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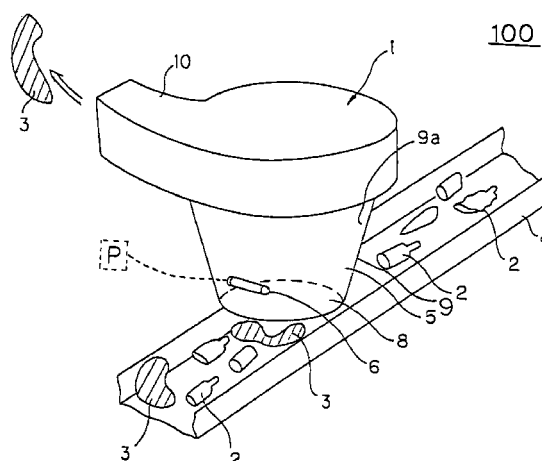
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(54) **Suction device and separator using same**

(57) A suction device utilizing a vortex flow of gas such as compressed air comprises a casing having a conical body formed with a conical inner peripheral surface having a small diameter side end to which a suction port is formed and at least one nozzle member provided for the conical body so as to jet gas inside the conical body along the inner conical surface thereof as a vortex flow of gas. The suction device may further comprise a cover member formed to the conical body so as to cover a large diameter side end of the conical body, the cover member having a side portion to which a discharge port is formed. The suction device is preferably utilized for a separator for selectively separating bags and films from other rubbishes during the conveyance thereof on a conveyor.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a suction device for sucking rubbish, trash or the like (called rubbish hereinafter), and more particularly, to a suction device for sucking rubbish bags after having been broken, films or the like gathered from homes by using a vortex or eddy flow of air and also relates to a separator using such a suction device.

[0002] Usually, cans, glass bottles, plastic bottles and the like, which are gathered after use from homes as valuable resource rubbish, are then packaged in rubbish bags and then fed to resource plants. In the resource plant, rubber bags in which the valuable rubbish are packaged are broken so as to selectively recover the rubbish bags, cans, bottles and the like, respectively.

[0003] Conventionally, although the rubbish bags after broken have been recovered manually, in recent years, the following publications have provided bag removing devices for automatically recovering these bags.

(1) Japanese Patent Laid-open Publication No. HEI 9-966.

This discloses a bag removing device, in which bags after broken are fed into a rotating drum provided at its peripheral portion with pipe means, the bags are hooked and then lifted by hooks formed to the pipe means, the lifted bags are thrown off on a receiving plate disposed on an upper side in the rotating drum, and the bags on the receiving plate are thereafter sucked by means of blower.

(2) Japanese Patent Laid-open Publication No. HEI 9-24916.

This discloses a bag removing device in which bags after broken are hooked by a rotating brush provided, at its peripheral portion, with elastic hooks and then floating the bags upward. The thus lifted bags are thereafter sucked by means of blower and collected by a cyclone collector or separator.

(3) Japanese Patent Laid-open Publication No. HEI 10-249282.

This discloses a wind power classifier or separator, in which rubbish including broken bags are conveyed by conveyer means and dropped down at a terminal end of the conveyer means. Air flow is jetted to the dropped rubbish from a lower side towards an upper side to thereby selectively float and classify the broken bags from other rubbishes and then recover the broken bags.

(4) Japanese Patent Laid-open Publication No. HEI 10-203515.

This discloses a bag removing apparatus provided with a bag breaking device having a bag

breaking wheel, in which a bag removing screen rotating at the same speed in the same direction as those of the bag breaking wheel is disposed at a bottom portion of the bag breaking wheel, and highly pressurized air flow is generated by means of nozzle. The bags are broken and torn by a bag breaking blade having a sharp front edge and a rotating force of the bag breaking wheel and then pushed against the bag removing screen and recovered by a recovering chute.

[0004] However, the above-mentioned conventional devices or apparatus have provided the following defects or problems.

(i) In the device disclosed in the above publication (1), a relatively complicated mechanical means or the like is needed for hooking and then lifting the bags upward, and a suction blower having large capacity is also required for sucking the bags by means of air flow.

(ii) In the device disclosed in the above publication (2), a relatively complicated mechanical means or the like is needed for hooking and then floating upward the bags, and a suction blower having large capacity is also required for sucking the floated bags by means of air flow.

(iii) In the classifier disclosed in the above publication (3), there is the possibility that the bags may not be surely recovered.

(iv) In the apparatus disclosed in the above publication (4), a relatively large and complicated mechanical system is needed for pushing the bags against the bag removing screen and recovering them by the recovery chute.

[0005] The rubbishes, from homes or the like, including cans, glass bottles, plastic bottles and the like are packaged in bags and then gathered to a rubbish treating site or plant at which the rubbish bags are broken or torn and then recovered. When only the broken bag and film are to be separated and removed from the other rubbishes by using a simple mechanical system or the like, it is preferred to suck up only bags or films selectively from rubbishes which are conveyed on a conveyer. In a conventional technology of using a duct having a suction port, it is a matter of common sense that a suction blower is connected to a discharge port to create a negative pressure state in the duct and then to suck the bags or films from the suction port. This sucking theory is common to that of a general cleaning machine (cleaner).

[0006] However, in order to suck up the bags and films conveying on the conveyer by the method mentioned above, it is necessary to utilize or locate a blower having extremely large size and capacity. This is because, in a practical suction-type bag removing device, it is required for the duct to have an opening, for

sucking the bags and films, having a dimension equal to or more than a width of the conveyer, and it is also required that a height from the conveyer surface to the suction port has a dimension which does not obstruct the passing of the resource materials such as bottles, cans or the like conveying on the conveyer. In order to satisfy the above requirements, it is necessary for the duct opening to have a dimension of more than 300 mm and also necessary for the height from the conveyer surface to the suction port to have a dimension more than 150 mm. It is therefore difficult to effectively suck the bags and films with the use of such suction system.

