to start stably supplying the viscous material to the metal pipe 6 after starting to actuate the pump 10, there arises a problem such that defective portions are manufactured in which the viscous material is not supplied

or poor inside the metal tube 6 of the optical fiber cable, at an earlier time immediately after starting manufacturing of the optical fiber cable.

Therefore, a second object of the present invention is to provide an optical fiber cable manufacturing apparatus capable of stably supplying the viscous material to the metal tube immediately after starting manufacturing of optical fiber cable, and reducing failures caused by the viscous material at an earlier stage of the manufacturing.

Thus, in order to overcome the above problems, the present invention aims to provide a metal sheathed optical fiber cable manufacturing apparatus with stable performance and capability.

Summary of the invention

The present invention provides a metal sheathed optical fiber cable manufacturing apparatus which comprises:

- (1) a forming apparatus that forms a metal tape into a tube so as to obtain a metal tube to sheathe an optical fiber;
- (2) a supplying apparatus that supplies to the metal tube a viscous material that protects the optical fiber inserted into the metal tube;
- (3) a bonding apparatus which is disposed on a stage movable forwardly and backwardly and which bonds joint portions of the metal tape formed into a tube; and
- (4) a pipe-shaped guide that guides the metal tape and protects the optical fiber in bonding the metal tape formed into a tube.

Further, the present invention provides a metal sheathed optical fiber cable manufacturing method that comprises the steps of:

- (1) forming a metal tape into a tube so as to obtain a metal tube to sheathe an optical fiber;
- (2) guiding a viscous material that protects the optical fiber inserted into the metal tube into a guide pipe that protects the optical fiber inserted into the metal tape formed into a tube; and
- (3) bonding joint portions of the metal tape formed into a tube while moving forwardly

and backwardly.

Brief descriptions of the drawings

Fig. 1 is a diagram showing a schematic configuration of an optical fiber cable manufacturing apparatus;

Fig. 2 is a side view showing an embodiment of a metal sheathed optical fiber cable manufacturing apparatus according to the present invention;

Fig. 3 is a graph showing a preferable relationship between a line speed and a travel speed of a welding torch in implementing the present invention;

Fig. 4 is a graph showing a preferable embodiment of a travel speed of a welding torch that travels periodically in the present invention;

Fig. 5 is a graph showing relationships between elapsed time after starting to manufacture optical fiber cables and a discharge flow rate of a viscous material to a metal tube in an embodiment of the present invention and in a conventional case;

Fig. 6 is a diagram showing an example of pressure control of an apparatus for supplying the viscous material in the present invention;

Fig. 7 is a flowchart illustrating the example of pressure control of the apparatus for supplying the viscous material;

Fig. 8 is a diagram to explain actuation amount control of a pressurizing pump including a pre-pressurizing control unit in another embodiment of the present invention; and

Fig. 9 show graphs illustrating an example of pressure control of the viscous material in another embodiment of the present invention.

Detailed description of the preferred embodiments

Embodiments of the present invention will be described specifically below.

A first embodiment of the invention is a metal sheathed optical fiber cable manufacturing apparatus that comprises:

- (1) a forming apparatus that forms a metal tape into a tube so as to obtain a metal tube to sheathe an optical fiber;

- (2) a supplying apparatus that supplies to the metal tube a viscous material that protects the optical fiber inserted into the metal tube;
- (3) a bonding apparatus which is disposed on a stage movable forwardly and backwardly and which bonds joint portions of the metal tape formed into a tube; and
- (4) a pipe-shaped guide that guides the metal tape and protects the optical fiber in bonding the metal tap formed into a tube.

A second embodiment of the invention is the manufacturing apparatus in which the forming apparatus is a roll forming apparatus provided with a plurality of U-shaped caliber rolls.

A third embodiment of the invention is the manufacturing apparatus in which the viscous material for protecting the optical fiber is a liquid synthetic resin.

A fourth embodiment of the invention is the manufacturing apparatus in which the bonding apparatus is a welding apparatus.

A fifth embodiment of the invention is the manufacturing apparatus in which the welding apparatus is a Tig welding apparatus.

A sixth embodiment of the invention is the manufacturing apparatus in which the welding apparatus is a plasma welding apparatus.

A seventh embodiment of the invention is the manufacturing apparatus in which the welding apparatus is a laser welding apparatus.

An eighth embodiment of the invention is the manufacturing apparatus in which a guide roll that guides the metal tape to be welded into a tube is disposed in the vicinity of the stage.

A ninth embodiment of the invention is the manufacturing apparatus in which the stage is provided with a guide roll that guides the metal tape to be welded into a tube.

A tenth embodiment of the invention is the manufacturing apparatus in which the stage provided with the bonding apparatus travels forwardly and backwardly in predetermined cycles in a direction of feeding the optical fiber, while welding joint portions of the metal tape formed into a tube.

An eleventh embodiment of the invention is the manufacturing apparatus in which a forward speed and a backward speed of the stage are not greater than a line speed of the

optical fiber.

A twelfth embodiment of the invention is the manufacturing apparatus in which the forward speed of the stage is greater than the backward speed of the stage.

A thirteenth embodiment of the invention is the manufacturing apparatus in which the supplying apparatus is provided with a tank to store the viscous material, a pipe line that supplies the viscous material from the tank to the metal tape that is formed but not welded yet, a pressurizing pump provided at a middle portion of the pipe line, and a valve that controls a supply amount of the viscous material.

A fourteenth embodiment of the invention is the manufacturing apparatus in which a pressure sensor for measuring a pressure of the viscous material is provided between the pump and the valve.

A fifteenth embodiment of the invention is the manufacturing apparatus in which the pressurizing pump is operated during a predetermined period of time using a pressure higher than a predetermined steady supply pressure based on a signal from the pressure sensor before manufacturing of the optical fiber cable is started.

A sixteenth embodiment of the invention is the manufacturing apparatus provided with a second pipe line that is provided between the pump and the valve and that supplies the viscous material stably through a control valve, and with a pre-pressurizing control apparatus that controls pressures of the second pipe line and the control valve.

A seventeenth embodiment of the invention is the manufacturing apparatus further provided with a control apparatus that controls an actuation amount of the pressurizing pump based on the pressure sensor for measuring pressures of the viscous material and the pump.

An eighteenth embodiment of the invention is a metal sheathed optical fiber manufacturing method that comprises the steps of:

- (1) forming a metal tape into a tube so as to obtain a metal tube to sheathe an optical fiber;
- (2) guiding a viscous material to be inserted into the metal tape formed into a tube into a guide pipe that protects the optical fiber inserted into the metal tape formed into a tube; and
- (3) bonding joint portions of the metal tape formed into a tube while moving forwardly

and backwardly.

A nineteenth embodiment of the invention is the manufacturing method in which the step of forming is performed in a roll forming apparatus provided with a plurality of U-shaped caliber rolls.

A twentieth embodiment of the invention is the manufacturing method in which the metal tape is bonded using a welding method.

A twenty first embodiment of the invention is the manufacturing method in which the welding method is a Tig welding method.

A twenty second embodiment of the invention is the manufacturing method in which the welding method is a plasma welding method.

A twenty third embodiment of the invention is the manufacturing method in which the welding method is a laser welding method.

A twenty fourth embodiment of the invention is the manufacturing method in which joint portions of the metal tape formed into a tube are bonded while a bonding position moves forwardly and backwardly in predetermined cycles in a direction of feeding the optical fiber.

A twenty fifth embodiment of the invention is the manufacturing method in which a forward speed and a backward speed are not greater than a line speed of the optical fiber.

