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(54) **VACUUM ATTACHMENT FOR A BLOWER**

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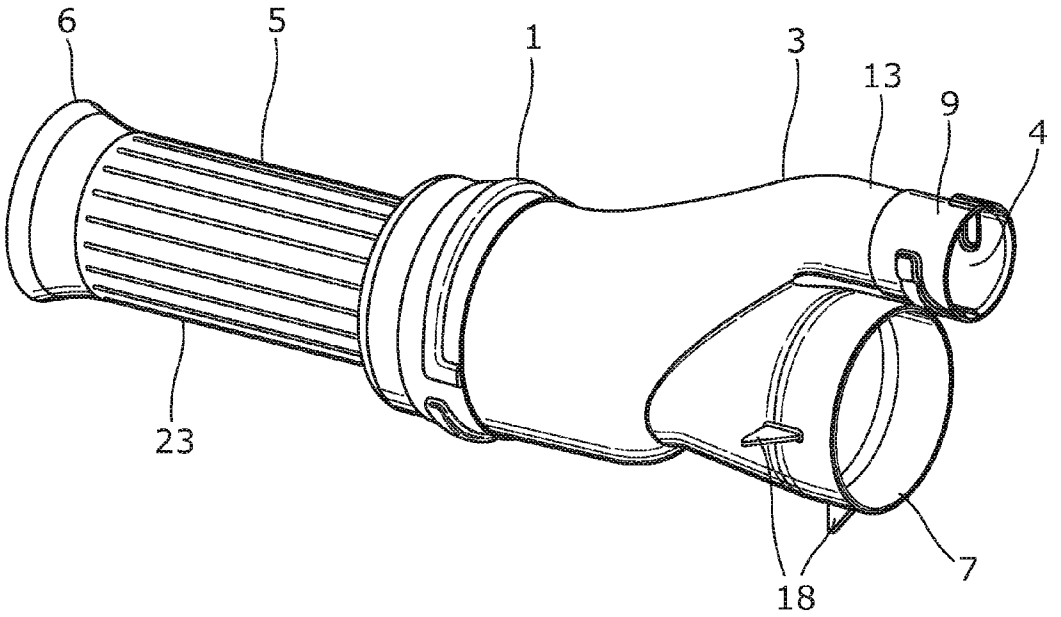
(57) **ABSTRACT**

A vacuum attachment (**1**) for a blower (**2**), comprising: an input air channel (**3**) having an air inlet (**4**); and a through channel (**5**) from a vacuum inlet (**6**) to an outlet (**7**), in which the input air channel (**3**) terminates in a port (**8**) in the through channel (**5**), in which the port (**8**) is positioned so as to direct air flowing from the input air channel (**3**) in a direction through the through channel (**5**) away from the vacuum inlet (**6**), in which the air inlet (**4**) has a mounting surface (**9**) on which can be mounted an air outlet (**10**) of the blower (**2**) in a releasable and re-engagable manner. Thus, with a blower (**2**) connected to the air inlet (**4**), an airflow introduced at the air inlet (**4**) will cause an airflow from the vacuum inlet (**6**) to the outlet (**7**), entraining debris with the airflow.