SUMMARY OF THE INVENTION

[0007] An object of the present invention is to substantially eliminate defects or problems encountered in the prior art mentioned above and to provide a suction device and a separator capable of surely recovering bags or the like by utilizing a small amount of vortex air (gas) flow without using a large and complicated mechanical system.

[0008] To achieve the above object, the inventors of the subject application thought out that the bags and films can be effectively and surely sucked up with a small amount of air flow by generating a vortex flow in the suction duct, that is, utilizing a theory of spout.

[0009] That is, the above and other objects can be achieved according to the present invention by providing, in one aspect, a suction device utilizing a vortex flow of gas such as compressed air comprising:

a casing having a conical body formed with a conical inner peripheral surface having a small diameter side end to which a suction port is formed and a large diameter side end;

nozzle means including at least one nozzle member provided for the conical body so as to jet air inside the conical body along the inner conical surface thereof as a vortex flow of air; and

means for supplying air to the nozzle means.

[0010] In a preferred embodiment of this aspect, the suction device may further comprise a cover member formed to the conical body so as to cover the large diameter side end, the cover member having a side portion to which a discharge port is formed. The cover member is formed with discharge nozzle means for jetting air towards the discharge port. The discharge nozzle means includes a first discharge nozzle member disposed to one side portion of the cover member on a downstream side of a vortex flow of air generated by the nozzle means formed to the conical body of the casing and a second discharge nozzle member disposed to another side portion of the cover member on an upstream side of the vortex flow of air generated by the nozzle means.

[0011] An amount of air jetted through at least one

of the nozzle means and discharge nozzle means is adjustable by a suitable adjusting device.

[0012] Furthermore, the nozzle means includes a plurality of nozzle members which are disposed on the same circumferential direction with a space from each other in a plane perpendicular to a central axis of the inner conical surface of the conical body or disposed in a manner shifted in locations from each other in a direction along the central axis of the inner conical surface of the conical body.

[0013] Nitrogen gas or carbon dioxide gas may be utilized in place of the compressed air in case explosion-proof is required.

[0014] According to the suction device of the above aspect, when a gas such as compressed air is supplied to the nozzle member, the compressed air is jetted at a high speed along the inner conical peripheral surface of the casing. At this time, the air has an upward velocity component due to an vertical angle effect, that is, the conical peripheral surface being widened upward in diameter, so that spiral turning air (vortex flow of air) is generated, which sucks air outside the casing. For this reason, bags and films near the suction port are also sucked together with the air inside the casing, then pushed against the inner peripheral surface by the centrifugal force and then lifted upward and surely discharged through the discharge port.

[0015] The location of a plurality of nozzle members in the same plane ensures the generation of the stable turning flow of air, resulting in the smooth sucking and discharging of the bags and films. Further, in the shifted location thereof, the sucking distance of the bags and films may be increased.

[0016] Furthermore, when the bags and films are discharged while turning them, there is the possibility of being caught to the side surface of the discharge port particularly on the downstream side of the vortex flow. However according to the arrangement of the discharge nozzle members including first and second ones of the present invention, since the discharge nozzle is provided for jetting air towards the discharge port, such bags and films can be forcibly discharged, and moreover, such jetting flow of air involves neighboring air, increasing the discharging ability, and hence, increased amount of air can be sucked through the suction port and the sucking and discharging ability and efficiency of the suction device can be remarkably improved.

[0017] By arranging the first discharge nozzle member so as to jet the air in a direction reverse to the vortex flow and the second discharge nozzle member so as to jet the air in the same direction as that of the vortex flow, the airs jetted from those nozzle members separately act to forcibly discharge the bags and films and increase and induce the sucked air amount.

[0018] The sucking and discharging ability of the suction device can be adjusted by the adjustment of the amount of the air jetted through the nozzle means and discharge nozzle means, and it is possible to improve

the purity of selection, that is, only the bags and films conveyed on the conveyer surface are sucked and other rubbishes such as cans, bottles are not sucked.

[0019] In another aspect of the present invention, there is also provided a separator for selectively separating bags and films mixed in rubbishes comprising:

a conveyer means having a conveyer surface on which the rubbishes are conveyed; and

a suction device disposed above the conveyer surface of the conveyer means and adapted to suck bags and films by means of vortex flow of air, said suction device comprising:

a casing having a conical body formed with a conical inner peripheral surface having a small diameter side end to which a suction port is formed and a large diameter side end;

a cover member formed to the conical body so as to cover the large diameter side end, the cover member having a side portion to which a discharge port is formed;

nozzle means including at least one nozzle member provided for the conical body so as to jet air inside the conical body along the inner conical surface thereof as a vortex flow of air; and

means for supplying air to the nozzle means.

[0020] In a preferred embodiment of this aspect, the separator further comprises at least a pair of auxiliary nozzle means disposed on both side portions of the conveyer means in an opposed arrangement so as to jet air towards the conveyer surface. The auxiliary nozzle means comprises flat nozzles finely extending in the conveying direction of the conveyer means.

[0021] The auxiliary nozzle means are disposed upstream side from a central portion of the suction device in the conveying direction of the conveyer means.

[0022] The conveyer means is at least partially covered by a conveyer cover connected to the suction port of the conical body of the suction device. The conveyer means is preferably an endless conveyer belt.