A twenty sixth embodiment of the invention is the manufacturing method in which the forward speed is greater than the backward speed.

A twenty seventh embodiment of the invention is the manufacturing method in which the viscous material is supplied while a pressure of the viscous material inside a supply pipe is maintained at a predetermined pressure.

A twenty eighth embodiment of the invention is the manufacturing method in which the pressure for supplying the material is maintained at a pressure higher than a predetermined steady supply pressure before manufacturing of the optical fiber is started.

A twenty ninth embodiment of the invention is the manufacturing method in which the pressure for supplying the viscous material is controlled by actuation amount of a pressurizing pump to be maintained, while being measured.

The present invention will be described below using embodiments with reference to accompanying drawings. However, the present invention is not limited to the embodiments, and includes any combinations thereof within the scope disclosed in the embodiments.

Embodiments of the present invention will be described specifically below with reference to drawings. As described previously, Fig. 1 shows a typical manufacturing apparatus. In the conventional manufacturing apparatus, a fixed welding torch welds a joint portion of a metal tape that is formed into a tube by U-shaped caliber rolls. In an embodiment of the present invention as shown in Fig. 2, the metal tape 2, for example, a stainless steel tape or aluminum tape, is formed into a tubular shape with a predetermined form by caliber rolls 3 provided with a caliber to form the tape into a tube; usually cylinder, or tube with an oval-shaped cross section. Then, a welding torch, for example, the welding torch 5 bonds joint portions of the metal tape 2 formed into a tubular shape. A bonding method is selected as appropriate from among Tig welding, plasma welding and laser welding using for example, an excimer laser, YAG laser or CO₂ laser. A welded metal tube 6 is fed in the direction of arrow P at a line speed of, for example, about 10m/min. In this figure, a guide pipe 13 is disposed so that a front end of the pipe 13 is located in the metal tube 6 at a position ahead (right side of the figure) of the welding torch 5. The optical fiber 11 is fed into the metal tube 6 through the guide pipe 13, and a viscous material 12 is fed into the metal tube 6 through the guide pipe 4. In Fig. 2, since the guide pipes 4 and 13 are provided separately, the guide pipe 4 also has the function of protecting the optical fiber from the welding torch. In addition, as shown in Fig. 1, the guide pipe 4 may supply both the optical fiber 11 and viscous material 12.

In the apparatus of the present invention, when metal sheathed optical fiber cables are manufactured, a welding apparatus, for example, the welding torch 5 performs welding, while reciprocating (traveling between solid line and broken line) along the joint of the metal tape 2 formed into a tube. In this way, since a position heated by the welding torch 5 of the guide pipe 13 varies in a longitudinal direction, a possibility that the pipe 13 causes damage due to heat greatly decreases as compared to the conventional case where the pipe 13 is locally heated. As a result, since the life of the guide pipe 13 increases, it is possible

to greatly reduce the frequency of exchange of the guide pipe 13, and to manufacture metal sheathed optical fiber cables with longer lengths. Further in the manufacturing apparatus, since the guide pipe 13 does not move, it is possible to feed the optical fiber 11 smoothly, and therefore the risk is reduced of degrading the optical fiber 11.

Various apparatuses are considered as a device to cause the welding torch 5 to reciprocate. For example, it may be possible that on a base 51 is provided a stage 50 slidable in the direction in which the metal tube 6 is moving, the welding torch 5 and a guide roll 53 are provided on the stage 50, and the stage 50 is operated to reciprocate by an actuator 52 fixed to the base 51 with the welding torch 5 always located on a joint of the metal tape in the relationship between positions of the welding torch 5 and guide roll 53. The stage 50 is, for example, operated to reciprocate distances of 100mm at a speed of about 5mm/min. Thus manufacturing metal sheathed optical fiber cables continuously for about fifteen hours resulted in no hole in the guide pipe 13. In the conventional apparatus with the welding torch fixed, a hole was bored in the guide pipe after three to five hours. Thus, the apparatus of the present invention provides a greatly increased life.

In addition, in Fig. 2 the guide roll 53 is configured to move along with the welding torch 5, but may be supported by another supporting member different from that of the welding torch 5. In this case, the guide roll 53 may be fixed, or may be provided movable in the longitudinal direction of the metal tube.

It is preferable as shown in Fig. 3 to set a travel speed of the welding torch 5 (travel speed of the stage 50) to be lower than and proportional to a line speed (moving speed of the metal tube 16). It is because a high line speed results in an increased amount of heat provided from the welding torch, and therefore it is necessary to move the welding torch faster to reduce the effect of the welding heat on the guide pipe to low as possible.

It is preferable as shown in Fig. 4 to control the travel speed of the welding torch 5 so that the speed at which the welding torch 5 is traveling in the direction the metal tube is moving is higher than the speed at which the welding torch 5 is traveling in the opposite direction. Thus controlling decreases a difference between a relative speed (forward welding speed) between the welding torch 5 and the metal tube 6 when the welding torch is

traveling in the direction the metal tube is moving and a relative speed (backward welding speed) between the welding torch 5 and metal tube 6 when the welding torch is traveling in the opposite direction. As a result, welding conditions become stable, and it is possible to obtain excellent welding states over the full length.

As described above, according to the present invention, the welding torch 5 performs welding while reciprocating along the joint of the metal tape, whereby it is possible to reduce damage of the guide pipe 13 due to the welding heat, and to increase the life of the guide pipe 13. In this way, the frequency of exchange of the guide pipe decreases, and therefore it is possible to increase the manufacturing efficiency and to manufacture metal sheathed optical fiber cables with longer lengths. Further, since the guide pipe is allowed to stand still, it is possible to avoid damage of the optical fiber due to the movement of the guide pipe, and to decrease an occurrence rate of defective piece.

Further, the manufacturing apparatus 1 for optical fiber cable of the present invention provides a specific supplying apparatus for supplying the viscous material 12. In the manufacturing apparatuses disclosed in Figs. 1 and 2 as previously explained, the pump 10 supplies the viscous material to the supply pipe 8 which is provided with a first valve 21 and a pressure control unit, as shown in Fig. 6, which are to control the pressure as an open/close apparatus for controlling open/close of a passage located downstream from the pump 10 during a predetermined period of time after starting manufacturing.

One of the major features in this embodiment is to actuate pump 10 with the first valve 21 closed before actually starting to manufacture optical fiber cables as a pre-pressuring operation for increasing the pressure of the viscous material inside the supply pipe 8 between the pump 10 and first valve 21, and then open the first valve 21 to start the manufacturing of optical fiber cable. In addition, any manufacturing methods are available after starting the manufacturing, and explanations of the methods are omitted herein.

Although it may be possible to manually perform the actuation of the pump 10 and open/close operation of the first valve 21 associated with the pre-pressurizing of the viscous

material 12, an example will be described of configurations for automatically controlling the actuation of the pump 10 and open/close operation of the first valve 21.

For example, in a first example of pressure control, the viscous-material supply pipe 8 between the pump 10 and first valve 21 is provided with a pressure sensor apparatus 22 that detects the pressure inside the pipe line. The pressure control unit 20 to control the optical fiber cable manufacturing apparatus 1 automatically controls the operation of pre-pressurizing of the viscous material.

For example, the pressure control unit 20 for the viscous material is provided with a configuration for fetching information of pressure sensor apparatus 22, and using the fetched information, automatically controlling the pump 10 and first valve 21 according to control procedures shown in the flowchart in Fig. 7. In other words, when detecting an instruction for starting the apparatus operation, for example, based on operation information of an operation start button by an operator (step S1 in Fig. 7), the pressure control unit 20 starts to actuate the pump 10 with the first valve 21 closed (step S2), and thus increases the pressure of the viscous material inside the viscous material supply pipe 8 between the pump 10 and first valve 21.

