

[54] **VACUUM CLEANER**
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[51] Int. Cl.....B01d 41/02
[58] Field of Search55/366-367, 378-380, 55/369, 282-283, 288-289, 291-293, 295, 299-301, 304-305, 429, 016.3, 471, 468, 334; 15/327 A-327 E, 327 R, 347, 349, 352; 210/315

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[57] ABSTRACT

In a vacuum cleaner comprising a housing including a motor fan unit and a dust collecting case detachably connected to the housing, the dust collecting case is provided at its outlet opening with a two-stage filtering means comprising a conical filter screen of relatively large meshes and a cloth main filter which extend toward the inside of the dust collecting case in such a spaced relationship that the outlet opening is covered in double.

10 Claims, 8 Drawing Figures

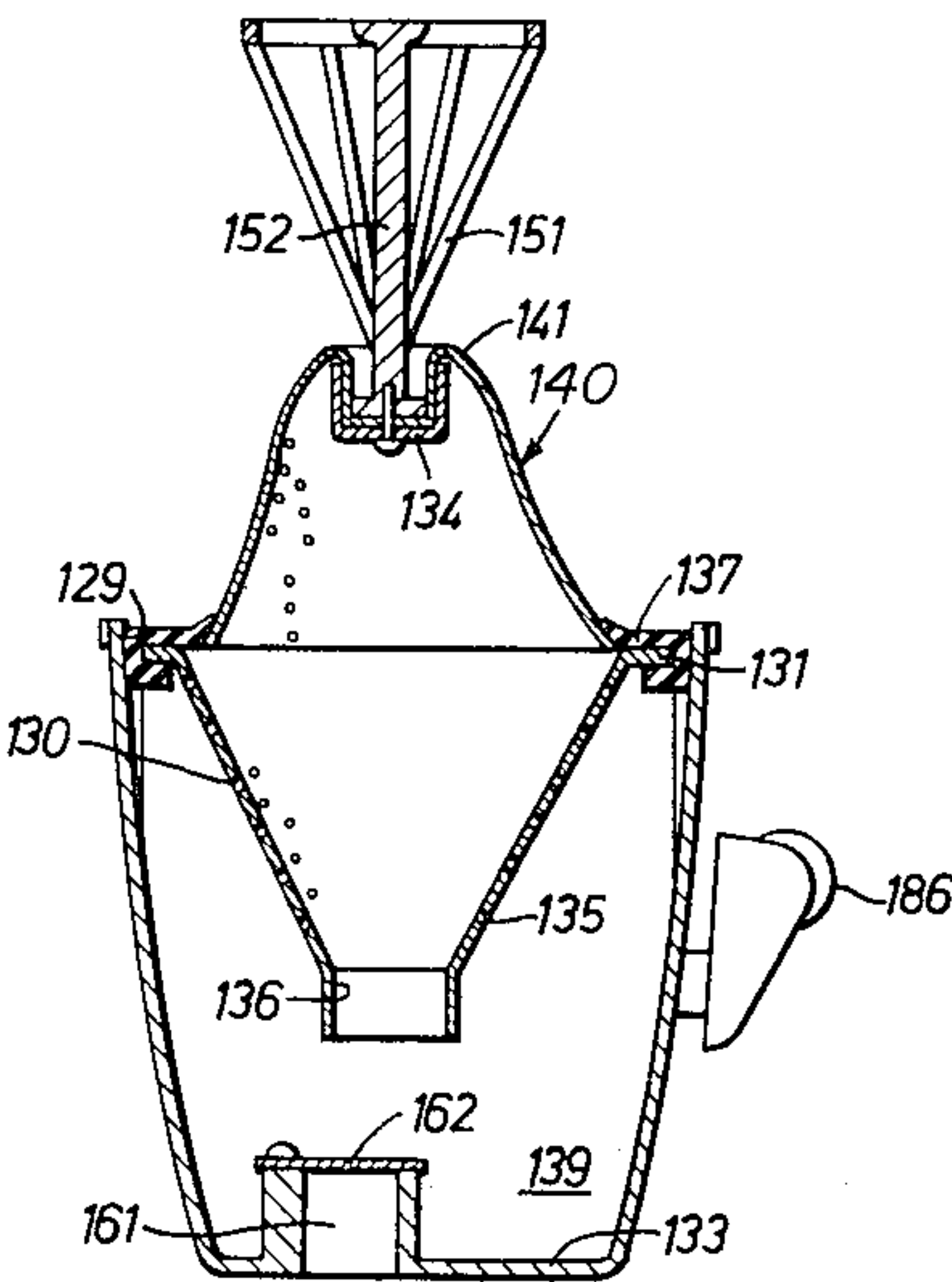
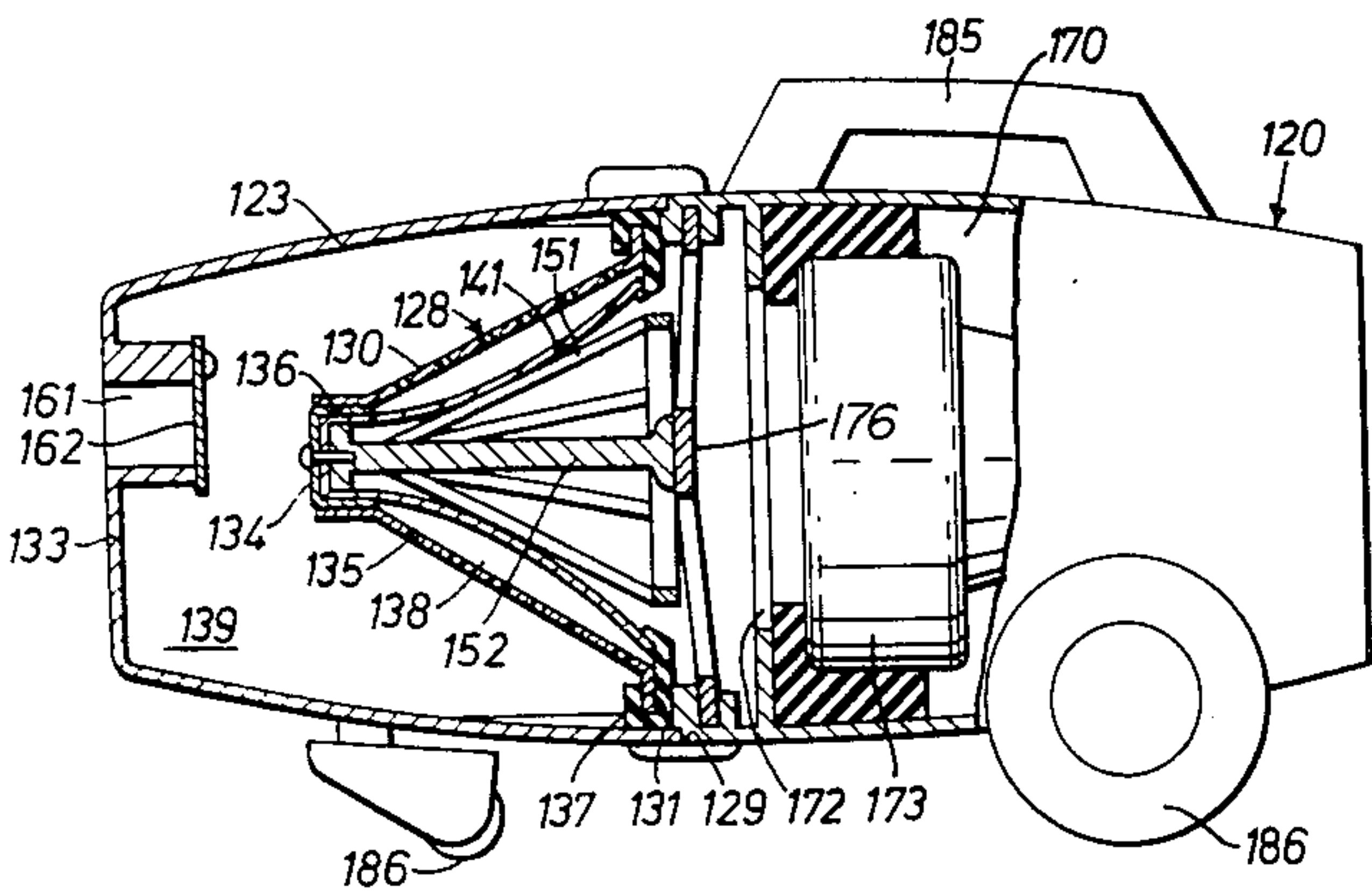