[0023] According to this aspect of the present invention, when the gas, for example, compressed air, is supplied to the nozzle member, only the bags and films conveyed on the conveyer surface are sucked up by means of turned air flow in the suction device, with other rubbishes such as cans, bottles and the like having relatively heavy weight being not sucked and remaining on the conveyer surface, thus surely recovering only the bags and films with small amount of air flow and without using any large and complicated mechanical system.

[0024] Furthermore, since the auxiliary nozzle members are disposed on both the side portions of the conveyer so as to be directed towards the conveyer surface, cans and bottles can be slightly moved upward together with the bags and films, so that the bags and films disposed under the cans or bottles can be taken

out. The use of the flat nozzle members can contribute the increasing of such floating force to the bags and films. Since the auxiliary nozzle members are disposed upstream side from the central portion of the suction device, the bags and films will be floated at the suction port and more easily sucked up.

[0025] The location of the conveyer cover can assist a fine and suitable flow of air jetted from the auxiliary nozzle members.

[0026] The nature and further characteristic features of the present invention will be made more clear from the following descriptions made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] In the accompanying drawings:

FIG. 1 is a perspective view showing a separator assembled with a suction device utilizing a vortex air flow according to first embodiment of the present invention;

FIG. 2 is a plan view of the suction device of FIG. 1; FIG. 3 is a sectional view taken along the line III-III in FIG. 2;

FIG. 4 is a sectional view similar to that of FIG. 3 but different therefrom in an arrangement of nozzles;

FIG. 5 is a plan view similar to that of FIG. 2 but relating to a suction device of a second embodiment of the present invention;

FIG. 6 is a perspective view similar to that of FIG. 1 but relating to a separator having the suction device according to the second embodiment of the present invention;

FIG. 7 is a sectional view taken along the line VII-VII in FIG. 6; and

FIG. 8 is a plan view showing an arrangement of auxiliary nozzles of the separator of FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] FIG. 1 shows a separator assembled with a suction device 1 utilizing a vortex flow of air according to a first embodiment of the present invention. The separator of the present invention may be referred to as selector, classifier or the like, and accordingly, in this application, the term of "separator" means a device for selectively separate rubbish bags and films from other rubbishes such as bottles, cans or the like. Further, the term "film" is used herein as a material, other than bags, which has a light weight such a vinyl tape piece, thin plastic piece or the like which is easily lifted and floatable by applying air flow from a lower side thereof.

[0029] With reference to FIG. 1, the separator 100 comprises a conveyer 4 conveying rubbishes including resource rubbishes 2 such as cans, glass bottles and plastic bottles, and bags and films 3 and a suction

device 1 disposed above the conveyer 4 and adapted to suck the bags and films 3, by using a vortex flow of air, selectively from the resource rubbishes 2. The separator 100 also includes a gas supply means such as air pump means P, which has itself known structure, for supplying gas to the suction device 1. Further, although nitrogen gas, carbon dioxide gas or the like gas, or air such as compressed air may be preferably utilized as gas supplied to the suction device 1, a term "air" is generally used hereinafter. For example, in a case where there is the possibility of explosion, the nitrogen gas or carbon dioxide gas will be preferably used.

[0030] The conveyer 4 is a known conveyer belt having a structure in which an annular endless belt, having a relatively wide width, is engaged with belt wheels at both end portions and the resource rubbishes are conveyed on the belt surface by circulating the conveyer belt.

[0031] The suction device 1 utilizing the vortex flow of air, which may be called herein as vortex flow suction device 1 or merely suction device 1, is utilized as a bag removing device and adapted to recover only the bags and films 3 selectively from the resource rubbishes 2 including cans, glass bottles and plastic bottles. The suction device 1 is arranged above the conveyer 4 and comprises a casing 5 having a vertically conical body portion 9 formed with an inner peripheral surface 9a in a conical shape and a plurality of nozzles arranged along the inner peripheral surface 9a of the casing 5. Air from the pump means P is jetted into the casing 5 through these nozzles 6 as vortex flow as mentioned hereinafter.

[0032] The casing 5 in the form of bucket is provided, as shown in FIGs. 2 and 3, with the conical body portion 9 having a diameter gradually widening from the lower side towards the upper side thereof. The upper end side of the conical portion 9 is closed by a cover 7 and the lower end side thereof is formed with a suction port 8. Further, a discharge port 10 is formed to the side surface of the cover 7.

[0033] The suction port 8 has a circular sectional shape and its opening is set so as to have a dimension slightly smaller than a conveyance width of the conveyer 4. Further, the height from the conveying surface of the conveyer 4 to the suction port 8 is set so as not to prevent the cans, bottles and the like from passing therebetween, and for example, the width of the suction port opening is set to more than 300 mm and the height is set to more than 150 mm.

[0034] The conical body portion 9 has an inner conical peripheral surface 9a having a vertical angle α set to be about 5 to 30°. This conical portion 9 of the casing 5 is, for example, formed by bending a plate member so as to provide a conical shape. It is preferred that the diameter and the height of the conical body portion 9 are determined so that a centrifugal force caused by the vortex flow of air is sufficiently applied so as to surely discharge the sucked bags and films 3. Further, in the

shape of the conical portion 9 having the vertical angle of near 0°, the shape of the inner conical peripheral surface of the conical portion 9 approaches a cylindrical shape, the vortex flow has no upward velocity component and the flow will turn along the cylindrical inner peripheral surface 9a, thus causing no sufficient sucking function.

[0035] Further, in the embodiment described above, although the cover 7 is disposed to the upper end of the conical body portion 9 of the casing 5 and the discharge port 10 is formed to the cover 7, in an alternation, the discharge port 10 may be directly formed to the conical body portion 9 as far as the sucked bags and films 3 can be surely discharged.

