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(54) ROTARY TYPE POWDER COMPRESSION MOLDING MACHINE

(57) In a rotary compression molding machine for powder material, a rotary table 3 is rotatably arranged in a frame 1 through an upright shaft 2, a die 4 having a die hole 41 is arranged on the rotary table 3, an upper punch 5 and a lower punch 6 are kept above and below the die 4 in a condition of vertically slidable and powder material filled in the die hole 41 is compressed and molded between a lower face 5a of the upper punch 5 and the upper face 6a of the lower punch 6 by pushing the upper punch 5 and the lower punch 6 so as to approach each other with their tips inserted into the die hole 41, and provided with a device LS for spraying small amounts of liquid which sprays small amounts of liquid lubricant L generally evenly on the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and an inner face 41a of the die 4 prior to compression for molding.

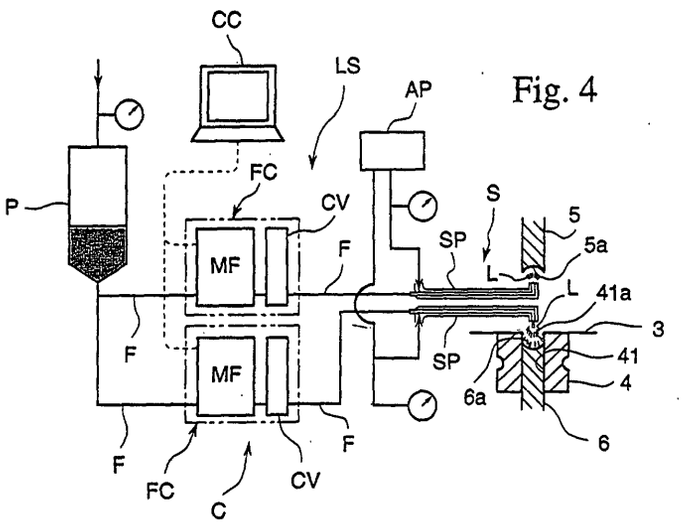


Fig. 4

EP 1 179 414 A1

Description

FIELD OF THE ART

[0001] This invention relates to a rotary compression molding machine for powder material which compresses powder material so as to mold a compressed product mainly including a medical tablet, food or toiletry.

BACKGROUND ART

[0002] A degradative agent, a shaping agent, a binding agent and a lubricant are compounded and mixed in addition to a medicine formulation ingredient i.e. a principal medicine so as to make raw powder material in manufacturing medical tablets by the use of this kind of a rotary compression molding machine. If the raw powder material is made of the principal medicine alone, a sticking phenomenon such that the raw powder material or the tablet sticks to a punch or a die might occur. Then the lubricant is mixed into the raw powder material in order to prevent this kind of problem. Magnesium stearate, calcium stearate, talc or the like is generally used as the lubricant.

[0003] Senile medical field is recently considered to be essential. This increases a demand for tablets which are easy to melt or collapse in a mouth so that elder persons can swallow it without difficulty or for tablets which melt immediately after swallowed so as to produce the efficacy of the medicine. The above-mentioned lubricant prevents adherence to the die or the punches or reduces resistance when the tablet is taken out of the die; however, the lubricant hinders water from infiltrating into the tablet due to its hydrophobic nature, which makes it difficult to meet the above-mentioned demand. Due to this characteristic of the lubricant, it takes time for the tablet to collapse, resulting in a problem such as delaying elution. In addition, due to a mixture of the lubricant, the inside of the tablet is hindered from being integrated, which makes it difficult to higher hardness of the tablet, resulting in fragile.

[0004] In view of the situation and with an object to prevent sticking considered, there is no need of mixing the lubricant with a principal medicine. Then it has been examined that the lubricant is sprayed so as to adhere to a part alone where sticking occurs such as a surface of the punches and the tablet is manufactured with raw powder material with which no lubricant is mixed. As this arrangement in which the lubricant is applied to a necessary portion alone conceived are that powder lubricant is sprayed to the upper punch, the lower punch and the die hole prior to compression by the upper and the lower punches or that only lubricant is first compressed by the upper and the lower punches so as to cover the upper punch, the lower punch and the die hole with the lubricant.

[0005] However, with the former one, the lubricant might be lowered in utility efficiency because it is scattered when sprayed or there might be a problem of contamination such that lubricant is mixed with principal medicine or principal medicine is mixed into lubricant when the lubricant is sprayed, resulting in unevenness of the lubricant adhering to the upper and lower punches. With the later one, a compressor is required in order to compress the lubricant, which makes a size of a machine as a whole bigger and reduces a speed of manufacturing tablets to generally a half of a usual speed. In addition to these arrangements, although a variety of different arrangements are conceived, there are the same problems for actual use.

DISCLOURE OF THE INVENTION

[0006] In order to solve all of the above problems the present claimed invention intends to provide a rotary compression molding machine for powder material in which small amounts of liquid lubricant is sprayed so as to adhere to at least an upper face of a lower punch and a lower face of an upper punch by the minimum necessary amount, which reduces an amount of the liquid lubricant mixed with a tablet by far, which makes it free from a problem of contamination and which does not complicate the arrangement thereof.

[0007] More specifically, a rotary compression molding machine for powder material is so arranged that a rotary table is rotatably arranged in a frame through an upright shaft, a die having a die hole is arranged on the rotary table, an upper punch and a lower punch are kept above and below the die in a condition of vertically slidable and powder material filled in the die hole is compressed and molded between a lower face of the upper punch and the upper face of the lower punch by pushing the upper punch and the lower punch so as to approach each other with their tips inserted into the die hole, and is characterized by comprising a device for spraying small amounts of liquid which sprays small amounts of liquid lubricant so as to adhere generally evenly to the lower face of the upper punch, the upper face of the lower punch and an inner face of the die hole prior to compression for molding.

[0008] In accordance with the arrangement, since the rotary compression molding machine is provided with the device for spraying small amounts of liquid which sprays small amounts of liquid lubricant generally evenly to the lower face of the upper punch, the upper face of the lower punch and the inner face of the die hole prior to compression to mold tablets, the liquid lubricant can adhere to the lower face of the upper punch, the upper face of the lower punch and the inner face of the die hole generally evenly by a small and the minimum necessary amount prior to compression of the powder material. In addition, since the liquid lubricant is sprayed and adheres to the lower face of the upper punch, the upper face of the lower punch and the inner face of the die hole generally evenly by a small and the minimum necessary amount, it is possible to prevent not only the

powder material from adhering to the upper and lower punches due to excessive liquid lubricant but also sticking without mixing the lubricant with the raw powder material beforehand.

[0009] Further, since no lubricant is mixed with the raw powder material, the compressed tablet is, especially in a case the raw powder material is medicine, not only sufficiently strong in hardness but also collapsible in a short time, thereby to manufacture the tablet which can be eluted easily. In addition, since the liquid lubricant is sprayed to the lower face of the upper punch, the upper face of the lower punch and the inner face of the die hole, it is possible to prevent diffusion of the liquid lubricant, thereby to avoid a problem of contamination. Further, unlike the one in which the lubricant alone is first compressed prior to compression of the powder material, the arrangement is free from problems such that a speed of compression to mold the tablet is lowered and that the machine becomes bigger and complicated. Thus arranged rotary compression molding machine is used for manufacturing mainly pharmaceuticals.

[0010] The device for spraying small amounts of liquid is preferable to comprise a storage tank which stores the liquid lubricant, a measuring portion which measures the liquid lubricant sent out from the storage tank by a given amount and a spraying portion which sprays the measured amount of the liquid lubricant. With this arrangement, the amount of the liquid lubricant to be sprayed can be measured based on a rotational speed of the rotary table. The device for spraying small amounts of liquid may further comprise a controller which sends the liquid lubricant measured by the measuring portion to the spraying portion by a predetermined amount. With this arrangement, the liquid lubricant can be sprayed with accuracy every time it is sprayed.

[0011] The measuring portion is preferable to comprise a flow controller which measures an amount of sprayed liquid lubricant by making use of temperature difference between two points where the liquid lubricant sent out from the storage tank passes. And the spraying portion is preferable to comprise a spray pipe which vaporizes the liquid lubricant sent out from the flow controller by means of pressure applied and an air compressor which supplies the spray pipe with pressurized air to apply pressure. With this arrangement, it is possible not only to measure small amounts of liquid lubricant with accuracy but also to vaporize and spray the liquid lubricant efficiently with a downsized device since no vaporizer is required.

[0012] With the above arrangement, as a timing to spray the liquid lubricant it is preferable that the liquid lubricant is sprayed to the lower face of the upper punch during a period of time from the die hole is in a condition of empty until the powder material is filled in the die hole and before the upper punch is inserted into the die hole and that the liquid lubricant is sprayed to the upper face of the lower punch and the inner face of the die hole during a period of time from the die hole is in a condition of empty until before the powder material is filled in the die hole. With this timing, the liquid lubricant can be sprayed in a condition that no powder material is in the die hole, thereby to prevent the liquid lubricant from mixed with the powder material.