Pressure control unit 20 fetches detection values from the pressure sensor apparatus 22 sequentially (step S3), and compares each fetched detection value with a set pressure value to determine whether the detection value reaches the set pressure value (step S4).

When the pump 10 is started to operate with the first valve 21 closed, as shown by chained line in Fig. 5, the pressure inside the viscous material supply pipe 8 gradually increases as time elapses. Then, after the viscous material is supplied to the metal tube 6 from the guide pipe 4 stably at a set flow rate R_s , the pressure of the viscous material inside the viscous material supply pipe 8 is maintained at an almost constant pressure P_s .

The required pressure P_s (pressure value required for stably supplying the viscous material from the guide pipe 4 to the metal tube 6 at the set flow rate R_s) is obtained by calculation, experiment, etc. The obtained pressure P_s is given in advance as the above-

mentioned set pressure value to the pressure control unit 20. Pressure control unit 20 compares the set pressure P_s with a detection value of pressure sensor apparatus 22, and when determining that the detection value of the pressure sensor apparatus 22 reaches the set pressure P_s , opens the first valve 21 (step S5). In this example, at the same time as opening the valve 21, the actuation of rolls 3 and supply of optical fiber from the optical fiber supply pipe 7 to guide pipe 4 are started, thus starting to manufacture optical fiber cables.

According to the first example of pressure control, the viscous material supply pipe 8 is provided in its portion located downstream from the pump 10 with the first valve 21, and the pump 10 is actuated with the first valve 21 closed to perform the pre-pressurizing operation for increasing the pressure of the viscous material inside the supply pipe 8 between the pump 10 and first valve 21 before starting to manufacture optical fiber cables. It is thereby possible to stably supply the viscous material into the metal tube 6 from the guide pipe 4 nearly at set flow rate R_s , as shown in Fig. 5, after opening the first valve 12 and starting to manufacture optical fiber cables. As a result, it is possible to eliminate almost all of failures at an earlier stage of manufacturing optical fiber cables and thus eliminate waste.

Next, a second example of pressure control different from the first example will be described. In addition, in the description in this example, the same structural components as in the first example of pressure control are assigned the same reference numerals to omit overlapping explanations thereof.

In an optical fiber cable manufacturing method in the second example of pressure control, as shown in Fig. 8, the viscous material supply pipe 8 between the pump 10 and first valve 21 is provided with a pressure adjusting apparatus 34 and a second valve 31, for example. The pressure adjusting apparatus 34 controls a pipe line 32 with an inner diameter almost equal to that of the viscous material supply pipe 8, a pipe line 33 with an inner diameter which is thinner than that of the pipe line 32 and almost equal to that of the guide pipe 4, and the second valve 31 provided between pipe lines 32 and 33. In the

pressure adjusting apparatus 34, one end of the pipe line 32 is communicated to the viscous material supply pipe 8 between the pump 10 and first valve 21, the other end of the pipe line 32 is connected to one end of the pipe line 33, and the other end of the pipe line 33 may be connected to, for example, tank 9 for storing the viscous material. Further, it may be possible to connect the other end of the pipe line 33 to the supply pipe 8 and circulate the viscous material to control the pressure.

Since the pressure adjusting apparatus 34 is connected to the pipe line 32 and pipe line 33 thinner than the pipe line 32, by actuating the pump 10 with the first valve 21 closed and the second valve 31 opened, it is possible to increase the pressure of the viscous material inside the supply pipe 8 between the pump 10 and first valve 21, and to stabilize the pressure to a predetermined pressure value set in advance even when the pressure of the viscous material varies. In the second example of pressure control, the set pressure P_s (pressure value required for stably supplying the viscous material from the guide pipe 4 to the metal pipe 6 at the set flow amount R_s) illustrated in the first example of pressure control is set as the above-mentioned set pressure.

In the second example of the pressure control, by performing the pre-pressurizing operation on the viscous material before starting to manufacture optical fiber cables, the pressure of the viscous material is increased inside the supply pipe 8 between the pump 10 and first valve 21. Then, after the pressure of the viscous material is stabilized by the pressure adjusting material 34, the first valve 21 is opened, and at the same, the manufacturing of optical fiber cable is started. In addition, any manufacturing methods are available after starting the manufacturing, and explanations of the methods are omitted herein.

Also in the second example of pressure control, since the manufacturing of optical fiber cable is started after performing the pre-pressurizing operation on the viscous material, it is possible to eliminate almost all of failures caused by the viscous material at an earlier stage of the manufacturing, as in the first example of control pressure.

As in the first example of pressure control, although in the second example of pressure control it may be possible to manually perform the actuation of the pump 10 and open/close operations of the first valve 21 and second valve 31 associated with the pre-pressurizing of the viscous material, an example will be described of configurations for automatically controlling the actuation of the pump 10 and open/close operations of the valves 21 and 31.

The optical fiber cable manufacturing apparatus explained in the second example of pressure control is provided with a pre-pressurizing control unit 30, as well as the second valve 31. Except the control unit 30 and valve 31, a configuration of the apparatus in the second example is almost same as that of the apparatus explained in the first example. In addition, in the second example of pressure control, if the pressure is set in advance to a value same as described in the first example of pressure control, it is not necessary to provide the pressure sensor apparatus 22.

In the second example of pressure control, when the optical fiber cable manufacturing apparatus 1 stops its operation, the first valve 21 is closed and the second valve 31 is opened. For example, when detecting an instruction for starting the apparatus operation, the pre-pressurizing control unit 30 starts to actuate the pump 10 while keeping the first valve 21 closed and the second valve 31 opened, and the thus actuated pump 10 increases the pressure of the viscous material inside the viscous material supply pipe 8.

When a predetermined valve opening condition is satisfied, the pre-pressurizing control unit 30 closes the second valve 31 and opens the first valve 21. Concurrently, the manufacturing of optical fiber cable is started. The first valve 21 and second valve 31 may be a general mechanical valve or electromagnetic valve. The control apparatus 34 may be a mechanical handle or a control apparatus that operates electromagnetically.

The valve opening condition is to indicate that the pressure of the viscous material inside the supply pipe 8 is maintained at a set pressure by the pre-pressurizing control unit 30. For example, since a time is almost determined which is required for the pressure of the viscous material inside the supply pipe 8 to be stabilized nearly at a set pressure by the

second valve 31 after starting to actuate the pump 10, such a time was obtained in advance and a lapse of the time (for example, two minutes) after starting to actuate the pump 10 is given as the valve opening condition.

The pre-pressurizing control unit 30 as described above enables automatic operation of the pre-pressuring before a start of the manufacturing of optical fiber cable.

In addition, the second valve 31 is only required to be provided with a configuration for adjusting the pressure of the viscous material inside the viscous material supply pipe 8 between the pump 10 and first valve 21 when the pre-pressurizing operation on the viscous material is performed before starting the manufacturing of optical fiber cable, and is not limited to a mechanical valve. For example, instead of pipe line 33 thinner than the pipe line 32, the pipe line 32 may be provided with a flow-rate control apparatus such as a needle valve that is capable of variably controlling a flow rate of the viscous material in the pipe line 32. For example, when a needle valve is provided, the degree of open of the needle valve is controlled so that the pressure of the viscous material inside the supply pipe 8 between the pump 10 and first valve 21 becomes a set pressure at the time of the pre-pressurizing operation on the viscous material.