[0036] That is, the upper end of the conical portion 9 of the casing 5 is closed by a discharge duct (cover) 7. The discharge duct 7 has a cylindrical shape having a diameter larger than that of the upper end of the conical body portion 9 and is formed with the discharge port 10 to the side surface thereof so as to discharge the bags and films 3, which are sucked and turned, in a tangential direction thereof. In this operation, the bags and films 3 are pushed against the side surface of the discharge duct 7 by the centrifugal force and then discharged outward through the discharge port 10.

[0037] Further, a suction duct, not shown, may be connected to the discharge duct 7 so as to forcibly suck or pull the bags and films 3 through the discharge duct 7 and then gather and treat them by means of cyclone, for example. In this arrangement, a blower connected to the suction duct is not used as a suction device for sucking the bags and films 3, so that the blower is operated as an auxiliary means having not so large capacity, thus making compact the entire structure of the device.

[0038] A pair of nozzles 6, 6 are arranged on the suction port side of the conical body portion 9 of the casing 5 so as to jet the air from the pump means P along the inner peripheral surface 9a of the conical body portion 9. The nozzles 6, 6 are arranged on the same peripheral portion in a plane perpendicular to the central axis 13 of the inner conical peripheral surface 9a preferably with an equal distance in the circumferential direction thereof, and that is, in the illustrated example, the nozzles 6, 6 are disposed with 180° relation so as to cause turning flows of air in the same direction, for example, in a clockwise direction.

[0039] The pump means is preferably a compressor from which compressed air is fed at a high speed to the nozzles 6, 6 through which the compressed air is jetted into the conical body portion 9 of the casing 5 along the inner peripheral surface 9a. Further, since the sucking force for sucking the bags and films 3 depends on the air flow velocity rather than air flow amount, in order to increase the sucking ability, it will be desired to reduce the sectional areas of the front end portions of the nozzles 6, 6 to thereby increase the air flow velocity.

[0040] Although the nozzles 6, 6 of this embodiment are arranged horizontally so as to jet the air having

horizontal velocity component, the front end portions thereof may be slightly directed upward so as to provide upward velocity component. Further, it is to be noted that the number of the nozzles 6, 6 is not limited to two and one or more than two nozzles, for example, six (6), may be disposed. The number of the nozzles will be determined depending on volume, bulk density or the like of materials to be sucked.

[0041] FIG. 4 shows another example of the arrangement of the nozzle, in which a plurality of, for example, two, nozzles 6, 6 are arranged at positions shifted from each other in the direction of axis 13 to make large the lifting distance of the sucked bags and films 3.

[0042] The resource rubbishes such as cans, glass bottles, plastic bottles and the like, which are packaged in bags formed of such as vinyl material or the like thin film material, are taken out by breaking the bags by a bag breaking apparatus or the like, not shown, and then conveyed along the conveyer 4, as shown in FIG. 1, together with the bags and films 3.

[0043] Among these rubbishes, the bags and films 3 having a small bulk density are recovered by the vortex flow suction device 1. Then, when the compressed air of high velocity is jetted through the nozzles 6, 6 into the conical body portion 9 of the casing 5, the jetted air is turned along the conical inner peripheral surface 9a thereof. The jetted air has an upward velocity component due to the conical shape, i.e. upward widened sectional shape, of the inner peripheral surface 9a of the casing 5, and as a result, the air constitutes a spiral air flow directed from the suction port 8 towards the discharge port 10. This spiral air flow acts to suck an external air through the suction port 8, and for this reason, the bags and films 3 near the suction port 8 are sucked and lifted upward together with the upwardly directed air flow. The thus sucked-up bags and films 3 are then floated and lifted upward while being pushed against the inner peripheral surface 9a of the conical body portion 9 by the centrifugal force of the air flow, whereby the bags and films 3 can be surely discharged outward through the discharge port 10 formed to the side surface portion of the casing 5. Further, during the operation mentioned above, the cans, glass bottles, plastic bottles 2 and the like each having a bulk density larger than that of the bag or film 3 are conveyed as they are under no influence of the air flow.

[0044] The thus recovered bags and films 3 are thereafter separated in accordance with gravities thereof and pelleted as pellets of, for example, vinyl chloride, polyethylene, polypropylene and the like. Further, the cans conveyed is classified into steel cans and aluminium cans by using an induction electromagnetic force. On the other hand, the glass bottles conveyed are classified in accordance with their colors and the plastic bottles conveyed are also classified in accordance with their substances.

[0045] FIG. 5 represents a suction device utilizing a

vortex flow according to the second embodiment of the present invention.

[0046] With reference to FIG. 5, the suction device 1 comprises a casing 5 having a conical body portion 9 formed with a conical inner peripheral surface 9a, nozzles 6, 6 jetting air from an air pump means P (see FIG.6) along the inner peripheral surface 9a and a discharge duct (cover) 7 covering an upper end opening having a larger diameter of the conical body portion 9 of the casing 5. The discharge duct 7 has a side surface to which discharge port 10 is formed. One side duct portion 7a formed on one side of the discharge port 10 is throttled towards the discharge port 10. First and second air discharge nozzles 11 and 12 are disposed on both sides of the discharge duct 7 so as to jet the air towards the discharge port 10.