[0013] The liquid lubricant is represented by that a substance having lubricity is dissolved in liquid, the substance disperses in liquid, the substance is emulsified and the substance having lubricity itself is liquid. More concretely, the liquid lubricant is represented by silicone emulsion. As mentioned above, if the liquid lubricant contains silicone, it is possible for the liquid lubricant to adhere in small amounts at least to the lower face of the upper punch and the upper face of the lower punch generally evenly, thereby to produce lubricity sufficiently in spite of small amounts. The silicone is represented by silicone oil such as KF96 made of dimethyl polysiloxane (trade name; manufactured by Shin-Etsu Chemical Co., Ltd.) and Dow Corning 360 Medical Fluid (trade name; manufactured by Dow Corning Corporation). The emulsion of the silicone oil is represented by KM787, KM740 (trade name; manufactured by Shin-Etsu Chemical Co., Ltd.) and Dow Corning 365, 35% Dimethicone NF Emulsion (trade mark; manufactured by Dow Corning Corporation). Liquid or paste silicone resin which is a mixture of dimethyl polysiloxane and silicone dioxide is represented by KS66, KS69, KM72 and KM72F (trade name; manufactured by Shin-Etsu Chemical Co., Ltd.).

[0014] It is preferable that the spray pipe is arranged at a position where a distal end of the spray pipe locates at least 13 mm higher than a level of a top face of the rotary table. More specifically, if the spray pipe is arranged so that the top thereof locates at the above-mentioned height, the liquid lubricant sprayed from the spray pipe diffuses so as to adhere to the lower face of the upper punch, the upper face of the lower punch and the die hole evenly at a time when the liquid lubricant reaches to the lower face of the upper punch, the upper face of the lower punch and the die hole. As a result, it is possible to spray the liquid lubricant effectively and to control scattering the surplus liquid lubricant to the minimum as well. The height of the spay pipe is adjusted according to a diameter of the molded product. More concretely, for example, the height of the spray pipe is set to be approximately 13.3 mm for a molded product whose diameter is 11 mm and that of the spray pipe is set to be approximately 18.1 mm for a molded product whose diameter is 15 mm.

[0015] In case the spray pipe is arranged at the above height, it is preferable that the liquid lubricant is sprayed at a spray angle of generally 45 degrees. If the liquid lubricant is sprayed at 45 degrees, the liquid lubricant diffuses to a range of a circle whose diameter generally equals to an outer diameter of the lower face of the upper punch, an outer diameter of the upper face of the lower punch and an inner diameter of the die hole when the sprayed liquid lubricant reaches the lower face of the upper punch, the upper face of the lower punch and

the die hole. As a result, it is possible to spray liquid lubricant effectively and to control scattering of the liquid lubricant to the minimum.

[0016] In order to prevent the liquid lubricant from adhering to unnecessary portion without fail, it is preferable that the rotary compression molding machine further comprises a retrieving device which retrieves surplus liquid lubricant. The retrieving device is represented by that comprising a spraying case which covers a part from which the liquid lubricant is sprayed and an absorbing device which absorbs the liquid lubricant overflowing the spraying case. With this arrangement comprising the retrieving device, it is possible to suppress the unnecessary liquid lubricant from adhering to the upper punch of the rotary table effectively, thereby to prevent deterioration of durability due to adherence of surplus liquid lubricant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a front cross-sectional view of a rotary compression molding machine for powder material showing one embodiment of the invention.

Fig. 2 is a schematic plane view showing a rotary table in the embodiment.

Fig. 3 is a cross-sectional front view showing the rotary table of the embodiment in a developed condition.

Fig. 4 is a block diagram showing an arrangement of a device for spraying small amounts of liquid in the embodiment.

Fig. 5 is a block diagram showing a general arrangement of a mass flow sensor in the embodiment.

Fig. 6 is a cross-sectional view of a spray pipe in the embodiment.

Fig. 7 is a cross-sectional view of a spray pipe in another embodiment of this invention.

Fig. 8 is a magnified plane view showing a lubricant spraying portion in the embodiment.

Fig. 9 is a cross-sectional end view taken along the line VIII-VIII in Fig. 8.

BEST MODES OF EMBODYING THE INVENTION

[0018] The invention will be described in detail with reference to an embodiment thereof shown in the accompanying drawings.

[0019] Fig. 1 shows a general arrangement of the rotary compression molding machine for powder material of the invention. The rotary compression molding machine for powder material has a device for spraying small amounts of liquid LS which sprays liquid lubricant L and a rotary table 3 is horizontally rotatably arranged in a frame 1 through an upright shaft 2, a plurality of dies 4 are arranged on the rotary table 3 at a predetermined pitch and upper punches 5 and lower punches 6 are vertically slidably kept above and below of each dies 4.

[0020] More specifically, the upright shaft 2 supported by a bearing 21 is arranged at a general center of the frame 1 and a worm wheel 22 is fixed near a bottom end of the upright shaft 2 so that rotational driving force of a motor 25 is transmitted to the worm wheel 22 through a worm 23 and a belt 24. The rotary table 3 which is divided into two functional parts is fixed near a head of the upright shaft 2. The rotary table 3 comprises an upper punch retaining portion 32 which is provided at the upper side thereof and retains the upper punches 5 in a vertically slidable condition and a die portion 33 which is provided at the lower side thereof and retains the lower punches 6 in a vertically slidable condition and provided with a plurality of die mounting holes for mounting the dies 4 detachably at positions facing to the upper punch retaining portion 32 on the same circle as that of the upper punch retaining portion 32. A plurality of punch retaining holes which hold the upper punches 5 and the lower punches 6 slidably are provided on the upper punch retaining portion 32 and the die portion 33. Each of the punch retaining holes and the die mounting holes are arranged so that centers of the lower punch 6, the upper punch 5 and the die 4 coincide with each other longitudinally on the rotary table 3. A big diameter portion is provided, as shown in Fig. 3, at an upper end of the upper punch 5 and a lower end of the lower punch 6 respectively and each of the upper punch 5 and the lower punch 6 is so arranged to make an up-and-down movement with its big diameter portion engaged and guided by a cam which will be described later. Longitudinally penetrating holes 41 are provided on the dies 4 in order to insert a tip of the upper punch 5 or the lower punch 6.

[0021] The rotary compression molding machine for powder material is, as shown in Fig. 2 and Fig. 3, provided with a filling portion 7, a leveling portion 8, a compressive molding portion 9, an unloading portion 10 and a lubricant spraying portion K sequentially along the direction of rotation.

[0022] The filling portion 7 introduces powder material which has been supplied on the rotary table 3 into the die 4 through a feed shoe 72 by lowering the lower punch 6 with a lowering device 71. The powder material is supplied on the rotary table 3 by means of a powder material supplying mechanism 73.

[0023] The leveling portion 8 raises the lower punch 6 to a predetermined level by means of an amount setting rail 82 and removes the powder material which has overflowed from the die 4 due to a rise of the lower punch 6 by means of a leveling plate 83.

[0024] The compressive molding portion 9 comprises an upper punch lowering cam 91 which lowers the upper punch 5 so as to insert a lower tip of the upper punch 5 into the die 4, upper and lower preliminary compression rollers 92, 93 which are to preliminarily compress the powder material filled in the die 4 with the upper and

lower punches 5, 6 each of whose lower and upper tips is inserted into the die 4 pushed from upside and downside to approach each other and upper and lower compression rollers 94, 95 which are to compress the powder material in the die 4 with the upper and lower punches 5, 6 pushed from upside and downside to approach each other in a full-scale manner.

[0025] The unloading portion 10 comprises, as shown in Fig. 2 and 3, an upper punch raising cam 100 which is to raise the upper punch 5 along a rising slant face so as to draw the tip of the upper punch 5 out of the die 4, a pushing up rail 106 which urges the lower punch 6 upward so that a tablet Q in the die 4 can be completely pushed out of the die 4 and a guide plate 105 which guides the tablet Q aside so as to introduce the tablet Q into a shoot 104.

[0026] The lubricant spraying portion K is so formed that a spray pipe SP which constitutes a spraying portion S of the device LS for spraying small amounts of liquid extends upward of the rotary table 3.

[0027] The device LS for spraying small amounts of liquid comprises a storage tank P which stores liquid lubricant L, for example, in a pressurized condition, a measuring portion C which measures the liquid lubricant L sent out from the storage tank P by a predetermined amount and a spraying portion S which sprays the measured liquid lubricant L. The storage tank P, the measuring portion C and the spraying portion S are connected by a liquid line F. In this embodiment the device LS for spraying small amounts of liquid is to spray the liquid lubricant L at a constant flow and the constant flow is set in accordance with a rotational speed (a number of revolution) or an amount to be used of the processed powder. The device LS for spraying small amounts of liquid is so arranged that an amount to be sprayed is digitalized so as to be output to a computer CC which controls the amount to be sprayed. The liquid lubricant L may be sprayed intermittently corresponding to a rotation of the rotary table 3, namely to be sprayed to each of the upper punches 5, lower punches 6 and dies 4 respectively. As the liquid lubricant L, for example, silicone emulsion is used. The liquid lubricant L is not limited to this, but it may be a stock solution of silicone, or a diluted solution of silicone or a diluted solution of silicone emulsion.

[0028] The storage tank P is so arranged that the liquid lubricant L stored in the storage tank P is sent out from a bottom thereof. In other words, the storage tank P can send the relatively high viscous liquid lubricant L from a discharge orifice provided at the bottom thereof by pressurizing a surface of the liquid lubricant L at a predetermined air pressure since above the surface is kept in an airtight condition when the liquid lubricant L is stored. The air pressure applied to the storage tank P is determined based on the viscosity and the amount of the liquid lubricant L to be sprayed.

[0029] The measuring portion C measures the liquid lubricant L sent out from the storage tank P based on temperature difference. More specifically, the measuring portion C comprises a flow controller FC which measures an amount of the liquid lubricant L to be sprayed by making use of temperature difference between two points where the liquid lubricant L sent out from the storage tank P passes.