A third example of pressure control will be described below. In the optical fiber cable manufacturing apparatus in the third example of pressure control, in the case where optical fiber cables are manufactured using the optical fiber cable manufacturing apparatus as shown in Fig. 1 or 2 previously mentioned, the pump 10 is actuated by actuation amount larger than a pump actuation amount J_s of steady operation, as shown in Fig. 9, in manufacturing optical fiber cables. In this way, the rise in the pressure of the viscous material, as shown by solid line A, inside the supply pipe 8 is enhanced as compared to the rise in the pressure of the viscous material, as shown by broken line B, in the conventional case. Therefore, it is possible to perform fast stabilization of supply of the viscous material from the guide pipe 4 to metal tube 6. In addition, this example may be applied to another optical fiber cable manufacturing apparatus.

Although controlling the actuation amount of the pump 10 may be performed manually, an example will be described of configurations for automatically controlling the pump 10. For example, the control apparatus of the optical fiber cable manufacturing apparatus 1 is provided with the pump actuation control unit 40 (see Fig. 1) for controlling the pump 10. In this example, the pump actuation control unit 40 is provided in advance with the pump actuation amount J_s of steady operation and pump actuation amount J_p of start of operation.

The pump actuation amount J_s of steady operation is an actuation amount of the pump 10 when the viscous material is stably supplied from the guide pipe 4 into the metal tube 6 at the set flow rate R_s . Further, the pump actuation amount J_p of start of operation is greater than the pump actuation amount J_s of steady operation, and is set as appropriate corresponding to various respects such as capability of the pump 10. In this example, information of the pump actuation amounts J_s and J_p are given to the pump actuation control unit 40 as information of the number of rotations of the pump 10.

When detecting a start of manufacturing of optical fiber cable, for example, based on operation information of an operation start button by an operator, the pump actuation control unit 40 actuates the pump 10 with the pump actuation amount J_p of start of operation. Then, according to a program given in advance, the pump actuation control unit 40 gradually decreases the actuation amount of the pump 10 to the pump actuation amount J_s of steady operation, and starts actuating the pump 10 with the pump actuation amount J_s of steady operation at about the time a stable supply of the viscous material from the guide pipe 4 into the metal tube 6 is started.

According to this example, since the actuation amount of the pump 10 at the time of starting to manufacture optical fiber cables is set to be greater than that of steady operation, it is possible to obtain the rise in the pressure of the viscous material inside the supply pipe 8 faster than the conventional case. In this way, a supply of the viscous material from the guide pipe 4 to the metal tube 6 is stabilized faster, and it is thereby possible to greatly reduce failures at an earlier stage of manufacturing optical fiber cables caused by lack or shortage of the viscous material.

The third example of pressure control is capable of, without providing the supply pipe 8 with the first valve 21, pressure sensor apparatus 12 and/or pressure adjusting apparatus 34, greatly reducing failures at an earlier stage of manufacturing optical fiber cables only by increasing the actuation amount of the pump 10 at the time of starting to manufacture optical fiber cables as described above than the steady operation, and therefore of having great effectiveness with the conventional configuration kept.

In addition, the present invention is not limited to above embodiments, and capable of being carried out in various embodiments. For example, in the first and second examples of pressure control, the set pressure P_s is a pressure value of the viscous material inside the supply pipe 8 at the time the viscous material is stably supplied from the guide pipe 4 to the metal tube 6. However, appropriate values other than the above pressure value may be used as a set pressure value.

Further, in the second example of pressure control, the pressure sensor apparatus 2 is omitted, but may be provided as in the first example of pressure control. In this case, it is possible to open the valve 21 when detecting that the pressure of the viscous material inside the viscous material supply pipe 8 is increased by the pre-pressurizing operation and stabilized by the pre-pressurizing control unit 30 based on the detection value of the pressure sensor apparatus 22.

The guide pipe 8 is provided with a pump and an open/close apparatus of the pipe at its portion located downstream of the pump, the pump is actuated with the open/close apparatus such as a valve closed before starting to manufacture optical fiber cables, thereby performing pre-pressurizing operation on the viscous material to increase the pressure of the viscous material inside the viscous material passing portion between the pump and open/close apparatus, and the open/close apparatus is opened to start manufacturing optical fiber cables. In this way, the pressure of the viscous material inside the material passing portion between the pump and open/close apparatus has been increased by the pre-

pressurizing operation on the viscous material, and then manufacturing of optical fiber cable is started. As a result, it is possible to supply the viscous material from the viscous material guide pipe into the metal tube at a flow rate nearly equal to the set flow rate when starting to manufacturing optical fiber cables.

In this way, it is possible to eliminate almost all of failures at an earlier stage of manufacturing optical fiber cables caused by lack or shortage of the viscous material.

Further, in the invention in which prior to starting to manufacture optical fiber cables, the actuation amount of the pump is set to be greater than the pump actuation amount of steady operation, it is possible to greatly hasten the rise in the pressure of the viscous material in the viscous material guide pipe as compared to the conventional case. It is thereby possible to hasten a stable supply of the viscous material from the viscous material guide pipe to the metal tube, and to, as in above-mentioned embodiments, eliminate almost all of failures at an earlier stage of manufacturing optical fiber cables caused by lack or shortage of the viscous material.

Further, in the apparatus provided with a configuration for automatically controlling the pump and/or the operation of the open/close apparatus for pre-pressurizing, for example, pressing an operation start button enables the apparatus to automatically operate a series of operations required for the pre-pressurizing with manual operations for the pump and open/close apparatus saved. In this way, without placing burdens on operators, etc, it is possible to greatly reduce failures at an earlier time of manufacturing optical fiber cables.

Industrial availability

The present invention is described to obtain a new apparatus for manufacturing metal sheathed optical fiber cables, and the same effectiveness is obtained when applying the present invention to an apparatus using plastic tapes, instead of metal tapes, to manufacture plastic sheathed optical fibers. The present invention is also applicable to apparatuses for sheathing various cable materials, instead of optical fibers, with metal or plastic to manufacture sheathed cables.

CLAIMS

1. A metal sheathed optical fiber cable manufacturing apparatus comprising:
 - (1) a forming apparatus that forms a metal tape into a tube so as to obtain a metal tube to sheathe an optical fiber;
 - (2) a supplying apparatus that supplies to the metal tube a viscous material that protects the optical fiber inserted into the metal tube;
 - (3) a bonding apparatus which is disposed on a stage movable forwardly and backwardly and which bonds joint portions of the metal tape formed into a tube; and
 - (4) a pipe-shaped guide that guides the metal tape and protects the optical fiber in bonding the metal tape formed into a tube.
2. The manufacturing apparatus of claim 1, wherein the forming apparatus is a roll forming apparatus provided with a plurality of U-shaped caliber rolls.
3. The manufacturing apparatus of claim 1, wherein the viscous material for protecting the optical fiber is a liquid synthetic resin;
4. The manufacturing apparatus of claim 1, wherein the bonding apparatus is a welding apparatus.
5. The manufacturing apparatus of claim 4, wherein the welding apparatus is a Tig welding apparatus.
6. The manufacturing apparatus of claim 4, wherein the welding apparatus is a plasma welding apparatus.
7. The manufacturing apparatus of claim 4, wherein the welding apparatus is a laser welding apparatus.
8. The manufacturing apparatus of claim 1, wherein a guide roll that guides the metal tape to be welded into a tube is disposed in the vicinity of the stage.
9. The manufacturing apparatus of claim 1, wherein the stage is provided with a guide roll that guides the metal tape to be welded into a tube.
10. The manufacturing apparatus of claim 1, wherein the stage provided with the bonding apparatus travels forwardly and backwardly in predetermined cycles in a direction of feeding the optical fiber, while bonding joint portions of the metal tape formed into a tube.
11. The manufacturing apparatus of claim 8, wherein a forward speed and a backward

speed of the stage are not greater than a line speed of the optical fiber.