[0047] The first air discharge nozzle 11 is arranged to a downstream side portion of the vortex flow of air ① generated by the nozzles 6, 6 so as to jet the air in a direction reverse to that of the air flow ①. On the other hand, the second air discharge nozzle 12 is arranged to an upstream side portion of the vortex flow of air ① generated by the nozzles 6, 6 so as to jet the air in the same direction as to that of the air flow ①. The amounts of airs jetted through these nozzles 6, 6, 11 and 12 can be adjusted by a regulation valve or the like, not shown, for improving the performance of the selection of the bags and films 3.

[0048] When the bags and films 3 are discharged while being turned in the casing 5, there is the possibility that the bags and films 3 may be caught or hooked to portions to the side surface of the discharge port 10, particularly, a side surface portion 10a on the downstream side of the vortex flow of air ①. According to the suction device 1 of the present invention, however, since the first and second air discharge nozzles 11 and 12 for jetting the air towards the discharge port 10 are arranged, the bags and films 3 caught to the side surface 10a of the discharge port 10 can be forcibly discharged by the first air discharge nozzle 11, and moreover, since the air jetted through the second air discharge nozzle 12 involves the surrounding air and then induces it, the amount of air to be discharged from the suction device 1 can be increased. As a result, the amount of air sucked through the suction port 8 can be increased, and hence, the sucking and discharging ability or performance of the suction device 1 can be also increased.

[0049] FIGs. 6 and 7 represent a separator 100 assembled with the suction device 1 of the second embodiment.

[0050] With reference to FIGs. 6 and 7, the separator 100 is also provided with a conveyer 4 for conveying resource rubbishes including cans, glass bottles, plastic bottles 2 and the like and a suction device 1 using the vortex flow of air disposed above the conveyer 4 and adapted to suck bags and films by means of the vortex flow of air.

[0051] In this separator 100, the conveyer 4 is partially covered by a conveyer cover 13 so as to extend in the upstream and downstream sides by substantially the same length as that of the suction port 8 as shown in FIG. 6. Further, the suction port 8 of the vortex flow type suction device 1 is connected to this conveyer cover 13 through a connection portion 14, as shown in FIG. 7, which has a shape downwardly widened in diameter and has a circular shape in section.

[0052] On both the sides of the conveyer 4 normal to the conveying direction, are arranged a pair of auxiliary nozzles 16a and 16b so as to oppose to each other and to jet air towards the conveying surface 4a, i.e., upper surface of the conveyer belt. The auxiliary nozzles 16a and 16b penetrate both the side guide surfaces 4b of the conveyer 4 and are directed downward at angles β of 30 to 60° between the auxiliary nozzle 16a (16b) and the conveyer surface 4a.

[0053] FIG. 8 is a brief illustration of a plan view of the auxiliary nozzles 16a and 16b. These auxiliary nozzles are disposed in a pair on both the sides of the conveyer 4 and are each composed of a flat nozzle so as to finely extend along the conveying direction of the conveyer 4. A pair of the nozzles 16a and 16b are disposed on the upstream side more than the central portion of the suction device 1 in the conveying direction C of the conveyer 4 and jet the air from both the side portions of the conveyer 4 in the direction normal to the conveying direction.

[0054] The resource rubbishes include cans, glass bottles, plastic bottles, bags after broken, films and the like, which are conveyed on the conveyer 4 in an overlapped manner in some time. In such case, if the bags or films 3 are overlapped, for example, disposed, below the cans or bottles 2, it is difficult to recover the bags or films 3 disposed below the cans or bottles 2. According to the separator 100 provided with the suction device 1 utilizing the vortex flow of the present invention, however, the air jetted through the auxiliary nozzles 16a and 16b which are directed to the conveyer surface 4a of the conveyer 4, and accordingly, the air jetted against the conveyer surface 4a create the upward air flow which will float up the cans or bottles 2 as well as the bags or films 3. Hence, even the bags or films 3 disposed below the cans or bottles 2 can be taken out therefrom and then floated upward.

[0055] As can be seen from the above disclosure, it will be found out that the separator provided with such auxiliary nozzles 16a and 16b are preferably usable for existing conventional conveyers or the like, and moreover, as a method of floating the bags or films 3 disposed below the cans or bottles 2, there will be provided a method of vibrating the conveyer surface of the conveyer or a method of sucking the bags or films at a connection portion of adjacent conveyers.

[0056] Furthermore, although in the above disclosure, the suction device utilizing vortex flow of air is utilized as a separator for separating and recovering bags

and films from other resource rubbishes such as cans, bottles or the like, the present invention is applicable as a separator for a suction device for sucking (incinerated) ash or a separator for sucking dead leaves fallen in gutters of roads. In the case of being used as the separator for sucking the ash, the ash can be sucked up even if the separator is separated by some distance from the ash, so that the separator may be easily constructed as an easily operable robot, and in the case of being used as the separator for sucking dead leaves, only the dead leaves can be sucked without sucking other heavy materials such as stones in the gutters.

[0057] In one preferred example performed by the inventors, there was used a suction device in which the suction port has a diameter of 400 mm and the casing has a height of 600 mm, and tests whether bag(s) disposed on a plane can be sucked up with how much distance is separated by changing vertical angles.

[0058] In the test result, the bag disposed on the plane apart by 200 mm from the suction port can be surely sucked up at the vertical angle of 15°, through the tests, it was found that the vertical angle of about 15° is desired, but substantially the same effect could be expected at angle of 5 to 30°. Furthermore, in a case of arranging two nozzles at opposite portions on the same circle, the bag could be smoothly sucked up and discharged.

[0059] It is to be noted that the present invention is not limited to the described embodiments and many other changes and modifications may be made without departing from the scopes of the appended claims.