[0030] The flow controller FC basically comprises, as shown in Fig. 5, a mass flow sensor MF, a control valve CV, a microcomputer CPU provided with EEPROM, an A/D converter AD, a D/A converter DA and a valve driver VD. And a preset input device PI and a zero adjusting input device ZI to set an amount to be spread are connected to the microcomputer CPU. The flow amount of the liquid lubricant L is measured based on the temperature of the liquid lubricant L. More specifically, the control valve CV is driven on-off so as to be open and closed at a very short cycle, then temperature difference of the liquid lubricant L between two points each spaced apart by a unit distance is calculated when the liquid lubricant L flows and the flow amount is measured based on the result of calculation.

[0031] In other words, for example, when the liquid lubricant L heated by a heater which is not shown in drawings flows into the mass flow sensor MF, temperature of the liquid lubricant L is measured at two points each spaced apart by a unit distance. The temperatures measured at two points are transformed into digital data by the A/D converter AD, and then temperature difference is calculated by the microcomputer CPU and a flow rate of the liquid lubricant L is measured by means of the temperature difference. The microcomputer CPU controls the flow rate of the liquid lubricant L with an open-close movement of the control valve CV through the D/A converter DA so as to be the flow rate set by, for example, a computer CC. As a result, the microcomputer CPU, the D/A converter DA and the control valve CV constitute a control unit in this embodiment. In addition, the flow rate of the liquid lubricant L is, for example, approximately 0.5cc/minute. Since the flow rate varies according to a concentration of the liquid lubricant L, it is not limited to the above value. The flow rate is set based on a rotational speed of the rotary table 3 or a number of the dies 4. The liquid lubricant L may be cooled down instead of heated so as to measure the flow rate.

[0032] The measured liquid lubricant L is sent from the control valve CV to the spraying portion S through the liquid line F. The spraying portion S comprises a spray pipe SP which evaporates the liquid lubricant L sent out from the flow controller FC by pressure applied and an air compressor AP which supplies pressurized air with the spray pipe SP. The air compressor AP compresses the air so as to be at a predetermined pressure and sends out the pressurized air kept at the predetermined pressure. The liquid lubricant L can be sprayed evenly because the liquid lubricant L is pressurized by the air compressor AP.

[0033] The spray pipe SP comprises, as shown in Fig.

6, a liquid storage SP1, a spraying inner pipe SP2 which projects out from the liquid storage SP1 and inside of which the liquid lubricant L flows, the spraying outer pipe SP3 which is provided to cover outer circumference of the spraying inner pipe SP2 wherein pressurized air flows in a gap between the spraying inner pipe SP2 and the spraying outer pipe SP3 and a spraying nozzle SP4 which is connected through the spraying inner pipe SP2 and the spraying outer pipe SP3 and which draws the liquid lubricant L in the spraying inner pipe SP2 from the spraying outer pipe SP3 in a decompressed condition by means of the pressurized air. The spraying nozzle SP4 has a hole SP41 for discharging the liquid lubricant L on a center thereof and a plurality of holes SP42 for discharging pressurized air from the spraying outer pipe SP3 are provided to surround the hole SP41. The air discharged from the holes SP42 forms a spiral air current near the hole SP41 and forms a space of a low atmospheric pressure near the hole SP41. As a result, the liquid lubricant L is decompressed instantly by being discharged into the space of the low atmospheric pressure, thereby to be vaporized and sprayed.

[0034] The spray pipe SP is arranged between the unloading portion 10 and the filling portion 7, namely at the lubricant spraying portion K. The spray pipe SP for spraying liquid lubricant L over the upper punch 5 is arranged with its hole SP41 facing upward and the spray pipe SP for spraying liquid lubricant L over the lower punch 6 and the die hole 41 is arranged with its hole SP41 facing downward. In this embodiment, the liquid lubricant L is sprayed after the lower punch 6 push the tablet Q so as to be out of the die 4 and at the time when the die hole 41 is in a condition of being able to be filled with powder, in other word, just before the lower punch 6 is lowered by the lowering device 71. As a result, the spray pipe SP for the lower punch 6 is arranged at a position closer to the filling portion 7 than the spray pipe SP for the upper punch 5, namely an advanced position along a direction of rotation. The position where the spray pipes SP are arranged is to secure enough time for drying the liquid lubricant L which is sprayed and which adheres to the lower face 5a of the upper punch 5, the upper face of the lower punch 6 and the inner face 41a of the die hole 41 prior to filling the power material. Each of the holes SP41 is arranged so that the center thereof coincides with a track of a center of the upper and the lower punches 5, 6.

[0035] Next operation of the rotary compression molding machine for powder material will be explained with reference to Fig. 3. Each of T0 ~ T5 in Fig. 3 means a phase. The upper and the lower punches 5, 6 are kept at the highest position in a step when passing the unloading portion 10 (T0). Next, the upper and the lower punches 5, 6 move to the lubricant spraying portion K by rotation of the rotary table 3 with the position of the upper and the lower punches 5, 6 kept the highest (T1). At this position, the device LS for spraying small amounts of liquid sprays the liquid lubricant L to the upper punch 5. When the rotary table 3 rotates, the lower punch 6 is lowered by an amount corresponding to thickness of the tablet Q at a front end portion of the lowering device 71. At this position, the device LS for spraying small amounts of liquid sprays the liquid lubricant L to the lower punch 6 and the die 4 (T2). As a result, the liquid lubricant L can adhere to the upper face 6a of the lower punch 6 and the inner face of the die hole 41 by the depth corresponding to the thickness of the tablet Q.

[0036] As mentioned above, since the liquid lubricant L is sprayed when the upper punch 5 is kept highest, the liquid lubricant L sprayed from the spray pipe SP adheres to the lower face 5a of the upper punch 5. Then since the lower punch 6 paired with the upper punch 5 passes below the spray pipe SP with the above-mentioned position kept, the liquid lubricant L sprayed from the spray pipe SP adheres to the lower punch 6 and the inner face 41a of the die hole 41. Since the amount of the sprayed liquid lubricant L is measured by the measuring portion C, the liquid lubricant L adheres evenly to general whole area of the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and the inner face of the die hole 41 by a predetermined depth. The liquid lubricant L adheres to the upper and the lower punches 5, 6 and the die 4 and then volatilizes a part of a solution of the liquid lubricant L by the time the powder material is filled so that the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and the inner face 41a of the die hole 41 are dried. As a result, each of the faces 5a, 6a, and 41a is not wet with the liquid lubricant L even though the liquid lubricant L is sprayed thereto, resulting in no powder material adhering to the faces 5a, 6a, and 41a.

[0037] Next, when the lower punch 6 moves to the filling portion 7 due to rotation of the rotary table 3, the lower punch 6 is first lowered to a middle position under the guidance of a front half of the lowering device 71 and then to a further lower position under the guidance of a rear half thereof (T3). On its way the powder material supplied on the rotary table 3 by the powder material supplying mechanism 73 is evenly introduced by making use of guide by the feed shoe 72. Then the lower punch 6 runs up onto an amount-setting rail 82, which raises the lower punch 6 until it reaches a predetermined height and a predetermined amount of powder material is filled into the die 4. The powder material which has overflowed from the die 4 is leveled when it passes through the leveling plate 8 and gathered toward the center of the rotary table 3. During this process, the upper punch 5 is kept at the highest position by a guide rail 102.

[0038] Next, the upper punch 5 is lowered (T4) under the guidance of the upper punch lowering cam 91 so as to insert the tip thereof into the die 4. Then the powder material in the die 4 is compressed and molded into the tablet Q by the upper and lower punches 5, 6 which pass between the upper and lower preliminary compression rollers 92, 93 and the upper and lower compression roll-

ers 94, 95 (T5).

[0039] After the tablet Q is molded, the upper punch 5 is raised under the guidance of the upper punch raising cam 100 so as to be withdrawn out of the die 4, and then the tablet Q in the die 4 is pushed upward so as to come out on the rotary table 3 by the lower punch 6 pushed by the pushing up rail 106. The tablet Q is guided onto a shoot 104 by the guide plate 105 and introduced out of the rotary compression molding machine for powder material. Next, the upper punch 5 is further raised under the guidance of the upper punch raising cam 100. As mentioned above, the rotary compression molding machine for powder material can produce a predetermined tablet Q repeatedly and successively with the powder material compressed and molded.

[0040] In accordance with thus arranged rotary compression molding machine for powder material of this embodiment, since the liquid lubricant L adheres evenly to portions which contact with the powder material, namely the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and the inner face 41a of the die 4 prior to compression every time the powder material is compressed, it is possible to prevent the powder material from sticking thereto without mixing powder lubricant with the powder material. In addition, since the sprayed amount of the liquid lubricant L is small and the minimum necessary to prevent sticking, the liquid lubricant L is atomized and a part of the solvent of the liquid lubricant L is volatilized and the liquid lubricant L is dried, it is possible to prevent the powder material from adhering to the upper punch 5, the lower punch 6 or the die hole 41 even though the liquid lubricant L is attached to the upper punch 5, the lower punch 6 or the die hole 41. As a result, it is possible to manufacture the tablet Q having sufficient hardness made of powder material mixed with no lubricant. Further, since the liquid lubricant L is sprayed to near the lower face 5a of the upper punch 5 and the upper face 6a the lower punch 6 by small amounts, it is possible to prevent contamination and to adhere the liquid lubricant L evenly with ease.