12. The manufacturing apparatus of claim 8, wherein the forward speed of the stage is greater than the backward speed of the stage.

13. The manufacturing apparatus of claim 1, wherein the supplying apparatus is provided with a tank to store the viscous material, a pipe line that supplies the viscous material from the tank to the metal tape that is formed but not welded yet, a pressurizing pump provided at a middle portion of the pipe line, and a valve that controls a supply amount of the viscous material.

14. The manufacturing apparatus of claim 13, wherein a pressure sensor for measuring a pressure of the viscous material is provided between the pump and the valve.

15. The manufacturing apparatus of claim 13, wherein the pressurizing pump is operated during a predetermined period of time using a pressure higher than a predetermined steady supply pressure based on a signal from the pressure sensor before manufacturing of the optical fiber cable is started.

16. The manufacturing apparatus of claim 13, further comprising:

a second pipe line that is provided between the pump and the valve and that supplies the viscous material stably through a control valve; and

a pre-pressuring control apparatus that controls pressures of the second pipe line and the control valve.

17. The manufacturing apparatus of claim 13, further comprising:

a control apparatus that controls an actuation amount of the pressurizing pump based on the pressure sensor for measuring pressures of the viscous material and the pump.

18. A metal sheathed optical fiber manufacturing method comprising the steps of:

(1) forming a metal tape into a tube so as to obtain a metal tube to sheathe an optical fiber;

(2) guiding a viscous material to be inserted into the metal tape formed into a tube into a guide pipe that protects the optical fiber inserted into the metal tape formed into a tube; and

(3) bonding joint portions of the metal tape formed into a tube while moving forwardly and backwardly.

19. The manufacturing method of claim 18, wherein the step of forming is performed in

a roll forming apparatus provided with a plurality of U-shaped caliber rolls.

20. The manufacturing method of claim 18, wherein the metal tape is bonded using a welding method.

21. The manufacturing method of claim 20, wherein the welding method is a Tig welding method.

22. The manufacturing method of claim 20, wherein the welding method is a plasma welding method.

23. The manufacturing method of claim 20, wherein the welding method is a laser welding method.

24. The manufacturing method of claim 18, wherein joint portions of the metal tape formed into a tube are bonded while a bonding position moves forwardly and backwardly in predetermined cycles in a direction of feeding the optical fiber.

25. The manufacturing method of claim 18, wherein a forward speed and a backward speed are not greater than a line speed of the optical fiber.

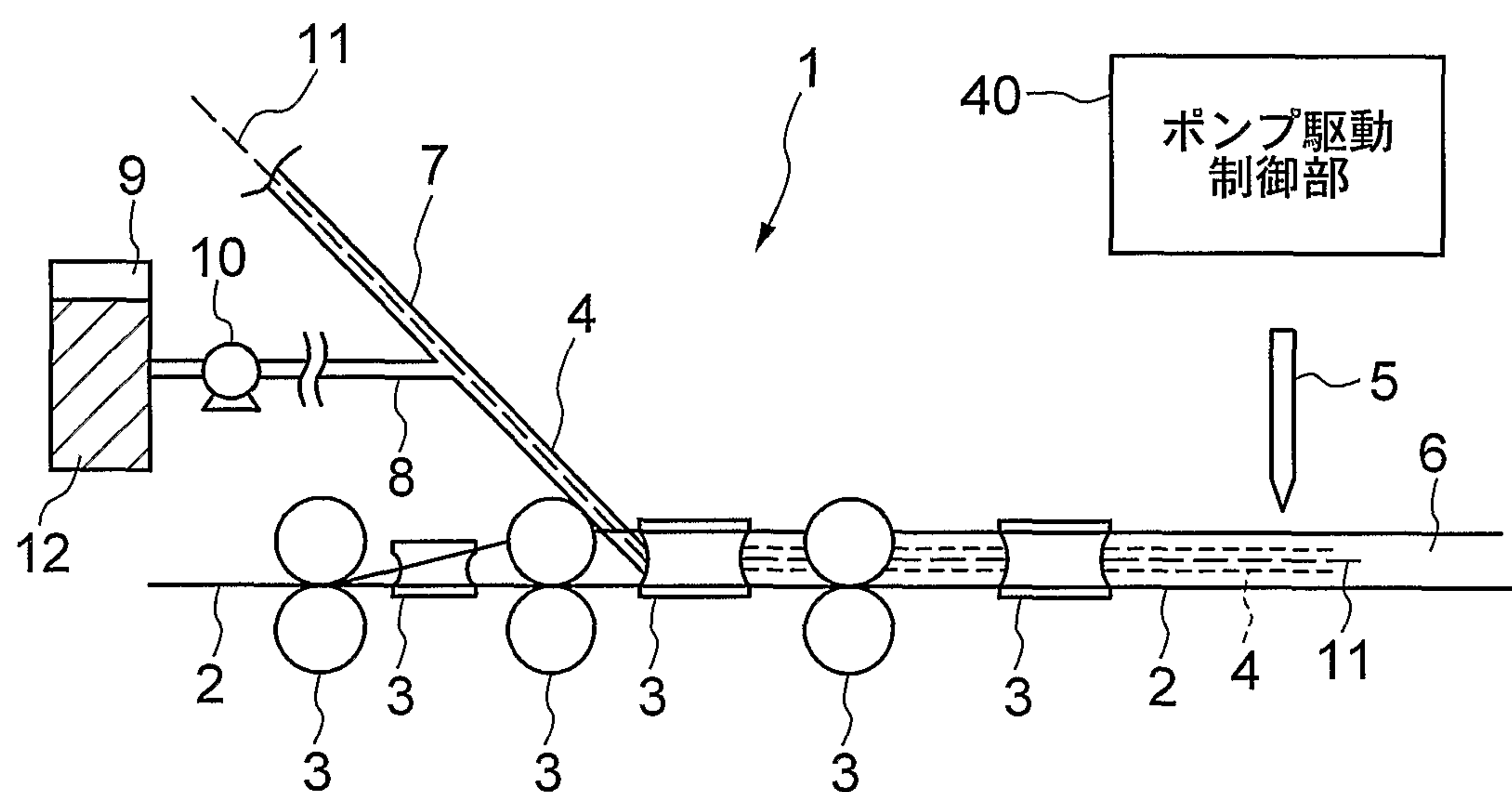
26. The manufacturing method of claim 18, wherein the forward speed is greater than the backward speed.

27. The manufacturing method of claim 18, wherein the viscous material is supplied while a pressured of the viscous material inside a supply pipe is maintained at a predetermined pressure.