Claims

1. A suction device utilizing a vortex flow of gas comprising:
 - a casing having a conical body formed with a conical inner peripheral surface having a small diameter side end to which a suction port is formed and a large diameter side end;
 - nozzle means including at least one nozzle member provided for the conical body so as to jet gas inside the conical body along the inner conical surface thereof as a vortex flow of gas; and
 - means for supplying gas to the nozzle means.
2. A suction device according to claim 1, further comprising a cover member formed to the conical body so as to cover the large diameter side end, said cover member having a side portion to which a discharge port is formed.
3. A suction device according to claim 2, wherein said cover member is formed with discharge nozzle means for jetting gas towards the discharge port.

4. A suction device according to claim 3, wherein said discharge nozzle means includes a first discharge nozzle member disposed to one side portion of the cover member on a downstream side of a vortex flow of gas generated by said nozzle means formed to the conical body of the casing and a second discharge nozzle member disposed to another side portion of the cover member on an upstream side of the vortex flow of gas generated by said nozzle means. 5 10
5. A suction device according to claim 3 or 4 wherein an amount of gas jetted through at least one of said nozzle means and discharge nozzle means is adjustable. 15
6. A suction device according to any one of claims 1-3, wherein said nozzle means includes a plurality of nozzle members which are disposed on a same circumferential direction with a space from each other in a plane perpendicular to a central axis of the inner conical surface of the conical body. 20
7. A suction device according to claim 6, wherein said nozzle members are arranged with equally spaced relationship in the circumferential direction. 25
8. A suction device according to any one of claims 1-3, wherein said nozzle means includes a plurality of nozzle members which are disposed in a manner shifted in locations from each other in a direction along a central axis of the inner conical surface of the conical body. 30
9. A separator for selectively separating bags and films mixed in rubbishes comprising: 35
 - a conveyer means having a conveyer surface on which the rubbishes are conveyed; and
 - a suction device disposed above the conveyer surface of the conveyer means and adapted to suck bags and films by means of vortex flow of gas, 40
 - said suction device comprising:
 - a casing having a conical body formed with a conical inner peripheral surface having a small diameter side end to which a suction port is formed and a large diameter side end; 45
 - a cover member formed to the conical body so as to cover the large diameter side end, said cover member having a side portion to which a discharge port is formed; 50
 - nozzle means including at least one nozzle member provided for the conical body so as to jet gas inside the conical body along the inner conical surface thereof as a vortex flow of gas; 55
 - and
 - means for supplying gas to said nozzle means.
10. A separator according to claim 9, further comprising at least a pair of auxiliary nozzle means disposed on both side portions of the conveyer means in an opposed arrangement so as to jet gas towards the conveyer surface.
11. A separator according to claim 10, wherein said auxiliary nozzle means comprises flat nozzles finely extending in the conveying direction of the conveyer means.
12. A separator according to claim 10 or 11, wherein said auxiliary nozzle means are disposed upstream side from a central portion of the suction device in the conveying direction of the conveyer means.
13. A separator according to any one of claims 9-12, wherein said conveyer means is at least partially covered by a conveyer cover connected to the suction port of the conical body of the suction device.
14. A separator according to claim 9, wherein said conveyer means comprises an endless conveyer belt.