[0041] The rotary compression molding machine for powder material of the invention can be arranged just by providing an existing rotary compression molding machine with a very simple change that the lowering device 71 of the lubricant spraying portion K is modified, the spray pipe SP is arranged at a predetermined position and the storage tank P, the flow controller FC, the air compressor AP and the liquid line F are added. As a result, unlike the one in which the lubricant alone is first compressed prior to compression of the powder material, the arrangement is free from problems such that a performance of compression to mold the tablet is lowered and that the machine becomes bigger and complicated due to necessity of complicated compression mechanism.

[0042] With the above arrangement, experimental results of a case in which tablets Q are actually molded will be , explained, however, this invention is not limited to this.

[0043] Experimental result-1. 500 ml of die lubricant of Silicone Emulsion Type KM-787 (trade name: manufactured by Shin-Etsu Chemical Co., Ltd.) as the liquid lubricant L was put in the storage tank P and the flow rate was controlled by the flow controller FC including the mass flow sensor MF comprising two liquid mass flow meters (LM2100: manufactured by LINTEC CO., LTD.) for the upper and lower punches 5, 6 and the die 4 and the control valve CV comprising control valves (CV-1100: manufactured by LINTEC CO., LTD.) in a condition pressurized by the pressurized air (0.04 MPa). Then the powder material containing Neusilin (composition: Neusilin 20%, Avicel 40%, milk sugar 40%) was compressed and molded together with the liquid lubricant L sprayed to the upper and lower punches 5, 6 and the die hole 41 by the use of the upper punch 5 whose lower face 5a was concave of a diameter of 8 mm (with 6 lines carved radially) and the lower punch 6 whose upper face was concave like the shape of the lower face 5a of the upper punch 5 (with 12 lines carved radially), at a revolutionary number of 30 rpm and a compressive pressure of 5.9 kN/cm^2 by the rotational compression molding machine for powder material on which the device LS for spraying small amounts of liquid was mounted. Scattered powder material due to spray of the liquid lubricant L was collected with a dust collector (not shown in drawings).

[0044] The powder material was compressed and molded after the liquid lubricant L was continuously sprayed at a rate of 0.15 g/min. to the lower face 5a of the upper punch 5 and at a rate of 0.30 g/min. to the upper face 6a of the lower punch 6 and the die hole 41, and then neither capping to tablets nor adherence of powder containing Neusilin to the lower face 5a of the upper punch 5 and the upper face 6a of the lower punch 6 was detected.

[0045] Experimental Result-2. 500 ml of silicone emulsion 365, 35% Dimethicone NF Emulsion (trade name: manufactured by Dow Corning Corporation) as the liquid lubricant L was put in the storage tank P and the powder material containing Neusilin was compressed and molded as the same way as that of the experimental result-1. The powder material was compressed and molded after the liquid lubricant L (Silicone Emulsion 365, 35% Dimethicone NF Emulsion) was sprayed at a rate of 0.1 g/min. to the lower face 5a of the upper punch 5 and at a rate of 0.20 g/min. to the upper face 6a of the lower punch 6 and the die hole 41. As a result neither capping to tablets nor adherence of the powder material containing Neusilin to the lower face 5a of the upper punch 5 and the upper face 6a of the lower punch 6 was detected, thereby to be a good result.

[0046] Experimental Result-3. 500 ml of silicone oil KF-96ADF (trade name: manufactured by Shin-Etsu Chemical Co., Ltd.) as the liquid lubricant L was put in the storage tank P and the powder material containing

Neusilin was compressed and molded as the same way as that of the experimental result-1. The powder material was compressed and molded after the liquid lubricant L (silicone oil KF-96ADF) was sprayed at a rate of 0.3 g/min. to the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and the die hole 41. As a result neither capping to tablets nor adherence of the powder material containing Neusilin to the lower face 5a of the upper punch 5 and the upper face 6a of the lower punch 6 was detected, thereby to be a good result.

Comparative Result

[0047] Without spraying the liquid lubricant L by the device LS for spraying small amounts of liquid, the powder material containing Neusilin (composition: Neusilin 20%. Avicel 40%, milk sugar 40%) was compressed and molded by the rotational compression molding machine for powder material on which the same upper punch 5 the lower punch 6 as those of the experimental result-1 are mounted, at a revolutionary number of 30 rpm and a compressive pressure of 5.9 kN/cm^2. As a result capping to tablets occurred immediately and adherence of the powder material containing Neusilin to the upper punch 5 and the lower punch 6 was detected.

[0048] This invention is not limited to the above-explained embodiments.

[0049] The spay pipe may be provided with nozzles at an upper and a lower sides of the front tip thereof. More specifically, as shown in Fig. 7, the spray pipe SPB comprises, like the above embodiment, a liquid storage SPB1, a spraying inner pipe SPB2 which projects out from the liquid storage SPB1 and inside of which the liquid lubricant L flows and the spraying outer pipe SPB3 which is provided to cover outer circumference of the spraying inner pipe SPB2 wherein pressurized air flows in a gap between the spraying inner pipe SP2 and the spraying outer pipe SPB3 and has a spraying upper nozzle SPB41a and a spraying lower nozzle SPB41b each of which sprays the liquid lubricant L at the front tip of the spraying outer pipe SPB3. The spray pipe SPB is arranged at a position where a distal end of the spray pipe SPB locates at least 13mm higher than a top face level of the rotary table 3. More specifically, for a tablet as a compressed product whose diameter is 11 mm, the position where the distal end of the spray pipe SPB is set to locate at approximate 13.3 mm higher than the top face level of the rotary table 3. The distal end of the spraying outer pipe SPB3 is closed by a cap member SPB3a. The spraying upper nozzle SPB41a is provided to face upward, namely, to the upper punch 5 and the spraying lower nozzle SPB41b is provided to face downward, namely, to the lower punch 6 when the spray pipe SPB is mounted. Bore diameter of the spraying upper and lower nozzles SPB41a, SPB41b is set, for example, 0.7mm. The liquid lubricant L sprayed from the spraying upper and lower nozzles SPB41a, SPB41b is sprayed from the center of the spraying upper and lower nozzles SPB41a, SPB41b radially at a spray angle of generally 45 degrees. As mentioned above, since the spray pipe SPB has the spraying upper and lower nozzles SPB41a, SPB41b at two positions vertically, only one flow controller FC is required to be connected to the spray pipe SPB, namely, there is no need of comprising two flow controllers FC for the measuring portion C of the device LS for spraying small amounts of liquid. As a result, one air compressor AP will do.

[0050] In this embodiment, as shown in Figs. 8 and 9, the lubricant spraying portion K is covered by a spray case JC which is formed to surround the spray pipe SPB in order to prevent the surplus liquid lubricant L from scattering over a wide area inside the rotary compression molding machine for powder material. The spray case JC is connected to the dust collector VD which retrieves the surplus liquid lubricant L scattering inside the spray case JC. A bottom face of the spray case JC is secured to be airtight to the rotary table 3 by a seal member SL. A retrieving device is formed by the spray case JC and the dust collector VD.

[0051] The spray case JC is mounted on the guide plate 105 and has a storing space portion JVa which stores the spray pipe SPB and a retrieving space portion JVb which is connected through the storing space portion JVa and which is to be filled with the surplus liquid lubricant L. A through hole TH which is arranged on a line connecting the spraying upper nozzle SPB41a of the spray pipe SPB and the upper punch 5 is provided on a top face of the storing space portion JVa and an air spouting outlet Aca for an air curtain AC to prevent the sprayed liquid lubricant L from going upward is arranged at a position facing the retrieving space portion JVb. The air curtain AC is formed at a position higher than the lower face 5a of the upper punch 5 and does not prevent the liquid lubricant L from adhering to the lower face 5a of the upper punch 5. An inlet JVc for taking the air curtain AC is formed at a bottom end of the upright face of the retrieving space portion JVb facing the through hole TH. A retrieving duct RD connecting through the retrieving device which absorbs and retrieves the surplus liquid lubricant L filled in the spray case JC is connected with an upper face of an end facing the inlet JVc of the retrieving space portion JVb. As mentioned above, since the air curtain AC is formed above the lower face 5a of the upper punch 5, it is possible to prevent the liquid lubricant L from going upward above the lower face 5a of the upper punch 5, thereby to prevent the liquid lubricant L from adhering to the upper punch 5 or its surroundings. In this embodiment, a bellow BL whose trunk portion is made of a flexible material covers a trunk portion of the upper punch 5 so that the liquid lubricant L does not adhere to a bottom of the trunk portion.

[0052] In this arrangement, the spray pipe SPB is mounted so that the liquid lubricant L is sprayed to the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and the die hole 41 after the lower

punch 6 pushes the tablet Q out of the die 4 and at a time when the die hole 41 is ready to be filled with the powder material, in other word, just before the lower punch 6 is lowered by the lowering device 71.

[0053] In accordance with this arrangement, since the liquid lubricant L is sprayed to the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and the die hole 41 at the same time, it is possible to reduce a number of the flow controller FC to one in comparison with the above embodiment, thereby to simplify the arrangement of the device LS. In addition, since the liquid lubricant L is prevented from scattering and is retrieved by the use of the spray case JC, it is possible to prevent effectively the surplus liquid lubricant L from adhering to the upper punch 5 and the rotary table 3, thereby to make maintenance easy.

[0054] The spray case JC can be applied to the above-mentioned embodiment having two spray pipes SP. Likewise, the bellow BL which covers the trunk portion of the upper punch 5 may be applied to the above-mentioned embodiment.