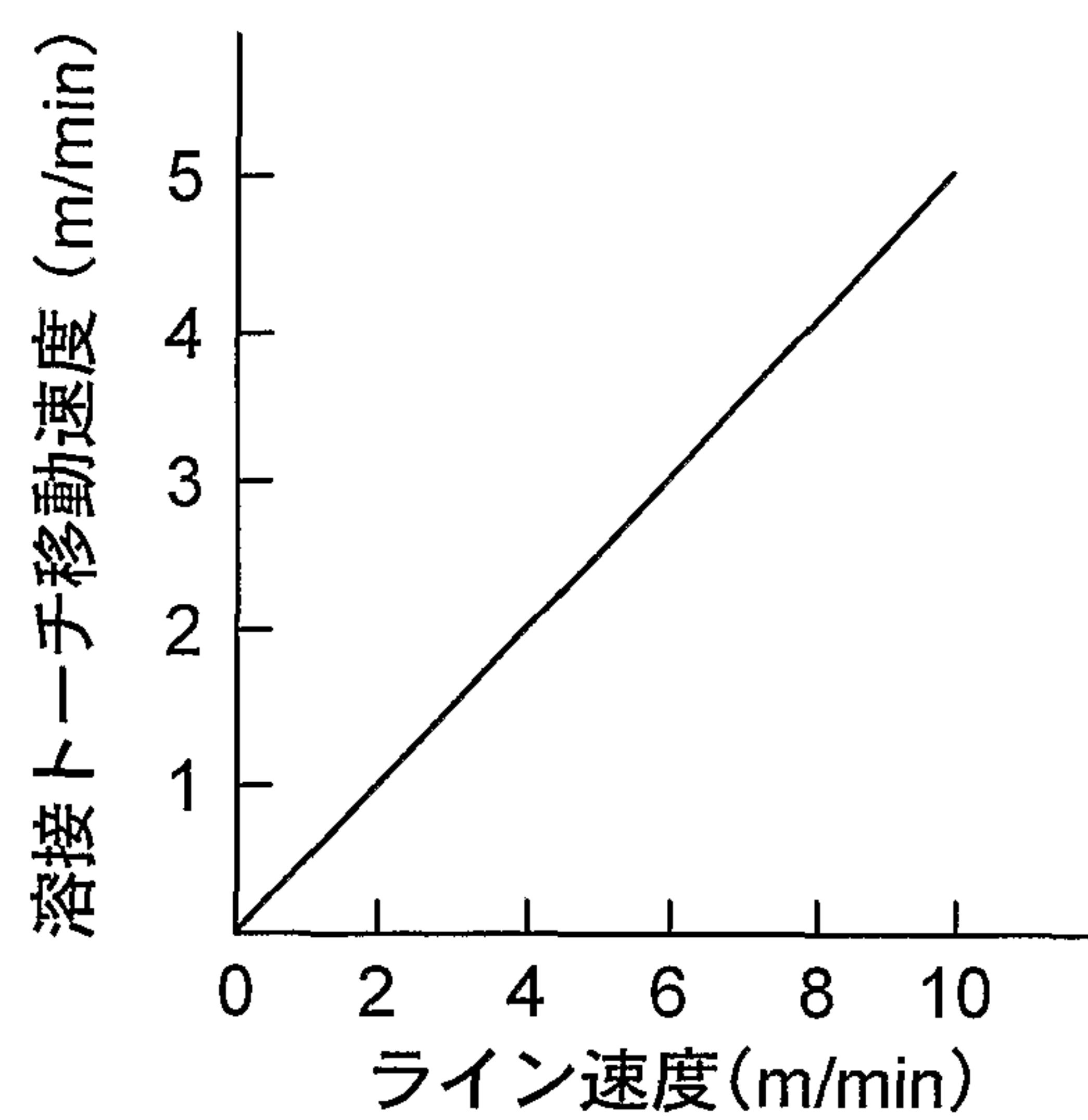
28. The manufacturing method of claim 27, wherein the pressure for supplying the material is maintained at a pressure higher than a predetermined steady supply pressure before manufacturing of the optical fiber is started.

29. The manufacturing method of claim 27, wherein the pressure for supplying the viscous material is controlled by actuation amount of a pressurizing pump to be maintained, while being measured.