FIG. 1

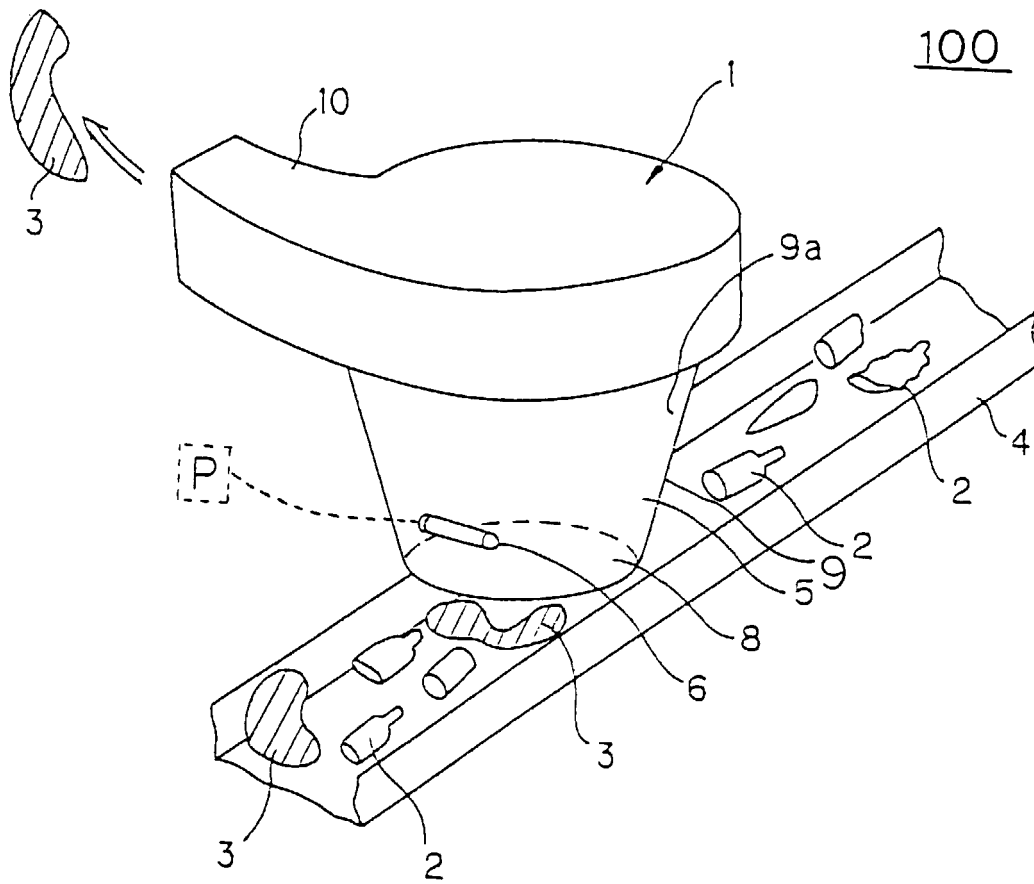


FIG. 2

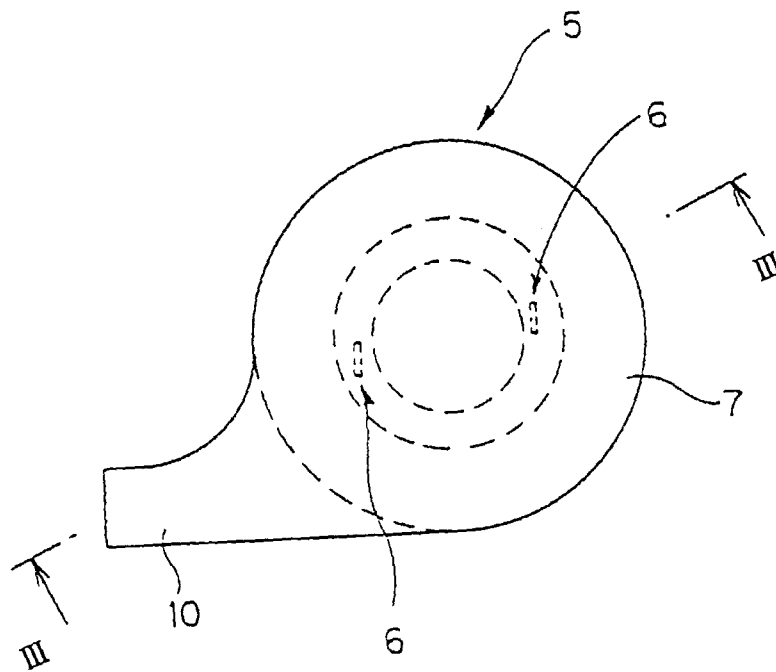


FIG. 3

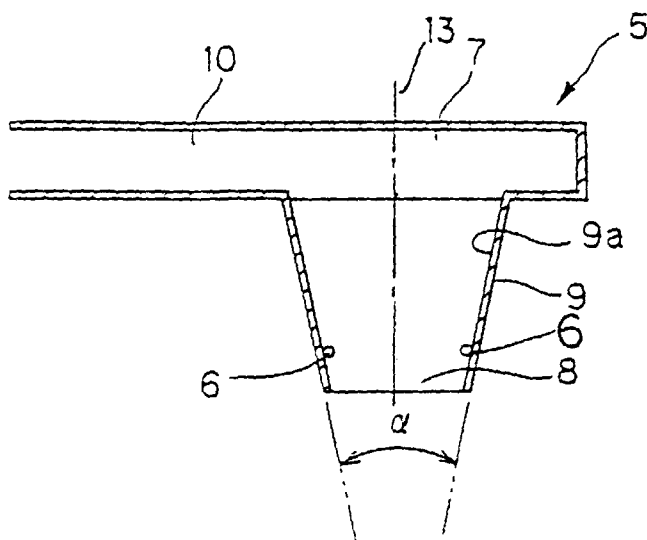


FIG. 4