[0055] The other arrangement of the component is not limited to the embodiment described in drawings and there may be various modifications without departing from the spirit of the invention.

POSSIBLE APPLICATIONS IN INDUSTRY

[0056] As mentioned above, the rotary compression molding machine for powder material is preferably used for molding a compressed product including a medical tablet, food or toiletry.

[0057] In a rotary compression molding machine for powder material, a rotary table 3 is rotatably arranged in a frame 1 through an upright shaft 2, a die 4 having a die hole 41 is arranged on the rotary table 3, an upper punch 5 and a lower punch 6 are kept above and below the die 4 in a condition of vertically slidable and powder material filled in the die hole 41 is compressed and molded between a lower face 5a of the upper punch 5 and the upper face 6a of the lower punch 6 by pushing the upper punch 5 and the lower punch 6 so as to approach each other with their tips inserted into the die hole 41, and provided with a device LS for spraying small amounts of liquid which sprays small amounts of liquid lubricant L generally evenly on the lower face 5a of the upper punch 5, the upper face 6a of the lower punch 6 and an inner face 41a of the die 4 prior to compression for molding.

Claims

1. A rotary compression molding machine for powder material wherein a rotary table is rotatably arranged in a frame through an upright shaft, a die having a die hole is arranged on the rotary table, an upper punch and a lower punch are kept above and below the die in a condition of vertically slidable and powder material filled in the die hole is compressed and molded between a lower face of the upper punch and an upper face of the lower punch by pushing the upper punch and the lower punch so as to approach each other with their tip inserted into the die hole, **characterized by** comprising a device for spraying small amounts of liquid which sprays small amounts of liquid lubricant so as to adhere generally evenly to the lower face of the upper punch, the upper face of the lower punch and an inner face of the die hole prior to compression for molding.

2. The rotary compression molding machine for powder material described in claim 1 and **characterized by** that the rotary compression molding machine for powder material is used for manufacturing mainly pharmaceuticals.

3. The rotary compression molding machine for powder material described in claim 1 or 2 and **characterized by** that the device for spraying small amounts of liquid comprises a storage tank which stores the liquid lubricant, a measuring portion which measures the liquid lubricant sent out from the storage tank by a given amount and a spraying portion which sprays the measured amount of the liquid lubricant.

4. The rotary compression molding machine for powder material described in claim 3 and **characterized by** that the device for spraying small amounts of liquid further comprises a controller which sends the liquid lubricant measured by the measuring portion to the spraying portion by a given predetermined amount.

5. The rotary compression molding machine for powder material described in claim 3 or 4, and **characterized by** that the measuring portion comprises a flow controller which measures an amount of sprayed liquid lubricant by making use of temperature difference between two points where the liquid lubricant sent out from the storage tank passes and that the spraying portion comprises a spray pipe which vaporizes the liquid lubricant sent out from the flow controller by means of pressure applied and an air compressor which supplies the spray pipe with pressurized air for application of pressure.

6. The rotary compression molding machine for powder material described in claim 1, 2, 3, 4 or 5, and **characterized by** that the liquid lubricant is sprayed to the lower face of the upper punch during a period of time from the die hole is in a condition of empty until the powder material is filled up in the die hole and before the upper punch is inserted into the die hole and that the liquid lubricant is sprayed to the

upper face of the lower punch and the inner face of the die hole during a period of time from the die hole is in a condition of empty until before the powder material is filled in the die hole.

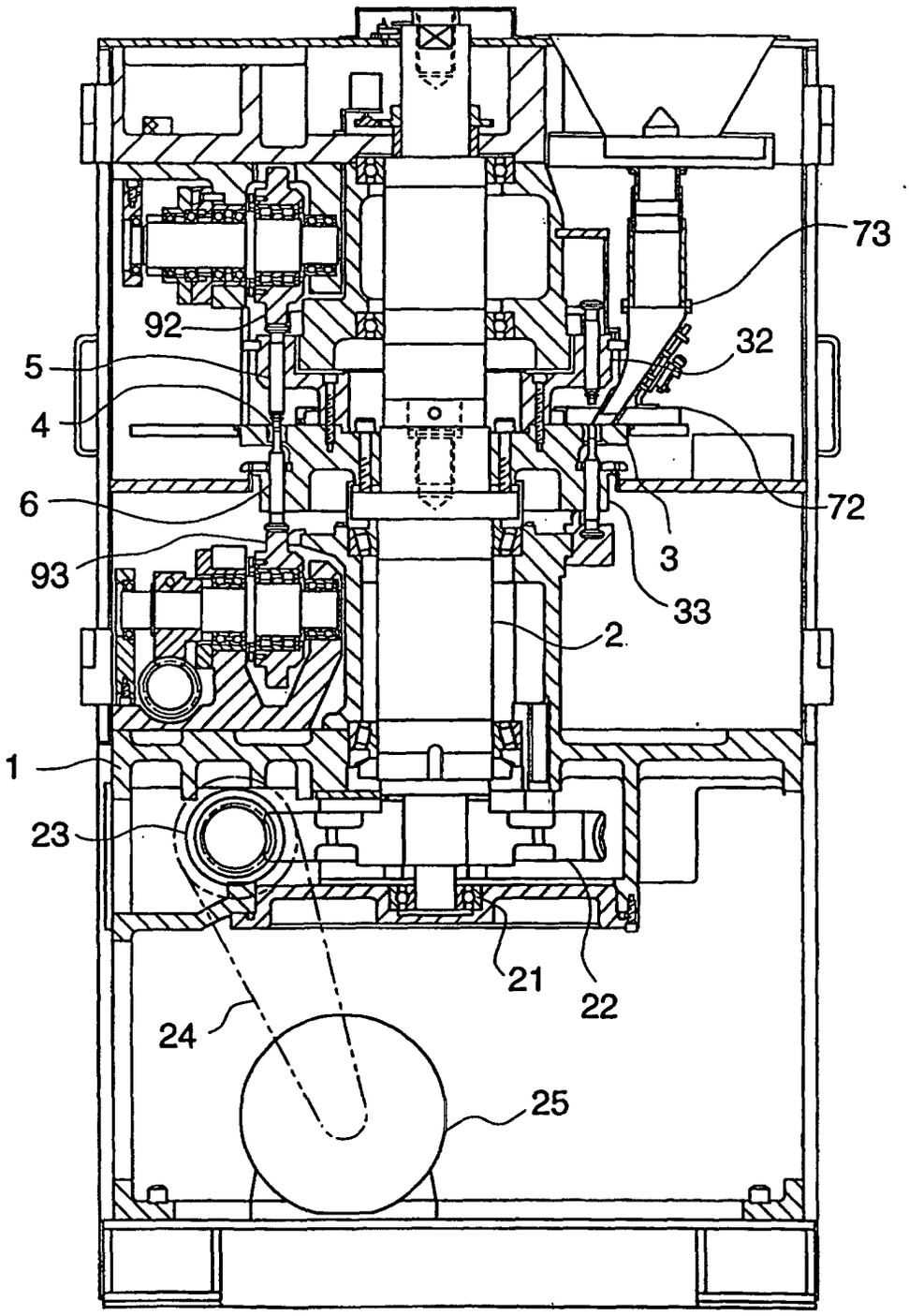
7. The rotary compression molding machine for powder material described in claim 1, 2, 3, 4, 5 or 6, and **characterized by** that the liquid lubricant contains silicone.

8. The rotary compression molding machine for powder material described in claim 5, and **characterized by** that the spray pipe is arranged at a position where a distal end of the spray pipe locates at least 13 mm higher than a level of a top face of the rotary table.

9. The rotary compression molding machine for powder material described in claim 1, 2, 3, 4, 5, 6, 7 or 8, and **characterized by** that the liquid lubricant is sprayed at a spray angle of generally 45 degrees.

10. The rotary compression molding machine for powder material described in claim 1, 2, 3, 4, 5, 6, 7, 8 or 9, and **characterized by** that further comprising a retrieving device that retrieves surplus liquid lubricant after the liquid lubricant is sprayed.