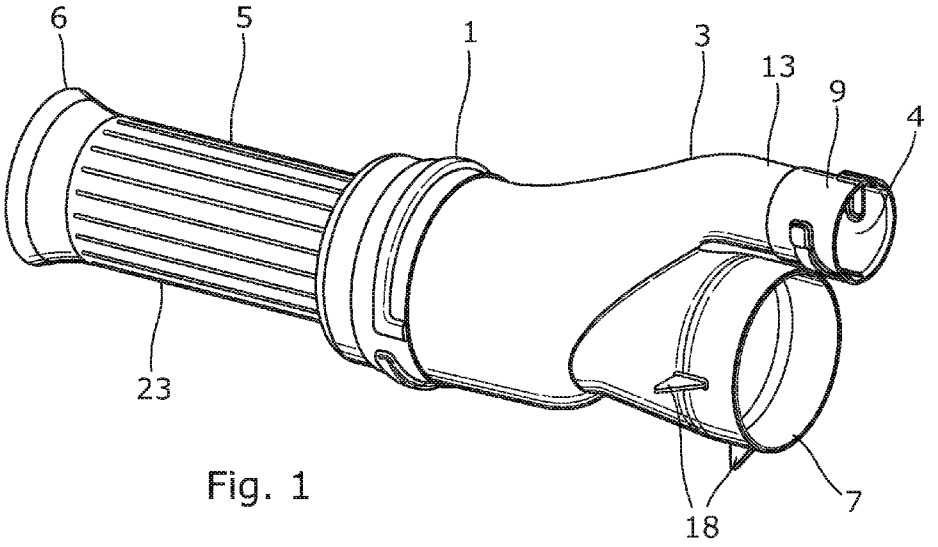


Fig. 1

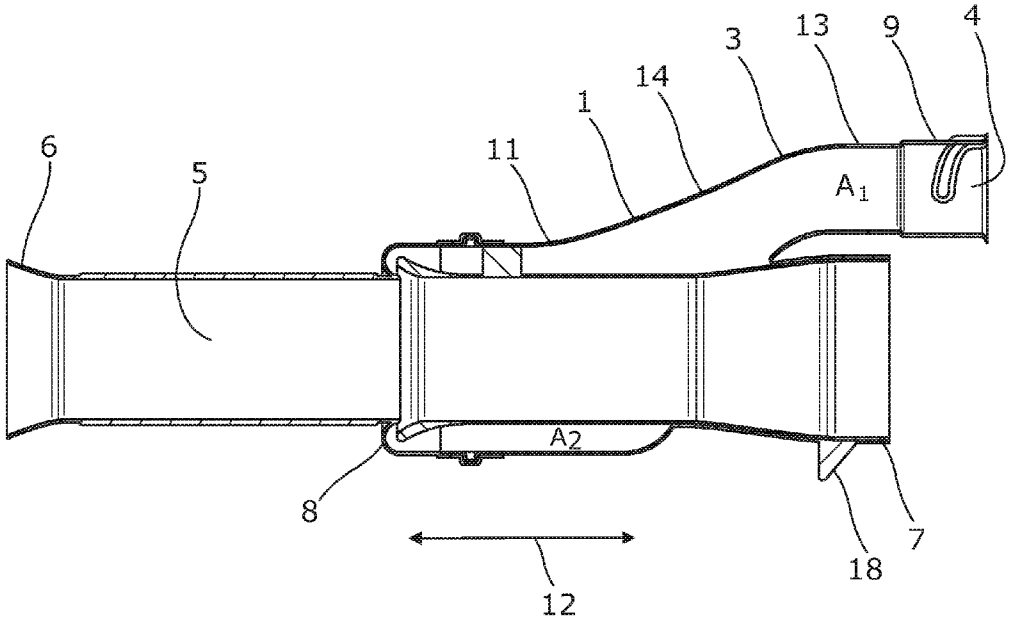


Fig. 2

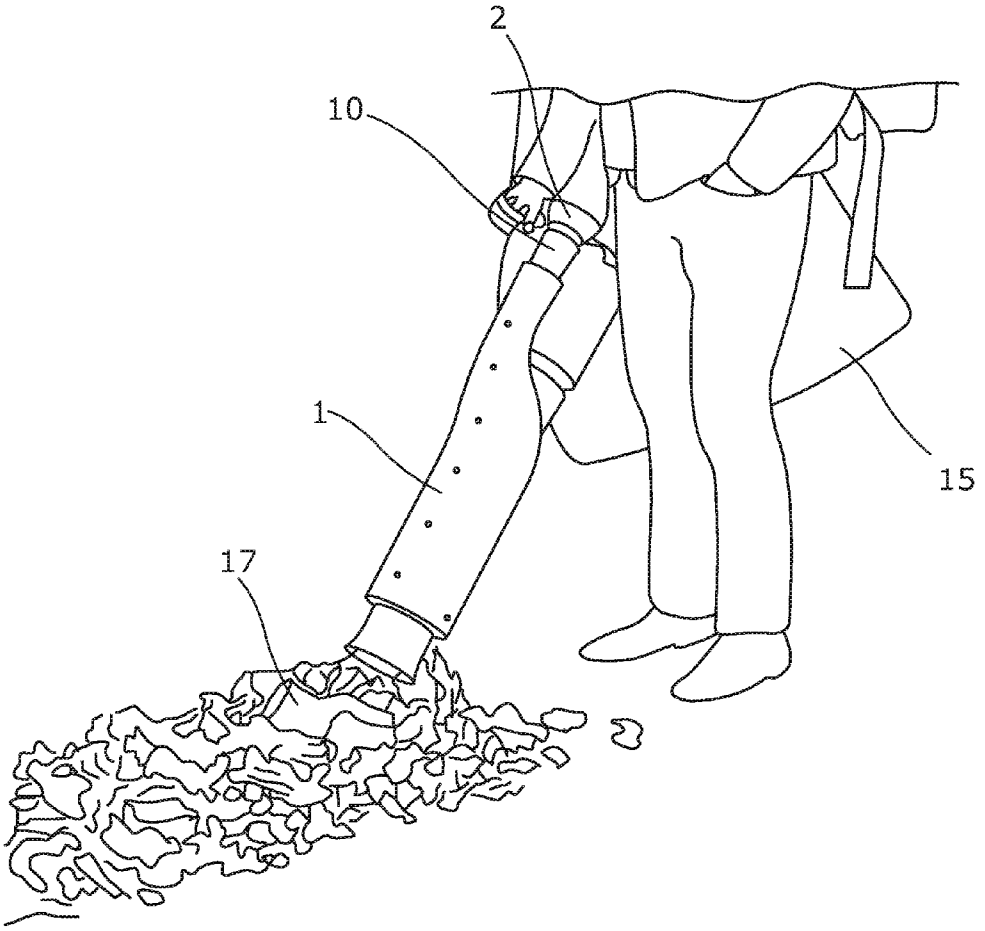


Fig. 3

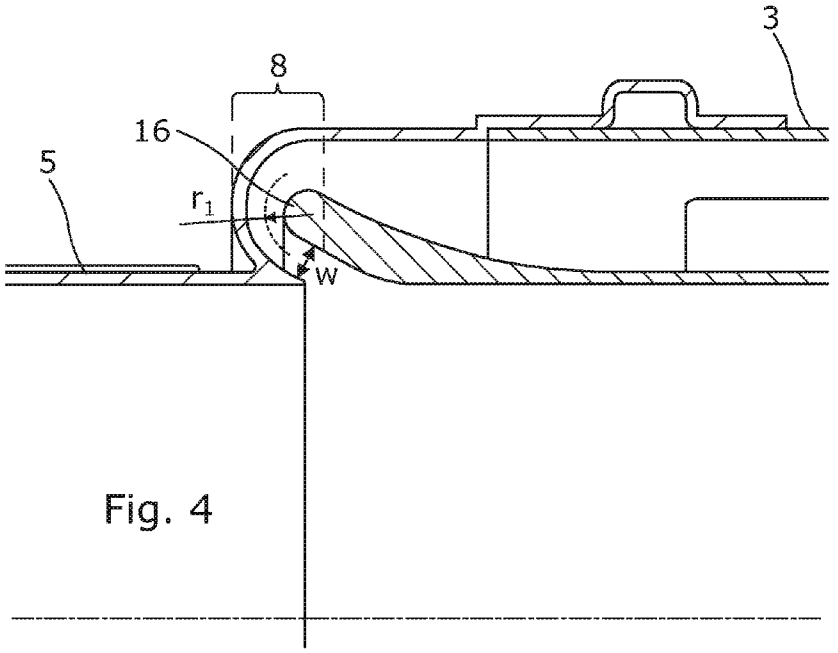


Fig. 4

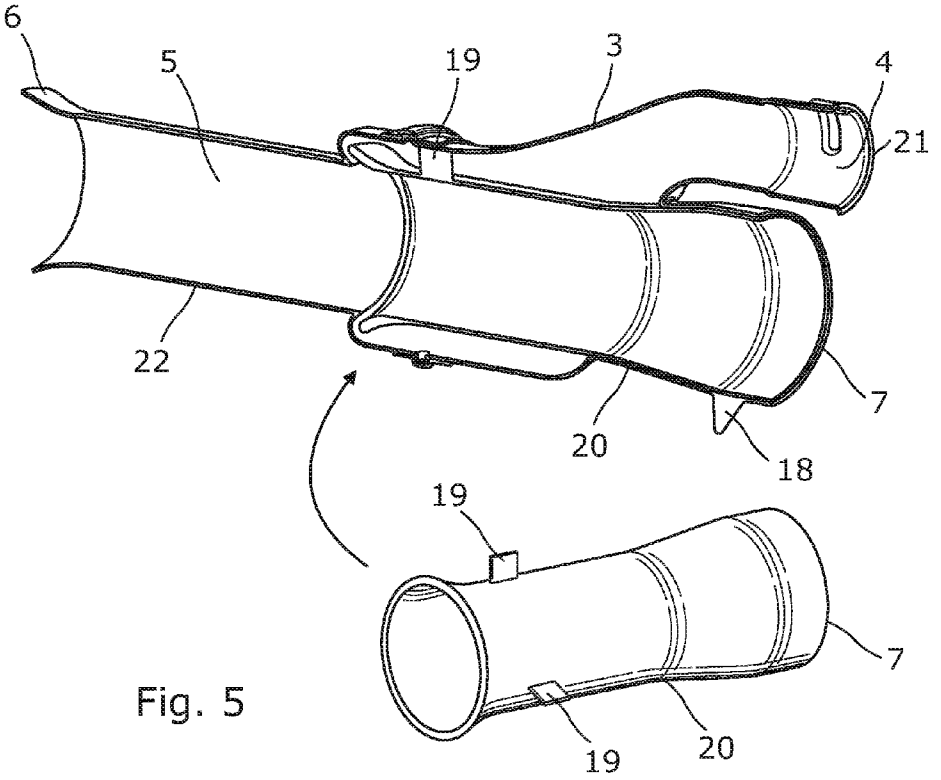


Fig. 5