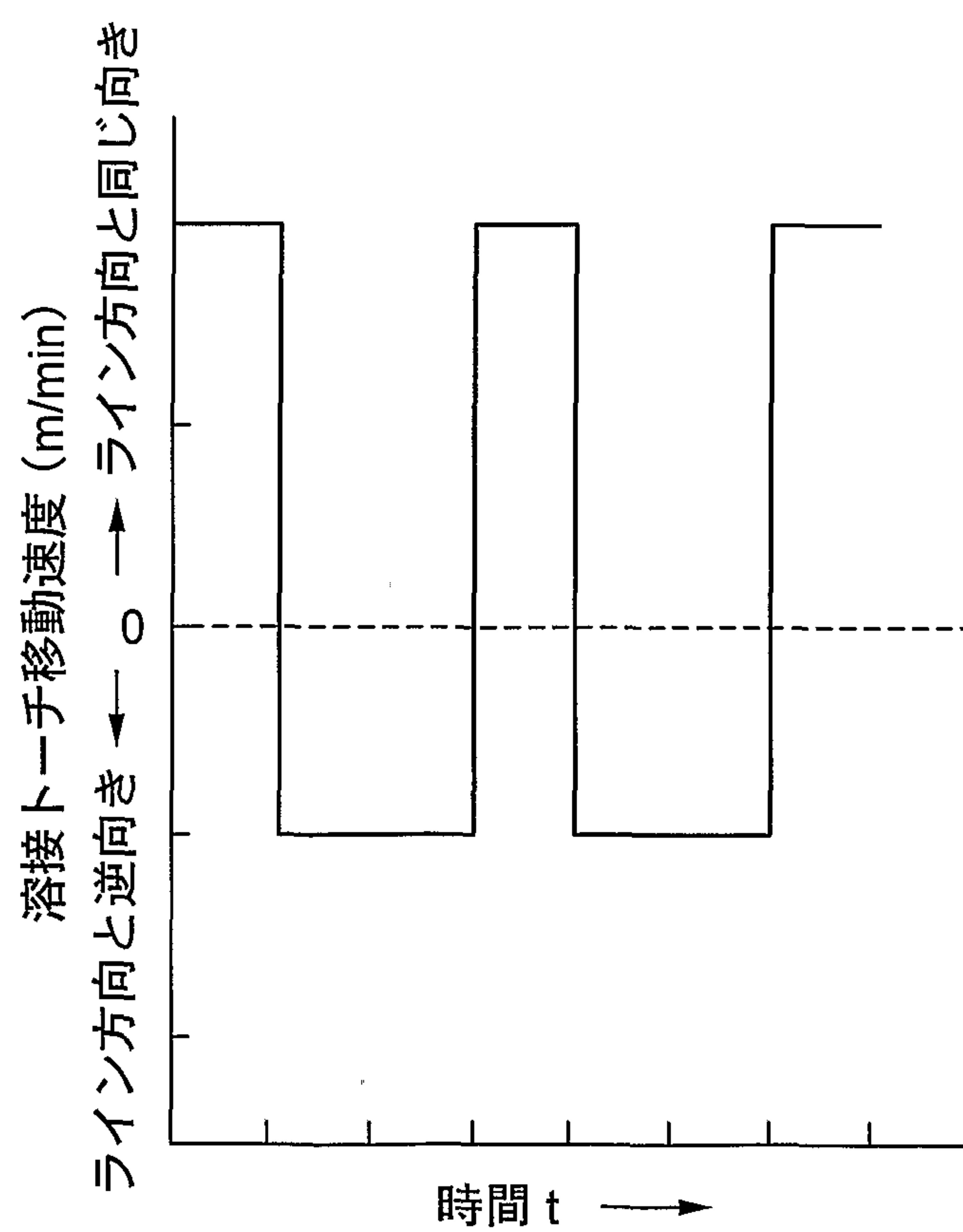
第 1 図



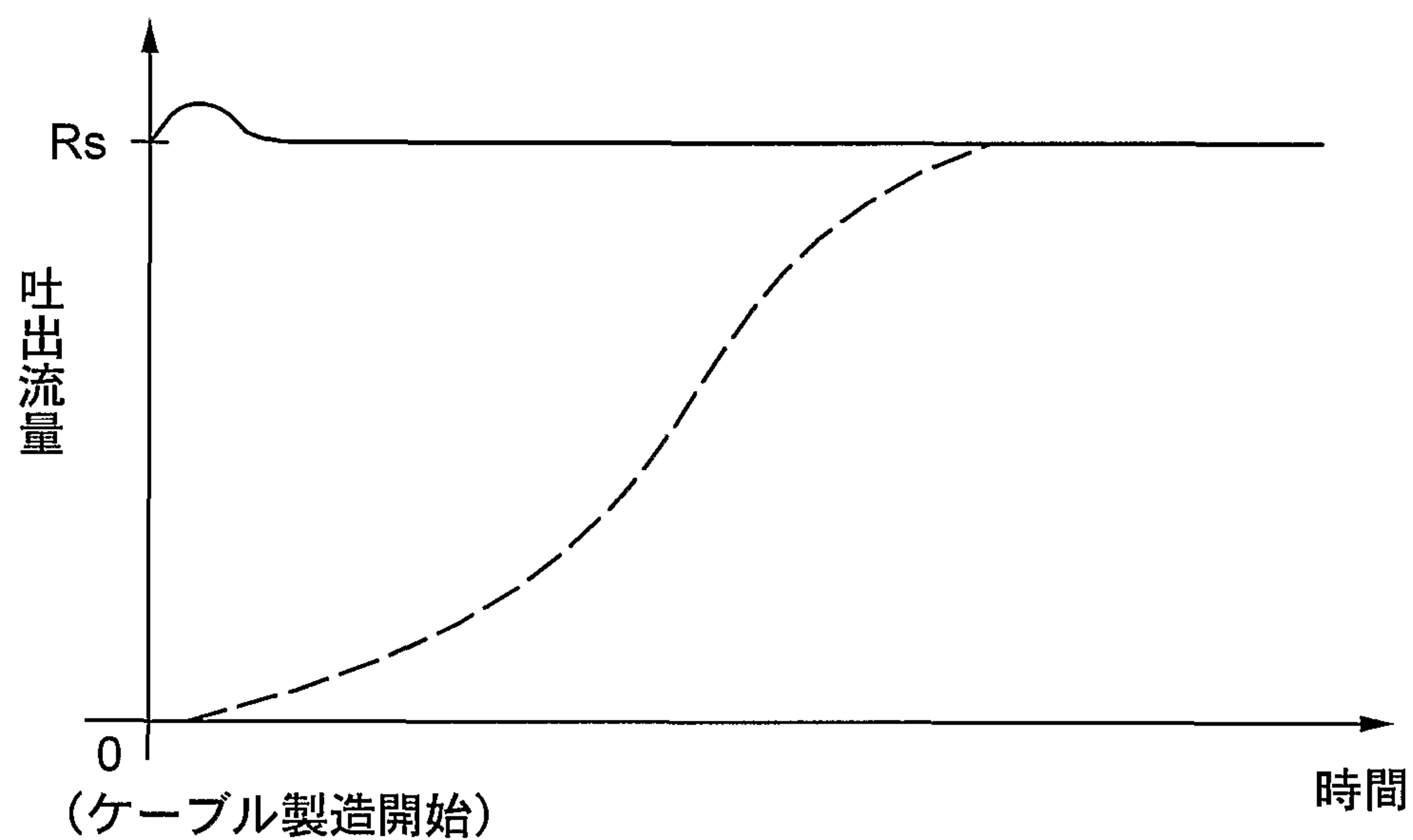
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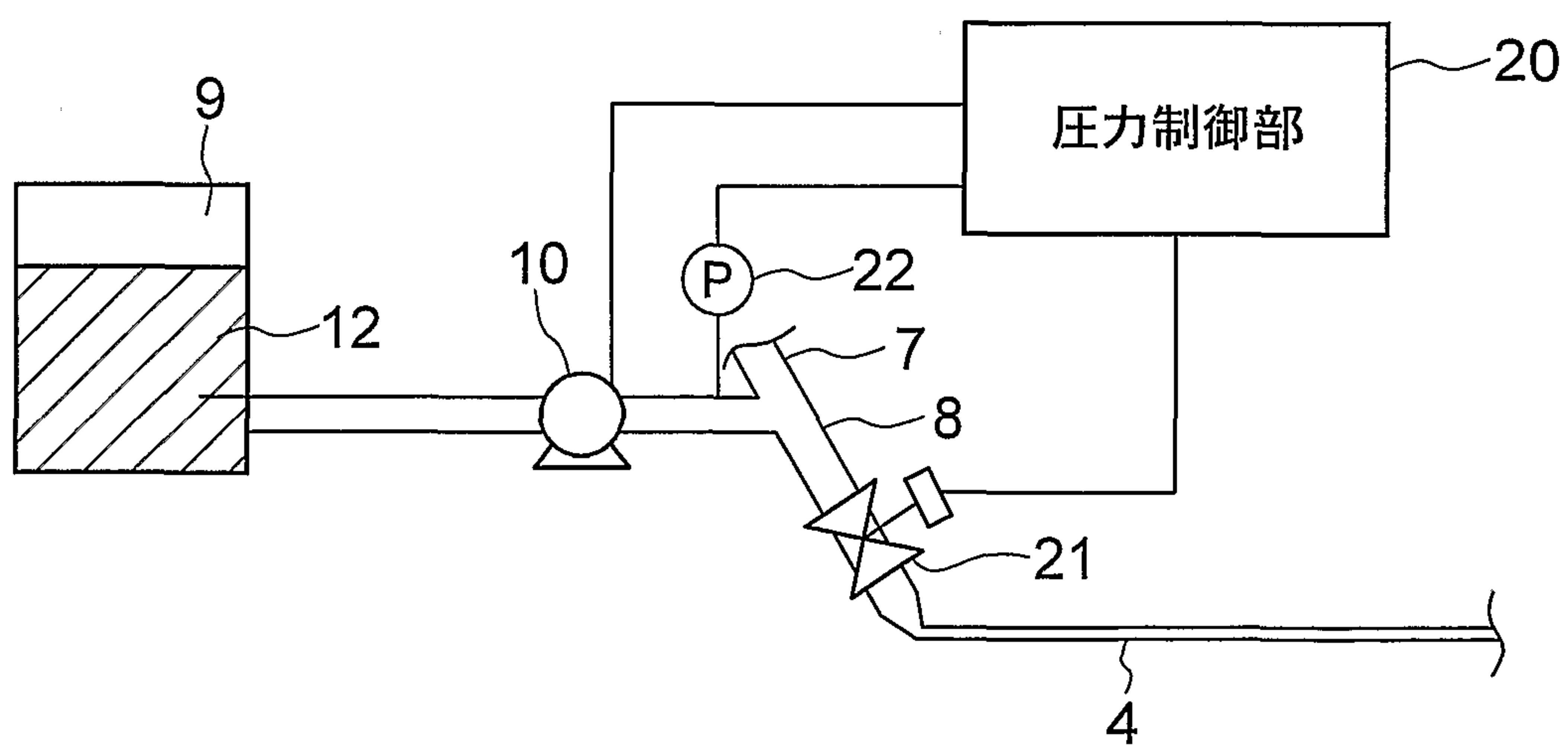