Fig. 1



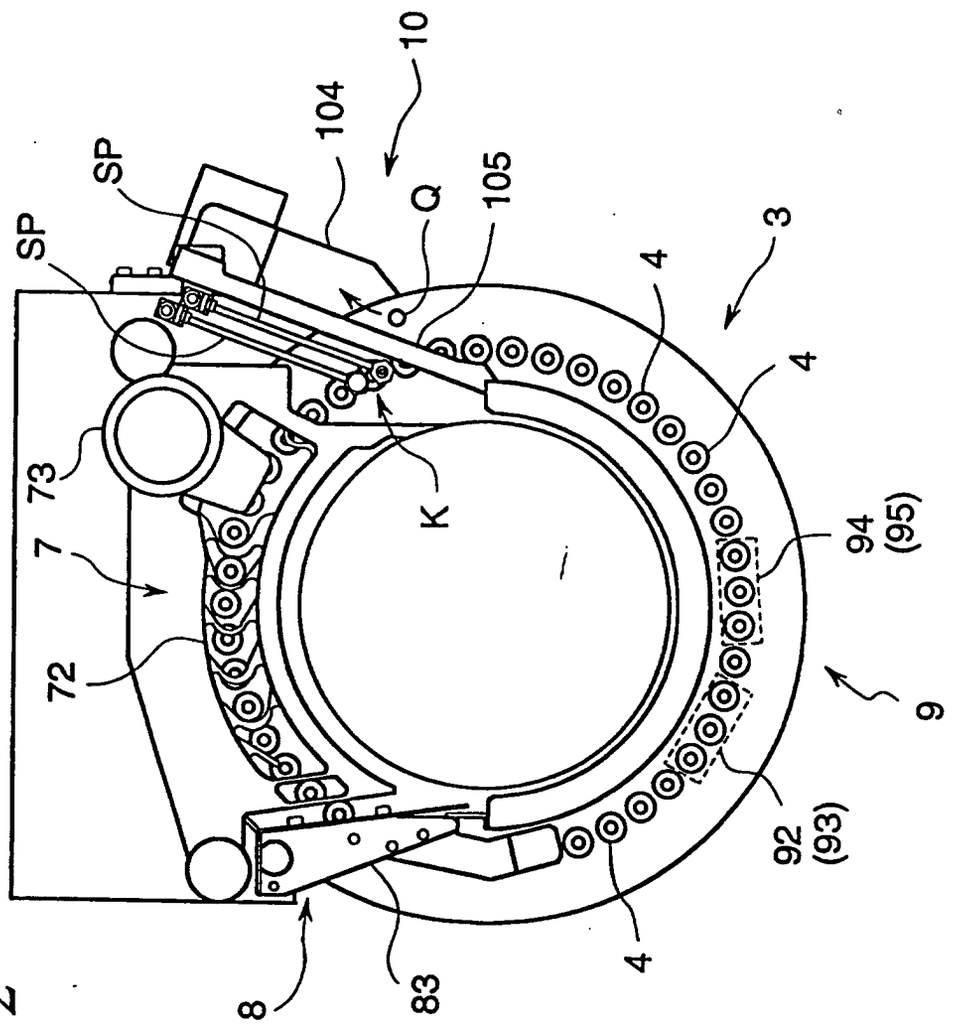
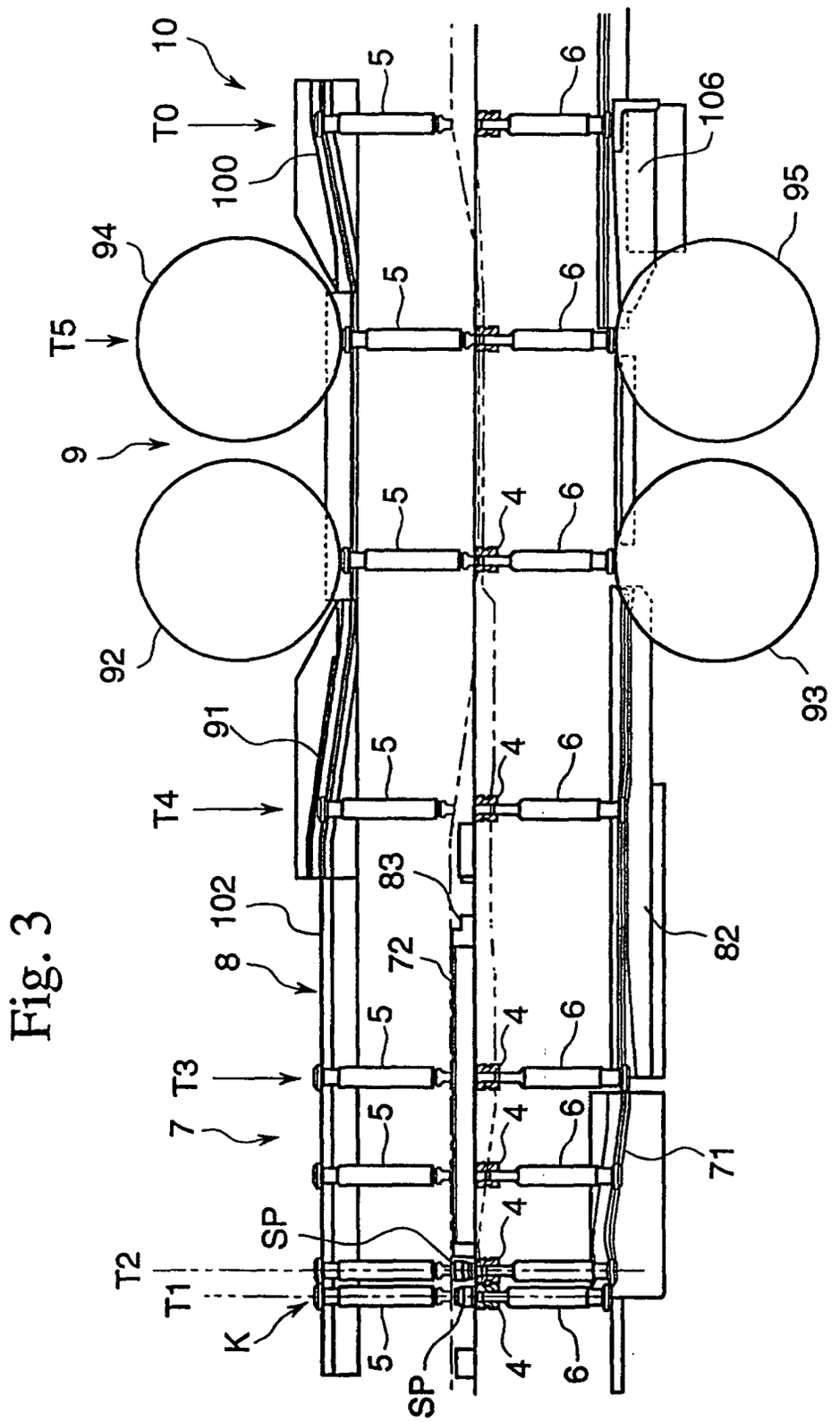


Fig. 2

Fig. 3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K
4

Fig. 4

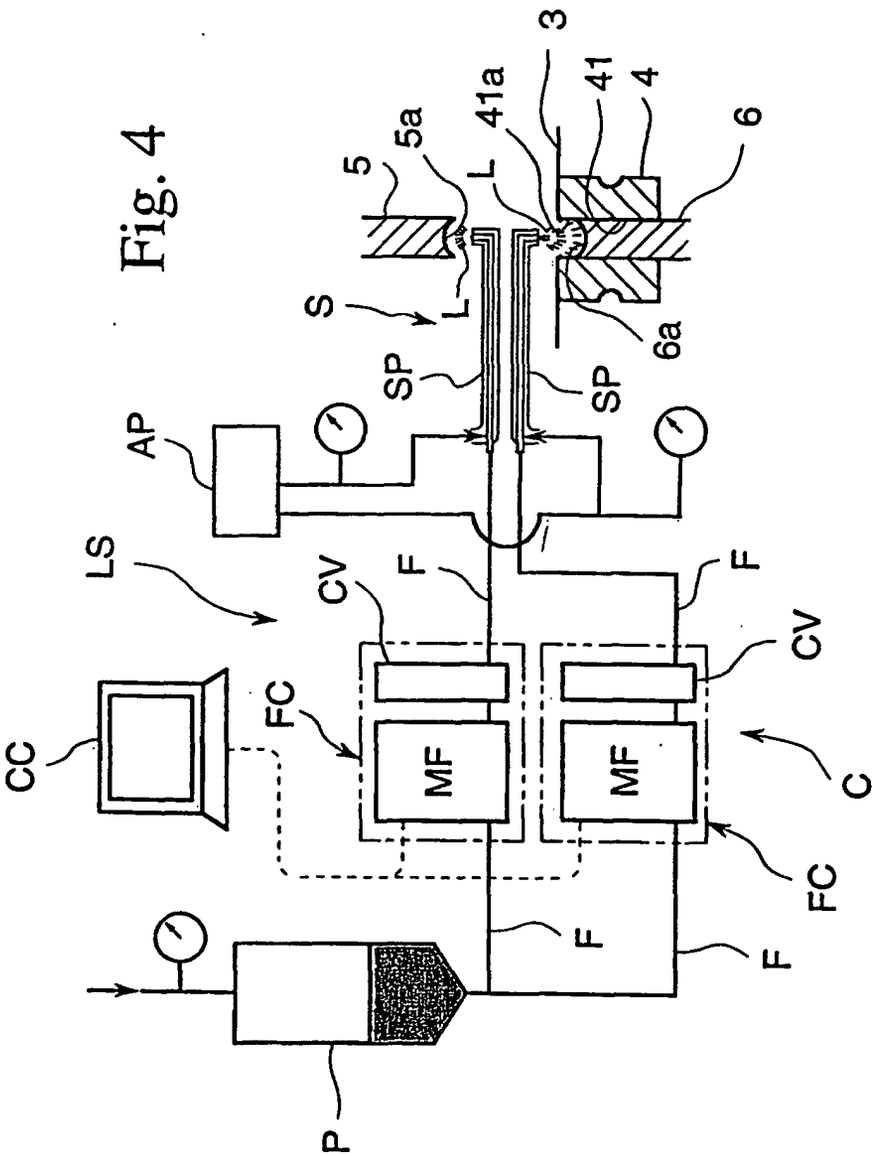
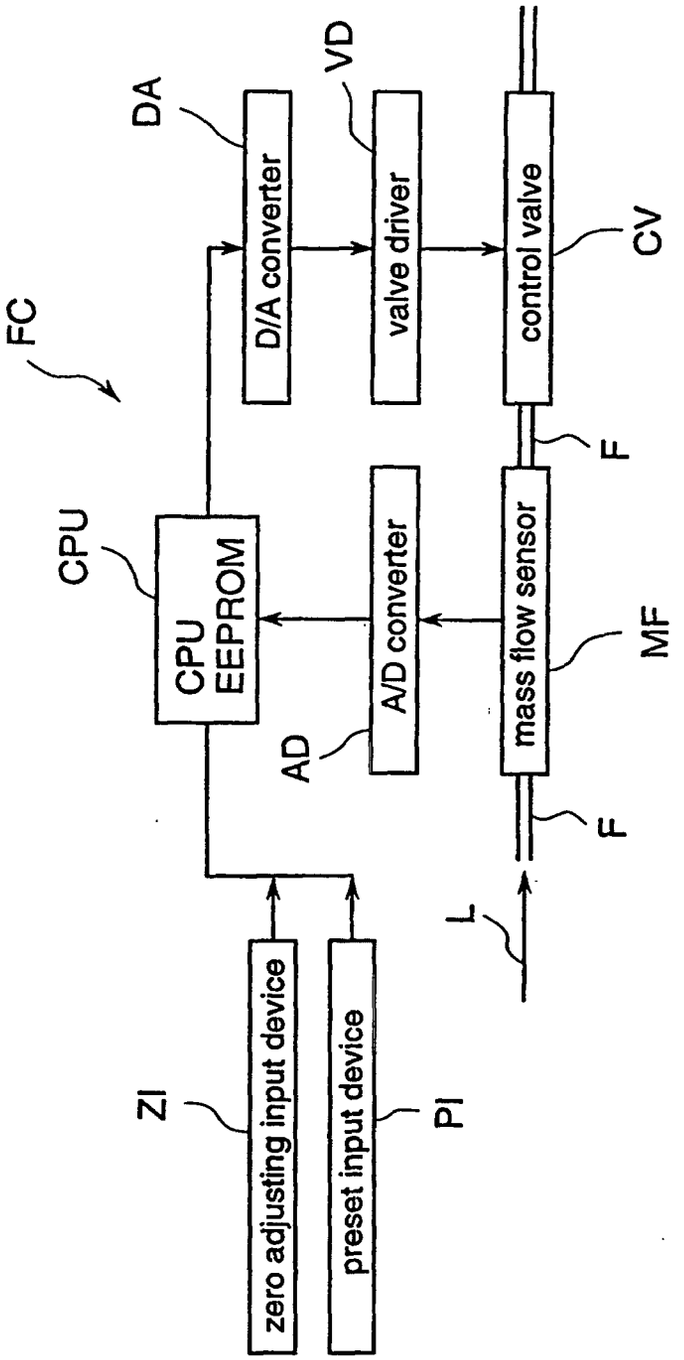