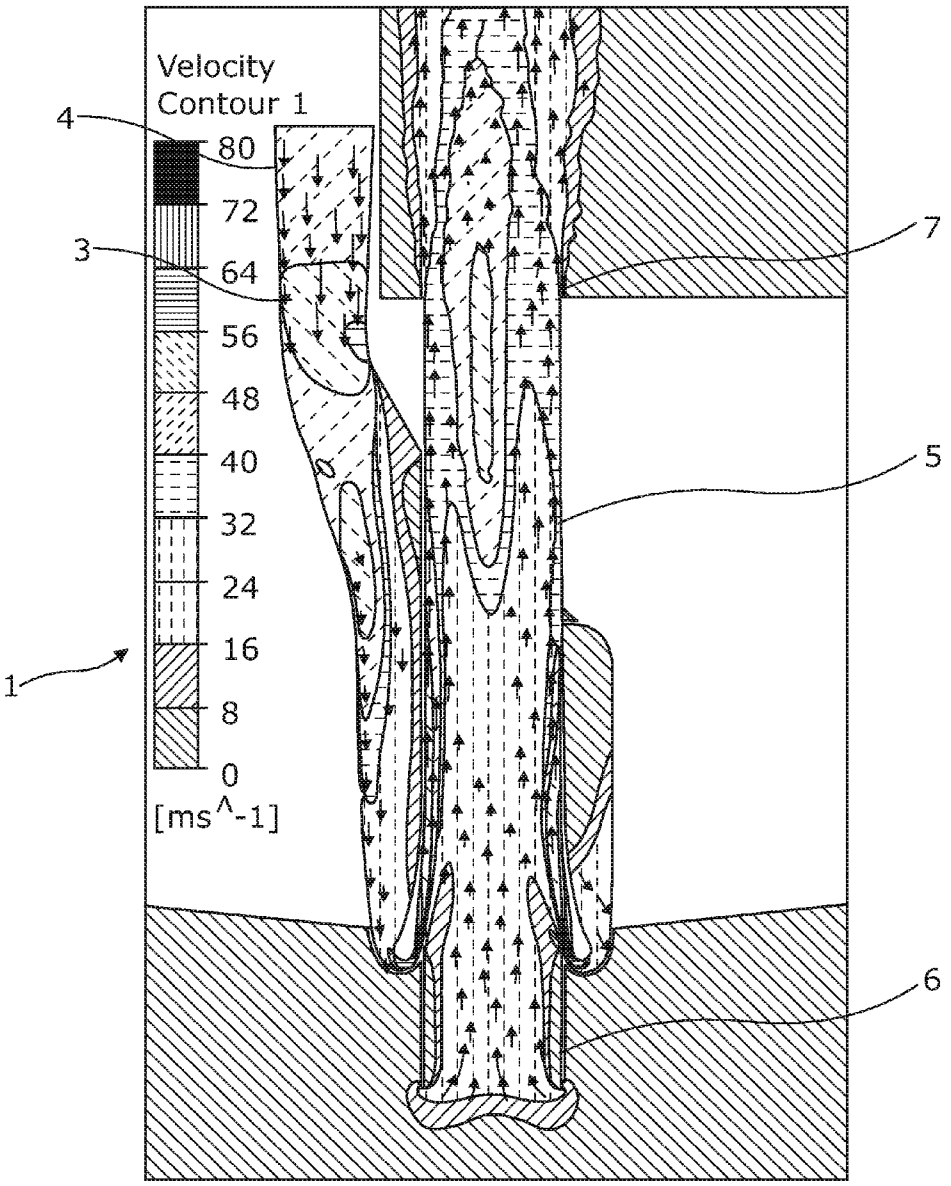


Fig. 6

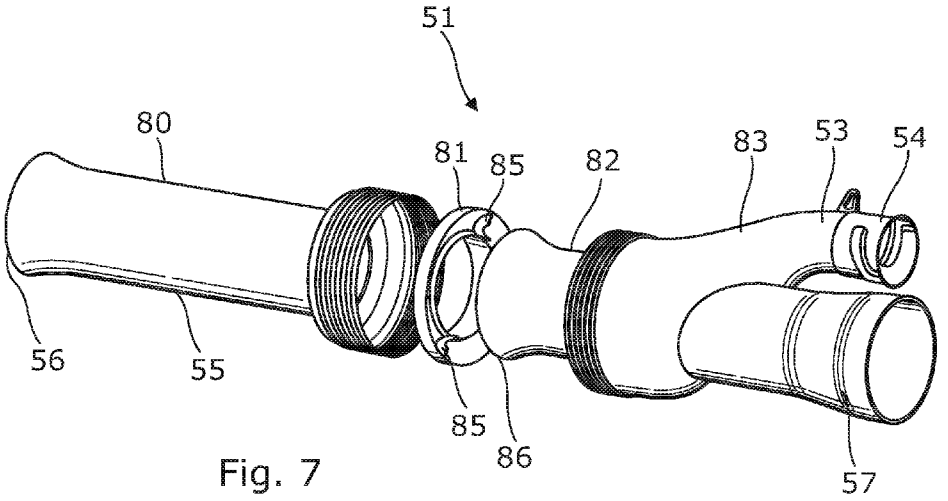

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Fig. 7

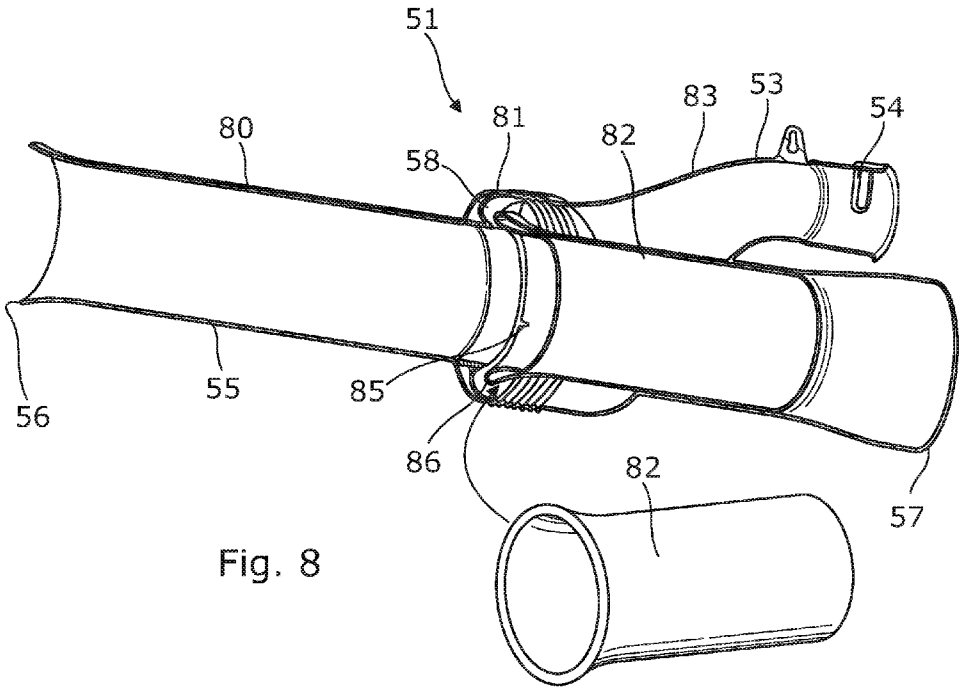
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Fig. 8

VACUUM ATTACHMENT FOR A BLOWER

[0001] This invention relates to a vacuum attachment for a blower, and to a related vacuum apparatus, the attachment and apparatus typically, but non-exclusively, being suitable for the collection of garden debris.