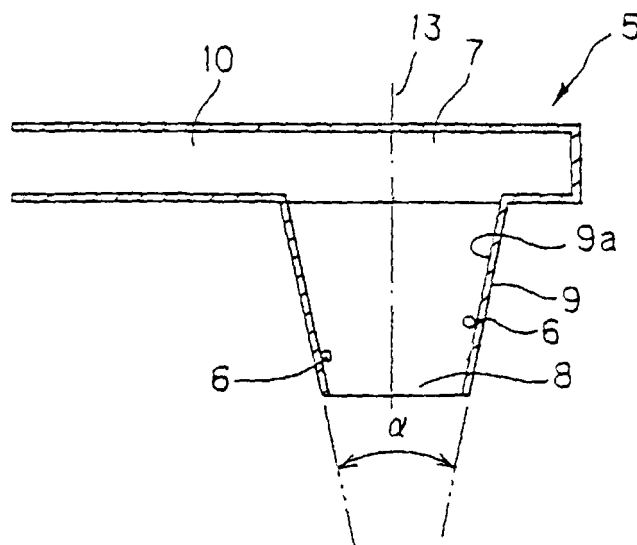


FIG. 5

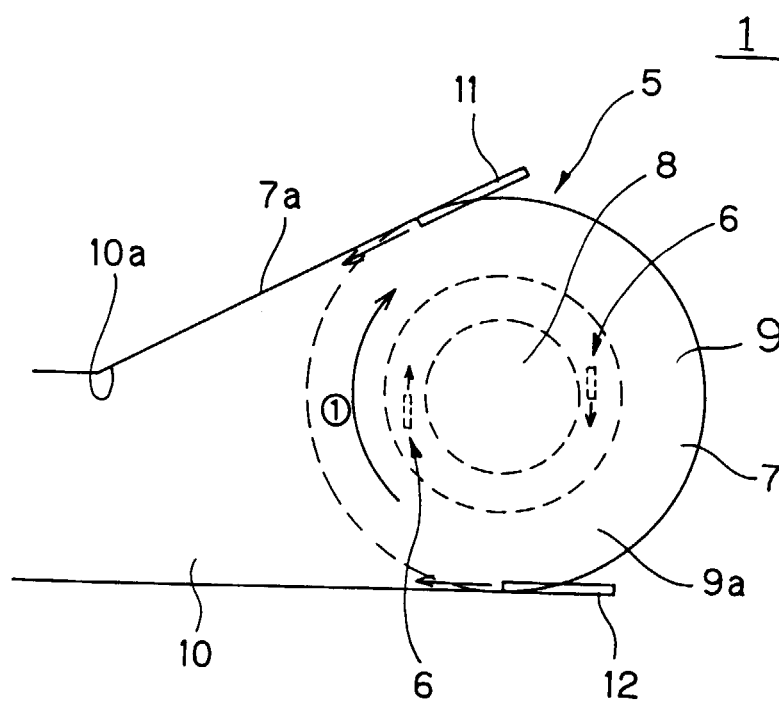


FIG. 6

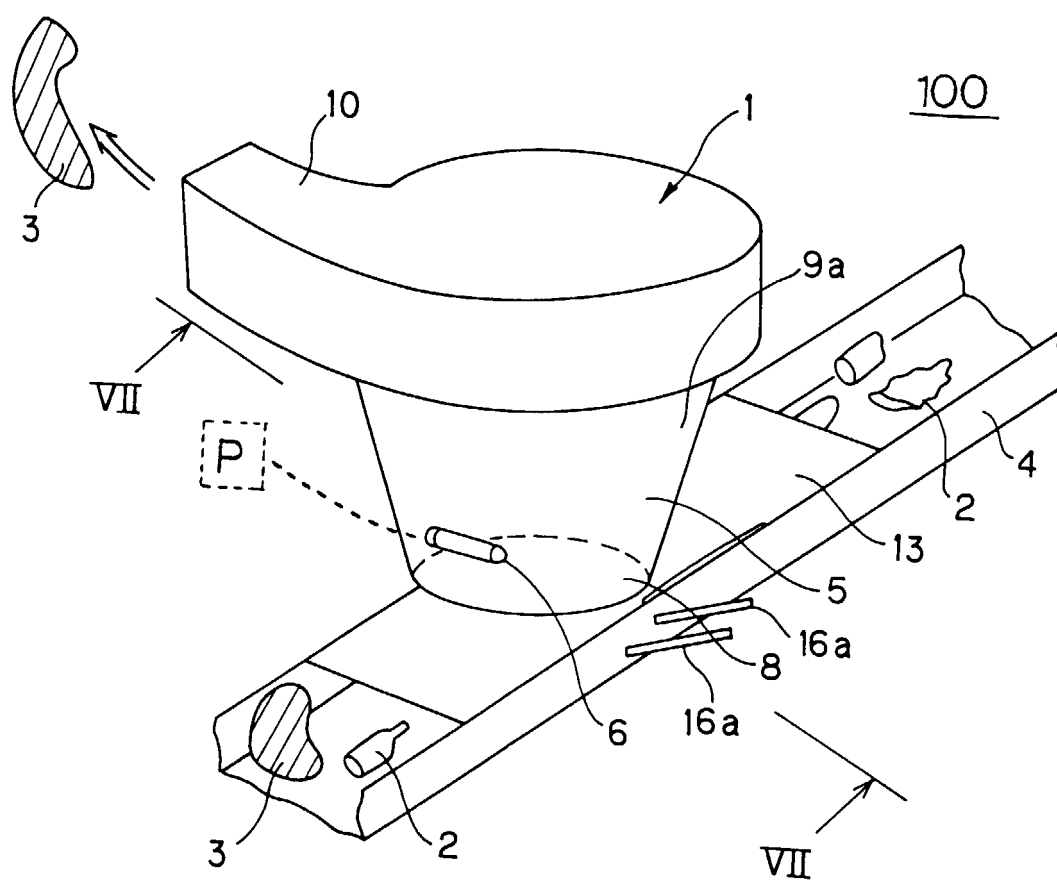


FIG. 7

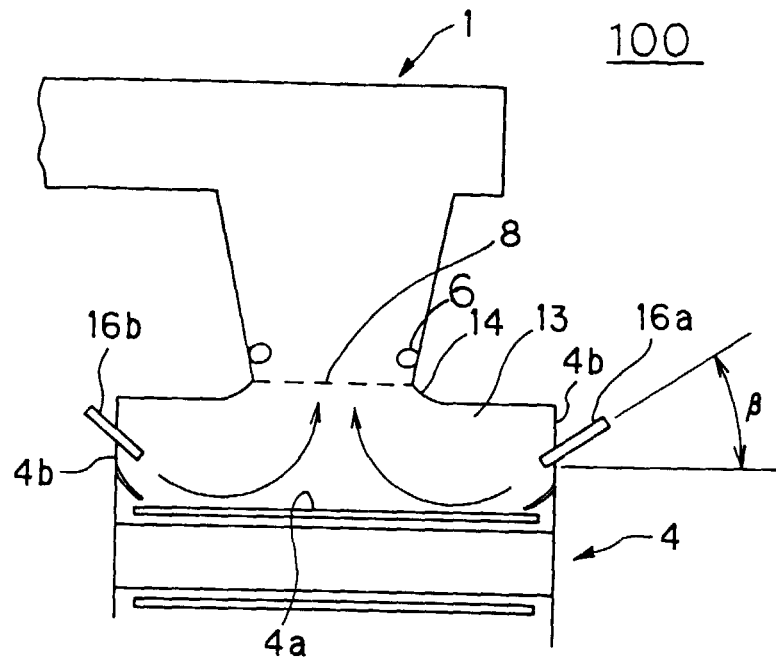


FIG. 8