Fig. 5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VD
D/A converter
valve driver
control valve
CV
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CPU
EEPROM
A/D converter
AD
mass flow sensor
MF
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ZI
zero adjusting input device
preset input device
PI

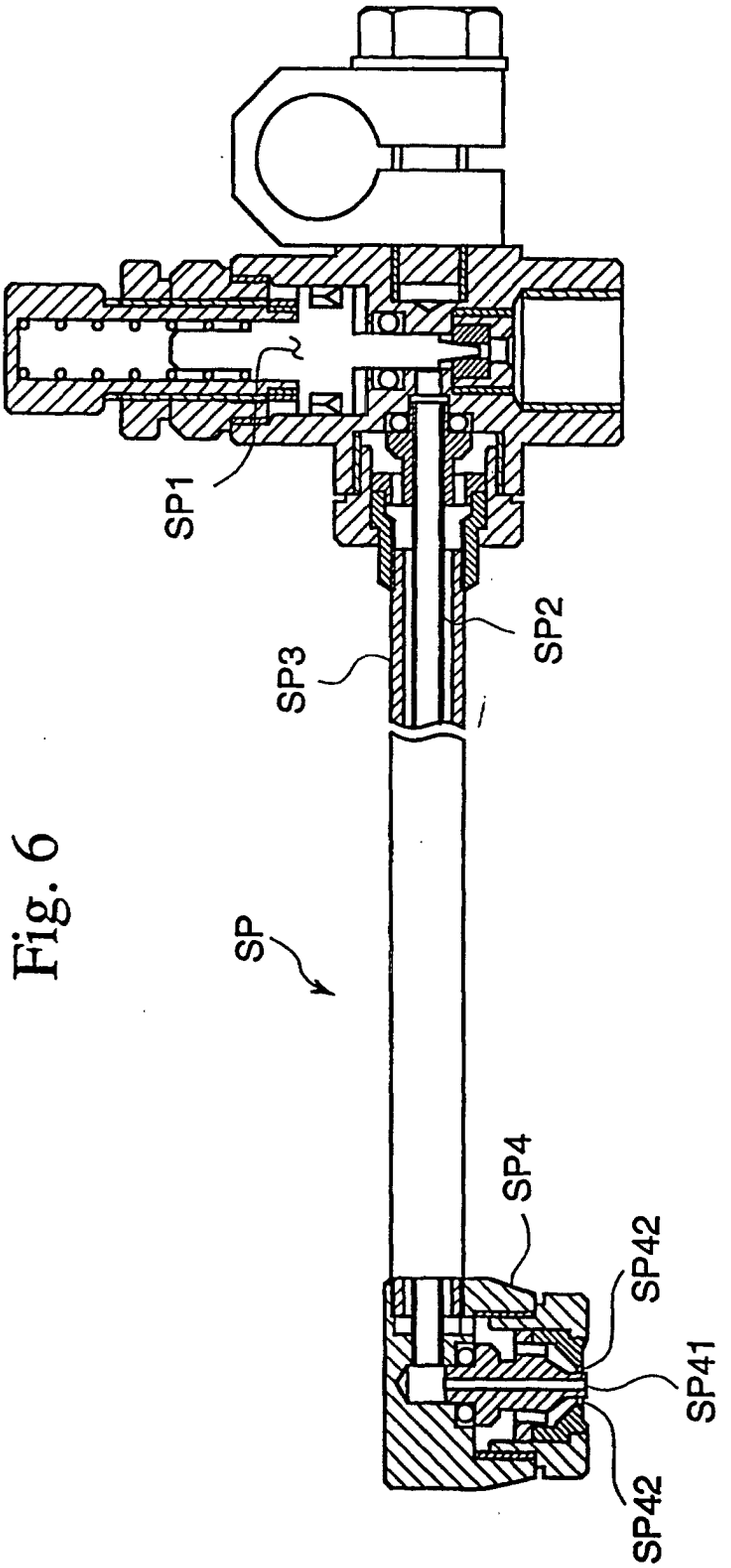


Fig. 6

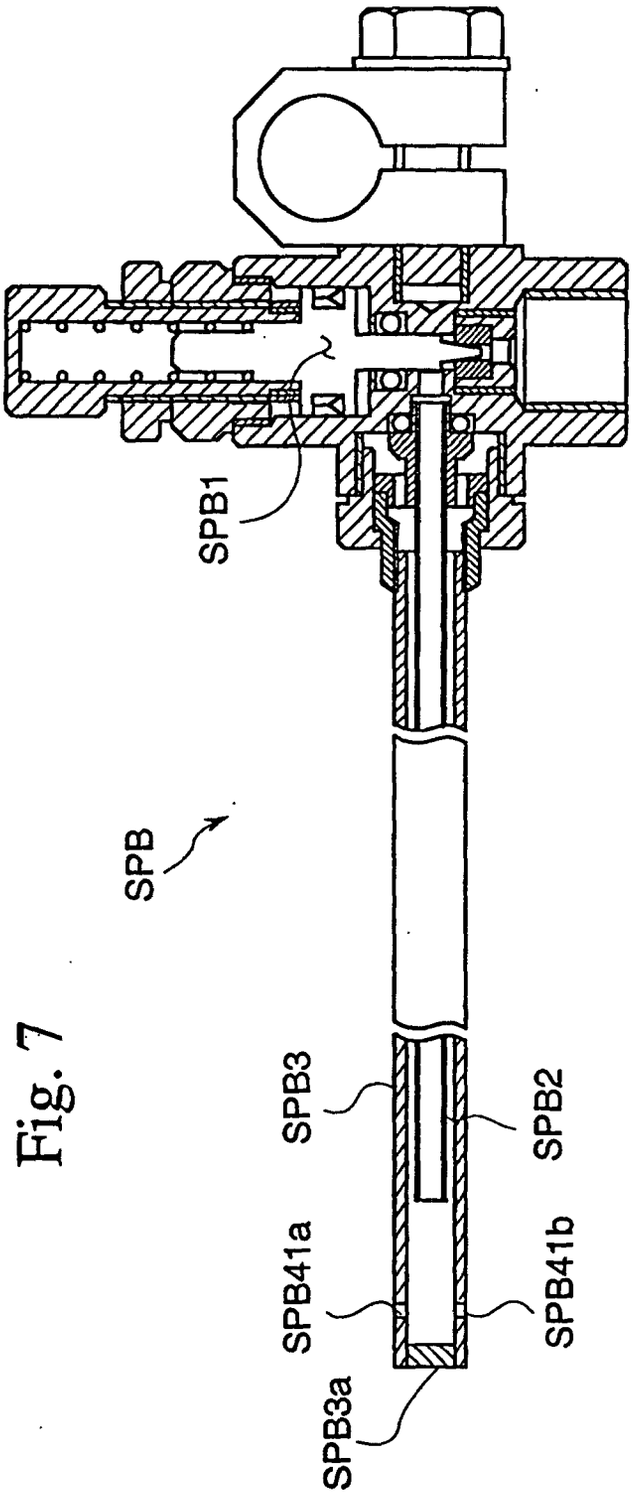


Fig. 7

Fig. 8

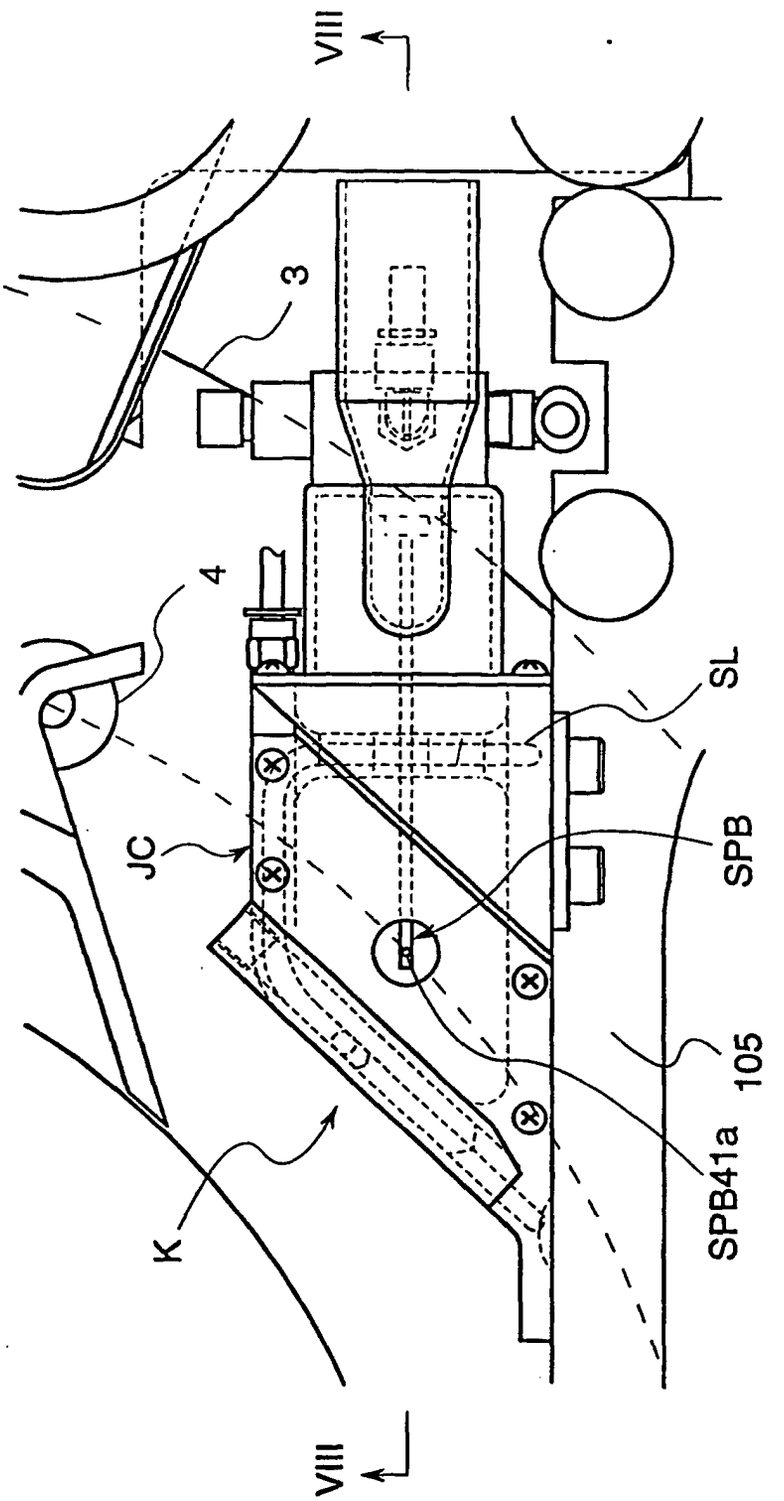
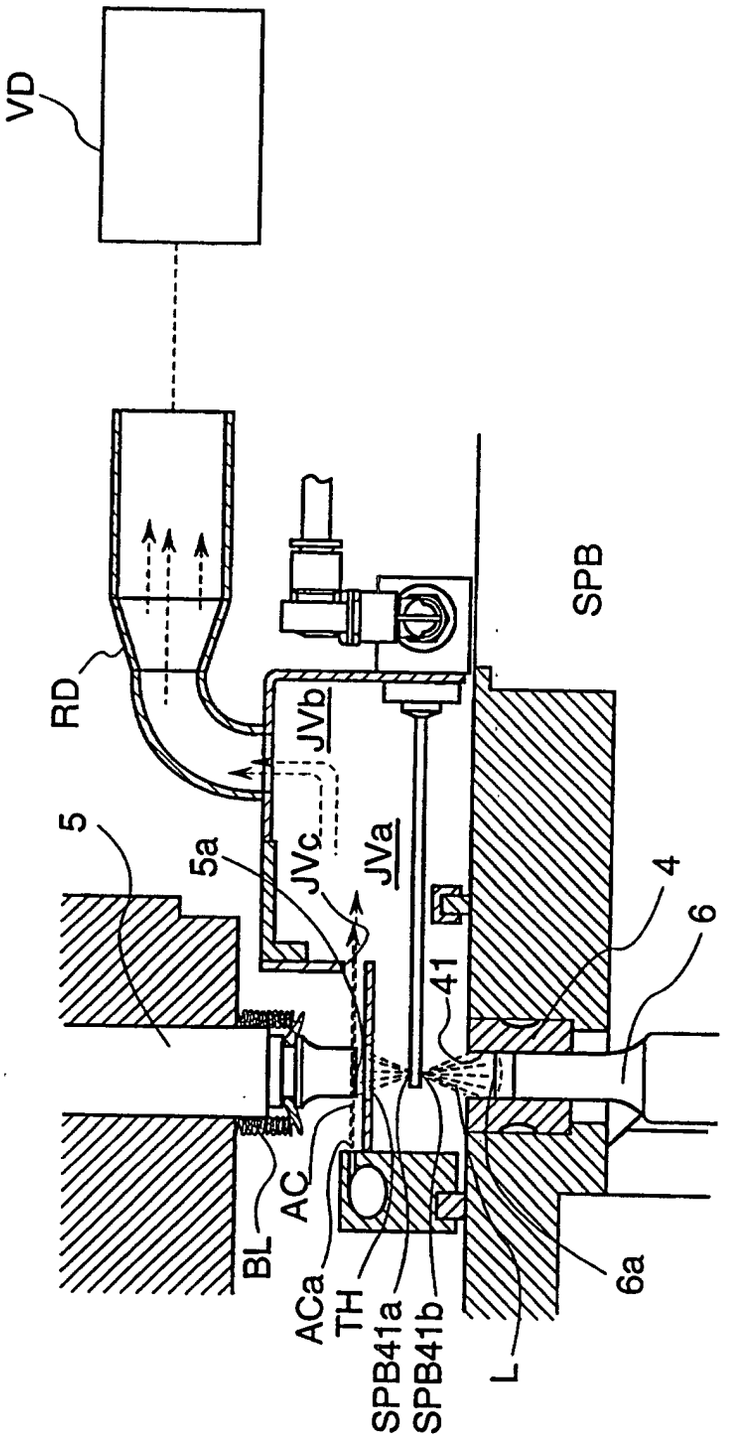


Fig. 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/02507

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B30B11/08, A61J3/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B30B11/08, A61J3/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Jitsuyo Shinan Toroku Koho 1996-2000
Kokai Jitsuyo Shinan Koho 1971-1996 Toroku Jitsuyo Shinan Koho 1994-2000

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, 4388343, A (Boehringer Ingelheim GmbH), 14 June, 1983 (14.06.83), Column 7, lines I-22; Figs. 3,4 & JP, 55-112200, A, page 6, upper left column, lines 4 to 19; Figs. 3, 4 & EP, 11269, A & DE, 2932069, A	1-10