[0002] Garden vacuum apparatus are known, and generally comprise a source of low pressure arranged so as to draw debris into a collection channel and to deposit the debris into a collection chamber, such as a reusable fabric bag. Generally, the source of low pressure is a rotary fan or other such impeller.

[0003] The function of such apparatus can be separated into two types: the first type can be referred to as a "dirty fan" system, where the debris passes over the fan between the collection channel and the collection chamber. However, this means that debris can adhere to the fan, causing a potential reduction in performance. Wet, sticky debris such as wet leaves can completely block the fan, meaning that a user has to remove the blockage from the fan manually. Hard objects passing through the fan can impact on a blade of the fan, possibly breaking it.

[0004] It is known from e.g. U.S. Pat. No. 5,638,574 to provide such a "dirty fan" vacuum apparatus in the form of a blower that can be converted into a vacuum apparatus by exchanging the blower tube for a vacuum tube. Typically, this requires some rebuilding of the blower to form a vacuum apparatus, which is quite cumbersome and time consuming for the user.

[0005] The second type, a "clean fan" system, uses a flow of air to create an underpressure (in line with Bernoulli's principle, which states that a moving fluid will reduce in pressure) and to use that underpressure to provide suction. Such a system is described in the Serbian Patent application published as P-2007/0092. Such systems have the advantage that debris need not, and generally does not, pass over the fan.

[0006] However, it is always desirable to improve the efficiency and flexibility of such systems.

[0007] According to a first aspect of the invention, there is provided a vacuum attachment for a blower, comprising:

[0008] an input air channel having an air inlet; and

[0009] a through channel from a vacuum inlet to an outlet,

[0010] in which the input air channel terminates in a port in the through channel, in which the port is positioned so as to direct air flowing from the input air channel in a direction through the through channel away from the vacuum inlet, in which the air inlet has a mounting surface on which can be mounted an air outlet of the blower in a releasable and re-engagable manner.

[0011] As such, this provides for an attachment that can be attached onto a blower in order to provide a vacuum debris collection device. Thus, two separate devices need not be provided; a user can have a blower, which can be used for when blowing of debris is required, and then convert it into a vacuum debris collection device when it is desired to collect debris. Furthermore, all that is needed in order to convert the blower into a vacuum apparatus is to engage the air inlet of the vacuum attachment with the outlet of the blower; no complicated rebuilding of the blower is required, and the blower still operates on a "clean fan" basis.

[0012] The input air channel may comprise a shell surrounding at least a portion of the through channel, with the shell and the portion of the through channel typically being cylindrical and/or coaxial, although the through channel and the shell could also be oval, elliptical or rectangular/square with rounded corners in cross section. The input air channel may comprise an input tube between the air inlet and the shell.

[0013] The input tube and the shell will typically have internal cross sectional areas, the internal cross sectional area of the input tube being less than the internal cross sectional area of the annulus formed between the shell and a portion of the through channel, the input air channel comprising a transition portion between the input tube and the shell, the transition portion having a cross sectional area smoothly varying from that of the input tube to that of the shell. This allows for a gradual decrease of the air velocity, so as to decrease the back pressure at the air inlet (and so on the fan of the blower). The input tube may be any desired shape in cross-section, such as circular, oval, elliptical or rectangular/square with rounded corners.

[0014] The input air channel may change direction through the port, typically by more than 90, as may be measured along an outer surface of the input air channel. The input air channel may change direction smoothly through the port; by smoothly, we may mean sufficiently smoothly so as not to create significant turbulence. As such, the port may have a radius of curvature r_1 (typically measured along the centreline of the port), which is greater than the width w of the exit of the port.

[0015] The through channel will typically have an inner circumference; the port may extend around at least three quarters of the circumference, and preferably around (substantially) the entire circumference. This has been found to provide a smoother airflow, and also means that the debris will preferentially be carried up the centre of the through channel, rather than being pressed against the side as with the case where the port is provided significantly asymmetrically around the through channel.

[0016] There may be a collection container coupled to the outlet, in which debris entrained in the air which has passed through the through channel can be collected. The collection container may comprise a bag formed of flexible material such as textile material, where the material allows the air flowing out of the inlet to escape but retains debris entrained in the air. Alternatively, it may be a perforated box or other such container, which can be opened to empty debris.

[0017] The through channel will typically be straight, or at least substantially straight, from vacuum inlet to outlet, although it may widen towards the outlet. Having a (substantially) straight through channel means that less debris will impact the internal walls of the through channel and that longer objects, such as bottles or cans, may be vacuumed without any hindrance on their way through the through channel. Widening the through channel towards the outlet will give a better vacuum performance than if the through channel has the same width the whole way to the outlet. For example, if the cross-sectional area of the through channel increases 100%, the so-called outlet losses may be as much as 75% smaller than in the case of a through channel which does not widen at the outlet. Typically, where the channel widens, the angle of inclination of the internal walls of the through channel to a central axis of the through channel may be between 5 and 20 degrees.