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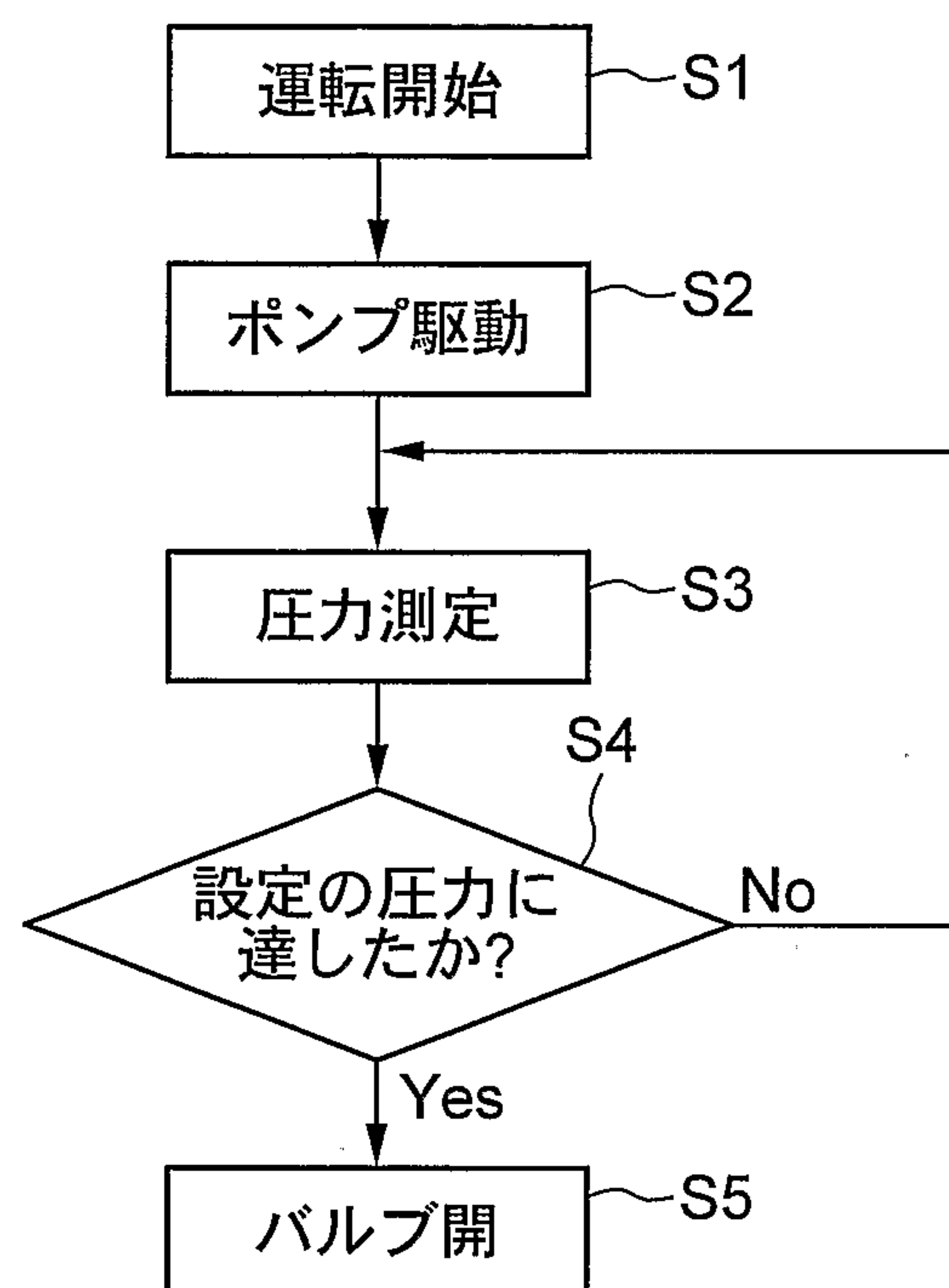
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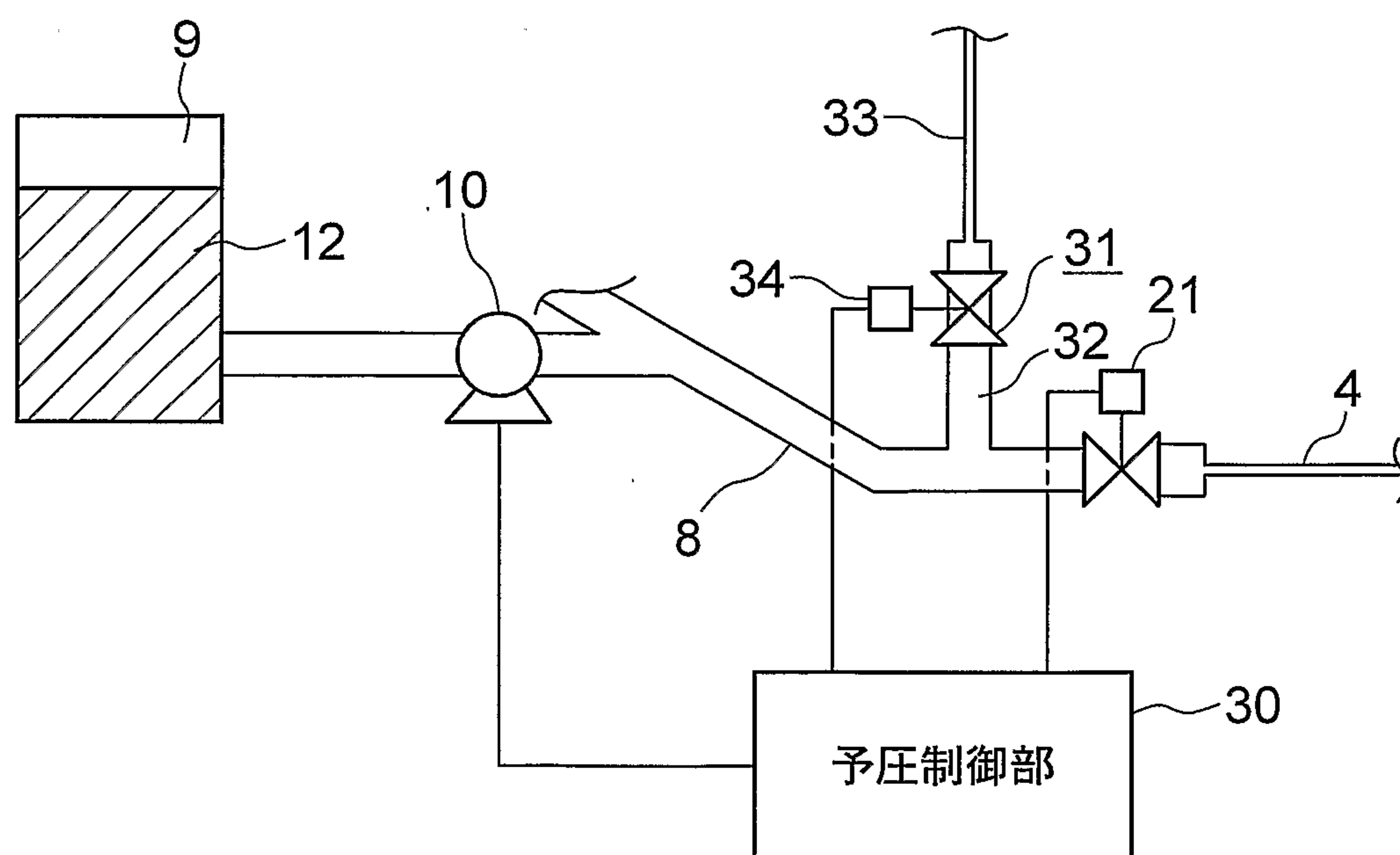
第 6 図



第 7 図



第 8 図



第 9 図