Y	JP, 63-93500, A (Dr. Karl Thomae GmbH), 23 April, 1988 (23.04.88), Claims & DE, 3633646, A1 & EP, 262538, A	1-10
Y	US, 4707309, A (Dr. Karl Thomae GmbH), 17 November, 1987 (17.11.87), ABSTRACT, Fig.4 & JP, 59-205970, A, Claims; Fig. 4 & DE, 3312634, A & EP, 122519, A	1-10
Y	US, 4373888, A (Takeda Chemical Industries, Ltd.), 15 February, 1983 (15.02.83), Figs. 1-5 & JP, 56-14098, A, Figs. 1, 2	1-10

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 July, 2000 (06.07.00)	18 July, 2000 (18.07.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/02507

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP, 7-91998, A (Sekisui Chemical Co., Ltd.), 07 April, 1995 (07.04.95), Par. No. [0005] (Family: none)	5-10
Y	JP, 62-20322, U (TOKICO LTD.), 06 February, 1987 (06.02.87), Claims (Family: none)	5-10
Y	JP, 10-317007, A (Kozo Ishizaki), 02 December, 1998 (02.12.98), Par. No. [0016] (Family: none)	7-10
Y	EP, 650826, A1 (KYOWA HAKKO KOGYO CO., LTD.), 03 May, 1995 (03.05.95), Column 6, lines 33 to 42 & JP, 7-124231, A, Par. No. [0015] & DE, 69403602, C	10

Form PCT/ISA/210 (continuation of second sheet) (July 1992)