[0018] The through channel has an internal diameter and the port is spaced at least half, or at least one internal diameter along the through channel from the vacuum inlet. This has been found to provide a stronger vacuum force, potentially

because the distance between the inlet and the port allows air drawn in to be of smoother flow than if it were directly drawn in at the port.

[0019] The attachment may comprise a tail part extending between the port and the vacuum inlet, which may define part of the through channel, preferably over at least half if not one internal diameter of the through channel along the through channel. This tail part has been found to be a particularly simple and light construction, as well as achieving the smoother flow discussed above.

[0020] The mounting surface may be shaped so as to provide a releasable engagement for the blower, such as a bayonet or screw engagement. Alternatively, it may provide a simple interference or friction engagement, a snap engagement or a clamp.

[0021] The attachment may be formed of two interengaging pieces, an insert and a channel member which defines part of the through channel, the insert and the channel member being held captive between the interengaging pieces and defining between them walls of the port, typically through the change of direction. Typically, the insert may define the walls of the port on the outside of the change of direction and a leading edge of the channel member may form the walls of the port on the inside of the change of direction. The channel member may define part of the through channel between the port and the outlet. The insert may be provided with spacers which act to space the insert from the channel member, the spacers being shaped complementary to the leading edge.

[0022] The interengaging parts may be a threaded or screw engagement. The channel member may be a tubular member, where the through channel is tubular.

[0023] According to a second aspect of the invention, there is provided a combination of a blower and a vacuum attachment in accordance with the first aspect of the invention, in which an air outlet of the blower is coupled to the air inlet of the vacuum attachment.

[0024] Thus, there is provided the blower and the attachment coupled together. The blower may be a back-mounted blower, which is typically worn on the back of a user in the manner of a backpack. This is more ergonomic than carrying the weight of an existing hand-held garden vacuum, particularly for professional users of such product.

[0025] According to a third aspect of the invention, there is provided a vacuum apparatus, comprising a source of pressurised air, an input air channel having an air inlet coupled to the source, a through channel from a vacuum inlet to an outlet, in which the input air channel terminates in a port in the through channel, in which the port is positioned so as to direct air flowing from the input air channel in a direction through the through channel away from the vacuum inlet, in which the through channel has an inner circumference, and in which the port extends around at least three quarters of the circumference.

[0026] This has been found to provide a smoother airflow, and also means that the debris will preferentially be carried up the centre of the through channel, rather than being pressed against the side as with the case where the port is provided significantly asymmetrically around the through channel.

[0027] Preferably, the port extends around the entire circumference.

[0028] The vacuum apparatus may have any of the optional features described above with reference to the first two aspects of the invention.

[0029] There now follows, by way of example only, embodiments of the invention, described with reference to the accompanying drawings, in which:

[0030] FIG. **1** shows a perspective view of a vacuum attachment in accordance with a first embodiment of the invention;

[0031] FIG. **2** shows a cross section through the vacuum attachment of FIG. **1**;

[0032] FIG. **3** shows the vacuum attachment of FIG. **1** being used by a user;

[0033] FIG. **4** shows an enlarged cross-section through the port of the attachment of FIG. **1**;

[0034] FIG. **5** shows a cross-sectional perspective view of how the attachment of FIG. **1** is formed of three separate mouldings;

[0035] FIG. **6** shows a simulation of the airflow through the attachment of FIG. **1**;

[0036] FIG. **7** shows an exploded view of a vacuum attachment in accordance with a second embodiment of the invention; and

[0037] FIG. **8** shows a cross-sectional perspective view of the vacuum attachment of FIG. **7**.

[0038] A vacuum attachment **1** in accordance with a first embodiment of the invention is shown in FIG. **1** to **5**. The attachment **1** comprises a moulded plastic body which forms a through channel **5** between a vacuum inlet **6** and an outlet **7**. The through channel **5** is preferably cylindrical, but may also have other cross-sectional shapes, such as for example oval or elliptic. The bore of this channel is generally straight, as air entrained with debris will pass through the through channel **5**, and it is preferably to leave as few obstacles as possible in the path of the debris.

[0039] The moulding forming the attachment also forms a further channel, the input air channel **3**. This starts at an air inlet **4** and at that point has the form of a tube. This inlet tube **13** is preferably cylindrical, but may also have other cross-sectional shapes such as oval, elliptic, square. The input air channel **3** continues through a transition portion **14** to a shell **11** surrounding a portion **12** of the through channel **5**. The shell **11** preferably has the same shape as the through channel **5**, i.e. if the through channel **5** is cylindrical, the shell **11** has a cylindrical shape. Further, the shell **11** may surround the portion **12** in a coaxial manner. To avoid losses in vacuum performance, the internal cross section A_1 of the inlet tube **13** is less than the internal cross section A_2 of the annulus created between the shell **11** and the portion **12** of the through channel **5**. The internal cross section A_2 of the annulus is measured upstream of the port **8**, i.e. before the input air channel **3** starts narrowing.

[0040] The transition portion **14** smoothly increases in cross section between the inlet tube **13** and the shell **11**, and also shifts the input air channel **3** from the position of the input tube **13**, parallel to but offset from the through channel, to be wrapped coaxially around the shell **11**. Keeping this transition smooth improves performance by reducing turbulence and keeps the pressure drop across the attachment low, which has advantages set out below.

[0041] The input air channel **3** terminates in a port **8** where the input air channel enters the through channel **5**. The cross section of the input air channel decreases as it approaches the port **8**, to cause an increase in the speed of the air flowing therethrough. As it passes through the port, the airflow changes in direction by preferably at least approximately 135 degrees, so that air flowing through the port is ejected into the through channel **5** in the general direction of the outlet **7**.

Again, the change in direction is smooth, in that the inner surface **16** of the port on the inside of the change of direction has a radius of curvature r_1, which is greater than the width w of the exit of the port **8**. The port, shown in cross section in FIG. **4** of the accompanying drawings, extends around the internal circumference of the through channel **5**, as can be seen in the cut-away drawing shown in FIG. **5** of the accompanying drawings.

[0042] The through channel **5** extends away from the port in both directions; at least half an internal through-channel diameter in the case of a tail part **23**, which extends towards the vacuum inlet **6**. The presence of the tail part **23** also gives a simpler and lighter construction than if the shell **11** and the portion **12** extended as far as the tail part **23** does. The outlet **7** has fixing hooks **18** for a collection bag **15**.

[0043] The air inlet **4** has a mounting surface **9** on which can be mounted the air outlet **10** of a blower **2**. This mounting surface **9** allows a releasable and re-engagable coupling of the blower and the attachment, so that the attachment **1** can be attached to the blower **2** when it is desired to vacuum debris. In the present embodiment, the coupling is shown as a bayonet-style coupling, although any suitable coupling that will keep the inlet **4** on the outlet **10** together can be used.

[0044] In use, the blower **2** will provide a stream of air to the inlet **4**. This air does not yet have any debris entrained in it, and so the fan in the blower is a "clean" fan that does not need to be protected against such debris in the airstream. The air will pass through the input air channel **3**, and pass out through the port **8** into the through channel **5**. The structure of input air channel **3** gives an even distribution of the air at port **8**.

[0045] A moving airstream will cause a drop in the local air pressure, and so the moving airstream from the port **8** directed towards the outlet **7** will cause a drop in pressure at the vacuum inlet **6**. As such, air will be drawn into the vacuum inlet **6**. The net result of the airflow from the blower being introduced into the air inlet **4** is therefore an airflow from the vacuum inlet **6** to the outlet **7**.

[0046] Debris **17** positioned near the vacuum inlet **6** will be entrained into the air flow, and will be carried through the through channel **5** and passed out the outlet **7**, where it can be collected in collection bag **15**. Debris therefore does not come into contact with the blower **2** at all.

[0047] Because the port **8** covers the entire circumference of the through channel, the airflow through the through channel **5** is relatively smooth, as can be seen on the airflow simulation in FIG. **6** of the accompanying drawings. With an airflow of 0.197 kilograms per second, the speed of the airflow measured at the vacuum inlet **6** is approximately 20 metres per second, and the effect of the attachment is to draw in approximately 1.74 times the airflow generated by the blower. The suction force generated is sufficient to lift most garden debris (wet leaves and the like), and is even sufficient to pick up a drinks can having mass of over 200 grams; the suction force is therefore easily able to pick up an empty 500 millilitre beer or soda can. As such, the combination of blower and attachment can be used to clean stadiums and the like, rather than manual litter-picking. A prototype of the attachment modelled in this simulation has been found to outperform these predictions.

[0048] The blower **2** can be a backpack-mounted blower, which allows part of the weight of the combination of blower **2** and attachment **1** to be taken on the user's back. This only leaves the relatively lightweight attachment **1**, and potentially the collection bag **15**, to be hand carried by the user. This is more ergonomic than in the prior art.

[0049] It was discussed above that one of the effects of the arrangement of the input air channel **3** was to reduce the pressure drop caused by the attachment. This is advantageous, as it reduces the back pressure on the blower, thus reducing the load on the blower and improving both its efficiency and durability.

[0050] The presence of the through channel **5** continuing a significant distance upstream from the port **8** towards the vacuum inlet **6** through the tail part **23** acts to smooth the airflow through the through channel **5** and has been found to provide an improved and more consistent suction force than if that extension is not present.

[0051] FIG. **5** of the accompanying drawings shows how the attachment can conveniently be formed as three separate mouldings. The first moulding **20**, forms the through channel **5** downstream of the port **8** and so may include the outlet **7**. It also provides support fins **19** for the second moulding **21**. The second moulding forms the input air channel **3** and is moulded over the first moulding **20**, such that the support fins support the second moulding over the first moulding so as to define part of the input channel **3** in the space between the shell **11** and the first moulding **20**. Finally, the third moulding **22** is moulded such that it can be fit over the first two mouldings **20**, **21**, and provides the through channel **5** upstream of the port **8** and so includes the vacuum inlet **6**.

[0052] It is desirable for the second moulding **21** to be an airtight fit over the first moulding **20**, so that the air flow from the input air channel **3** as it enters the shell smoothly flows towards the port **8** and does not reverse direction and cause turbulence and so hamper the vacuum effect.

[0053] An attachment **51** in accordance with a second embodiment of the invention is shown in FIGS. **7** and **8** of the accompanying drawings. In this embodiment, features equivalent to those of the first embodiment described above have been given corresponding reference numerals, raised by 50.

[0054] The functioning of the attachment of this embodiment is identical to that described above, in that air blown into air inlet **54** will pass through input air channel **53** and port **58** into through channel **55**. This will cause an airflow through through channel **55** from vacuum inlet **56** to outlet **57**, entraining debris therewith. The differences between this embodiment and the first embodiment lie in the construction of the attachment **51**.

[0055] Rather than being formed of three mouldings as discussed above with respect to FIG. **5**, the attachment **51** of the present embodiment is formed of several pieces as follows:

[0056] A tail part **80** forming the through channel **55** upstream of the port **58**;

[0057] An insert **81** forming part of the walls of the port **58**;

[0058] A tubular member **82**, which forms a channel member as described above, forming at least part of the through channel downstream of the port **58**; and

[0059] An inlet part **83** forming the input air channel **53** and the outlet **57**.

[0060] The tail part **80** and inlet part **83** may be screwed together or otherwise fixed to each other to hold the insert **81** and tubular member **82** captive between them. The insert **81** and the tubular member **82** define the walls of the port **58**,

with the tubular member **82** providing the walls on the inside of the bend in the airflow through the port **58** and the insert **81** providing the outside walls.

[0061] The insert **81** is provided with wings **85** which space the insert **81** from the tubular member **82**. The wings are shaped so as to be complementary to the curved leading edge **86** of the tubular member (that is, the edge that provides the inner wall of the port **58**). The shape of the wings therefore assists in keeping the tubular member **82** coaxial with the insert **81** and with the inlet part **83**. Unless the insert **81** and tubular member **82** are correctly aligned with the wings **85** spacing the insert **81** from the tubular member **82**, the tail part **80** will not be able to be screwed onto the inlet part **83** correctly, and so it will be apparent to the assembler that the parts are not correctly aligned. This may improve the accuracy with which the device is assembled, as it will be apparent when it is not correctly assembled. Furthermore, the support fins **19** of the previous embodiment are no longer required.

[0062] It is to be noted that the insert **81** could, in an alternative embodiment, be made integral with the tail part **80**, as those parts need not be separable.

1. A vacuum attachment for converting a blower into a vacuum apparatus, comprising:

an input air channel having an air inlet; and

a through channel from a vacuum inlet to an outlet, in which the input air channel terminates in a port in the through channel, the port is positioned so as to direct air flowing from the input air channel in a direction through the through channel away from a vacuum inlet; the through channel has an inner circumference and the port extends around at least three quarters of this circumference; the air inlet has a mounting surface on which can be mounted an air outlet of the blower in a releasable and re-engagable manner.

2. The attachment of claim **1**, in which the input air channel comprises a shell surrounding at least a portion of the through channel.

3. The attachment of claim **2**, in which the shell and the portion of the through channel are cylindrical and/or coaxial.

4. The attachment of claim **2**, wherein the through channel has an oval or elliptic cross sectional shape.

5. The attachment of claim **2**, in which the input air channel comprises an input tube between the air inlet and the shell.

6. The attachment of claim **5**, in which the input tube is cylindrical, and has a cross-sectional shape that is circular, oval, elliptic, square, rectangular or square with rounded corners.

7. The attachment of claim **5**, in which the input tube and the shell have internal cross sectional areas, the internal cross sectional area of the input tube being less than the internal cross sectional area of the shell, the input air channel comprising a transition portion between the input tube and the shell, the transition portion having a cross sectional area smoothly varying from that of the input tube to that of the shell.

8. The attachment of claim **1**, in which the input air channel changes direction by more than 90 degrees through the port.

9. The attachment of claim **8**, in which the input air channel changes direction smoothly through the port.

10. The attachment of claim **8**, in which the port has a radius of curvature, which is greater than the width of the exit of the port.

11. The attachment of claim **1**, in which one port extends entirely around the circumference.

12. The attachment of claim **1**, comprising a collection container coupled to the outlet.

13. The attachment of claim **1**, wherein the through channel is substantially straight from the vacuum inlet to the outlet.

14. The attachment of claim **1**, wherein the through channel widens towards the outlet.

15. The attachment of claim **14**, wherein the angle of inclination of the internal walls of the through channel to a central axis of the through channel is between 5 and 20 degrees.

16. The attachment of claim **1**, comprising a tail part extending between the port and the vacuum inlet.

17. The attachment of claim **16**, in which the tail part defines part of the through channel.

18. The attachment of claim **17**, in which the through channel has an internal diameter and the port is spaced at least half an internal diameter along the through channel from the vacuum inlet.

19. The attachment of claim **18**, in which the tail part defines the through channel along at least half an internal diameter of the through channel.

20. The attachment of claim **1**, formed of two inter-engaging pieces, an insert and a channel member which defines part of the through channel, the insert and the channel member being held captive between the inter-engaging pieces and defining between them walls of the port.

21. The attachment of claim **1**, wherein the attachment is formed as at least three separate mouldings that are fit together.

22. The attachment of claim **21**, wherein a second moulding of the at least three separate mouldings is airtight fit over a first moulding.

23. The attachment of claim **1**, wherein an air outlet of a blower is coupled to the air inlet of the attachment.

24. A backpack mounted vacuum apparatus, comprising a source of pressurized air, an input air channel having an air inlet coupled to the source, a through channel from a vacuum inlet to an outlet, in which the input air channel terminates in one port extending around an internal circumference of the through channel, the port is positioned so as to direct air flowing from the input air channel in a direction through the through channel away from the vacuum inlet, and the port extends around at least three quarters of the circumference.

25. The vacuum apparatus of claim **24**, in which the port extends entirely around the circumference of the through channel.

26. (canceled)

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