FIG.1

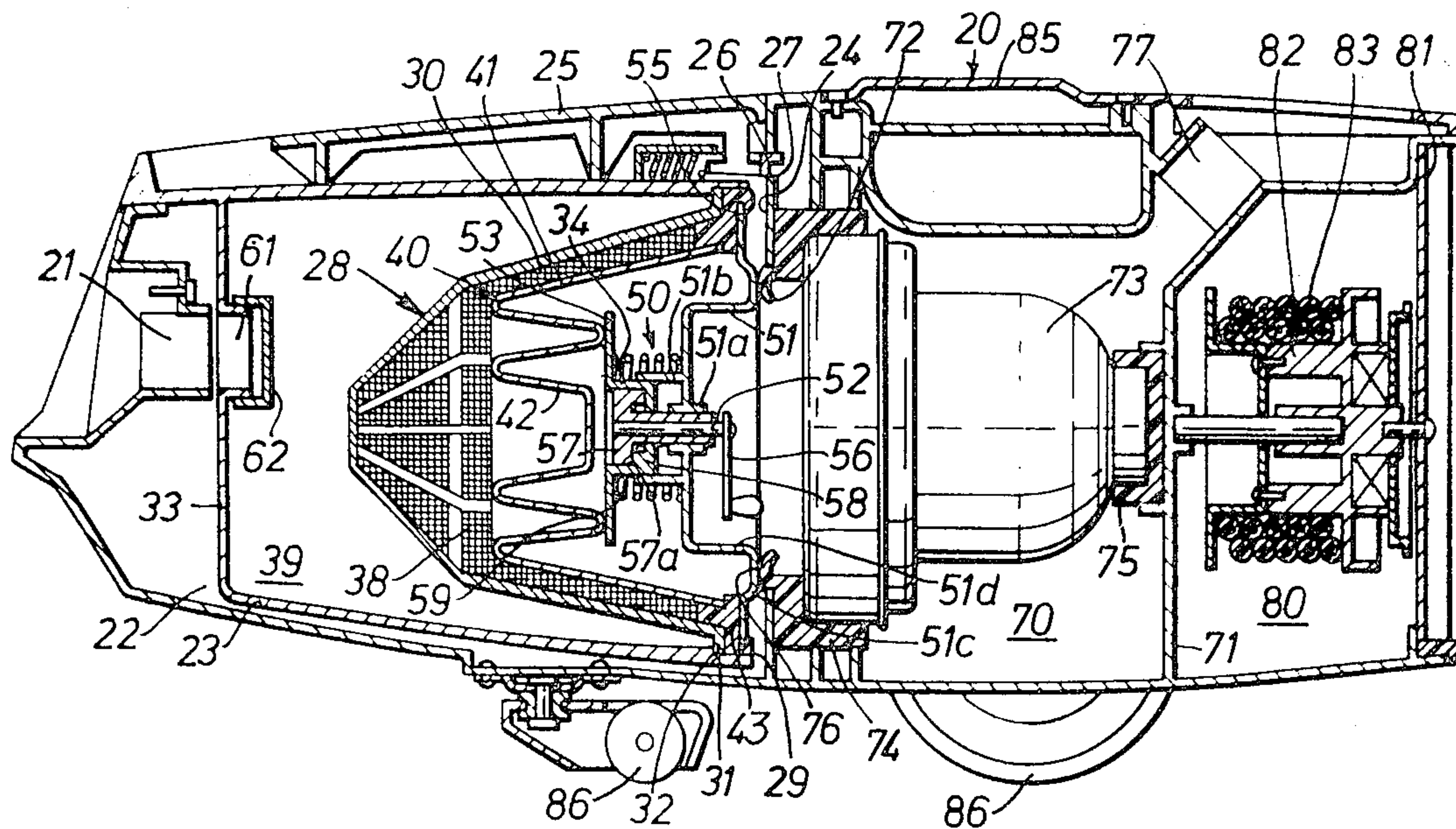
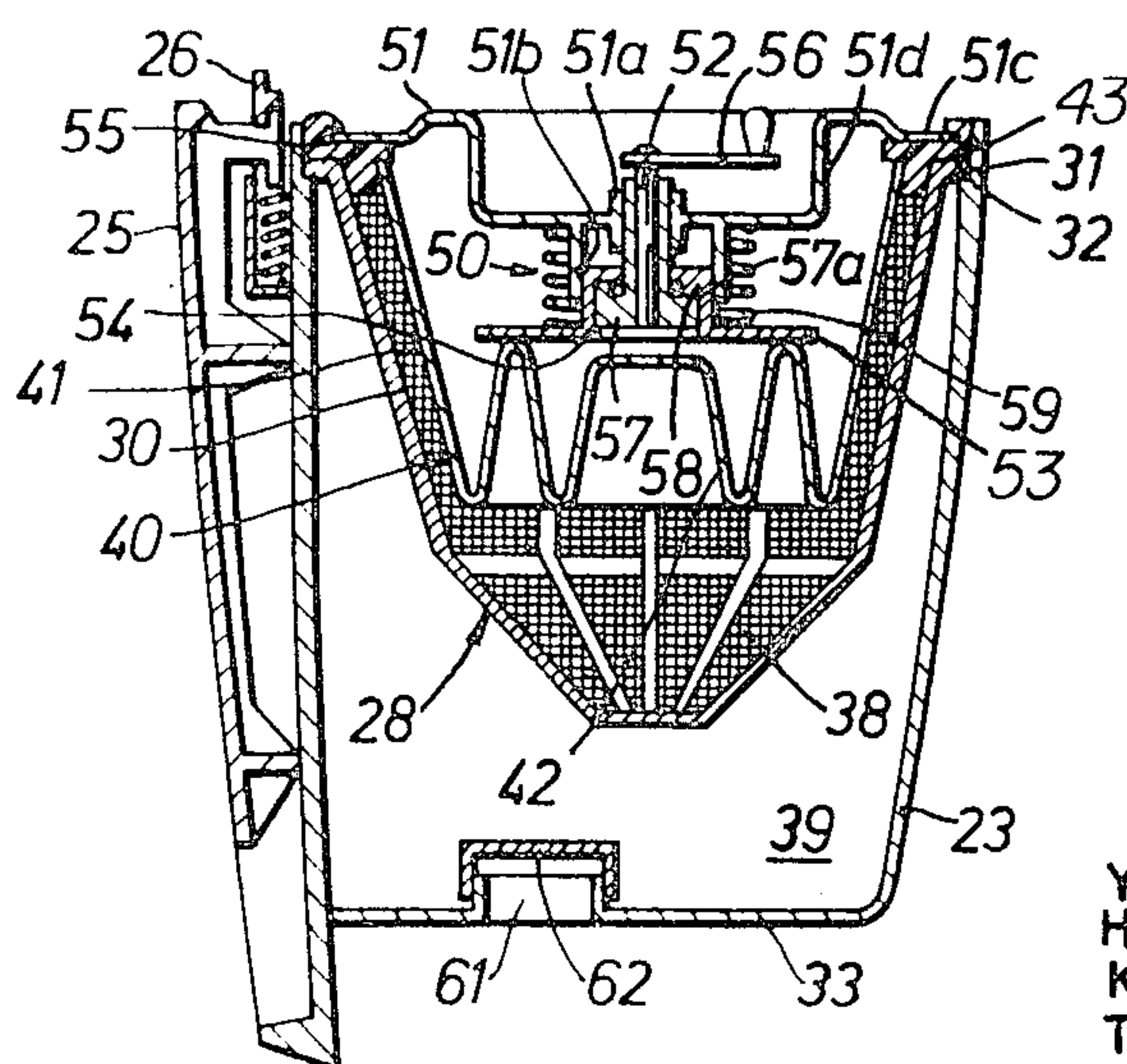


FIG.2



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FIG. 3.

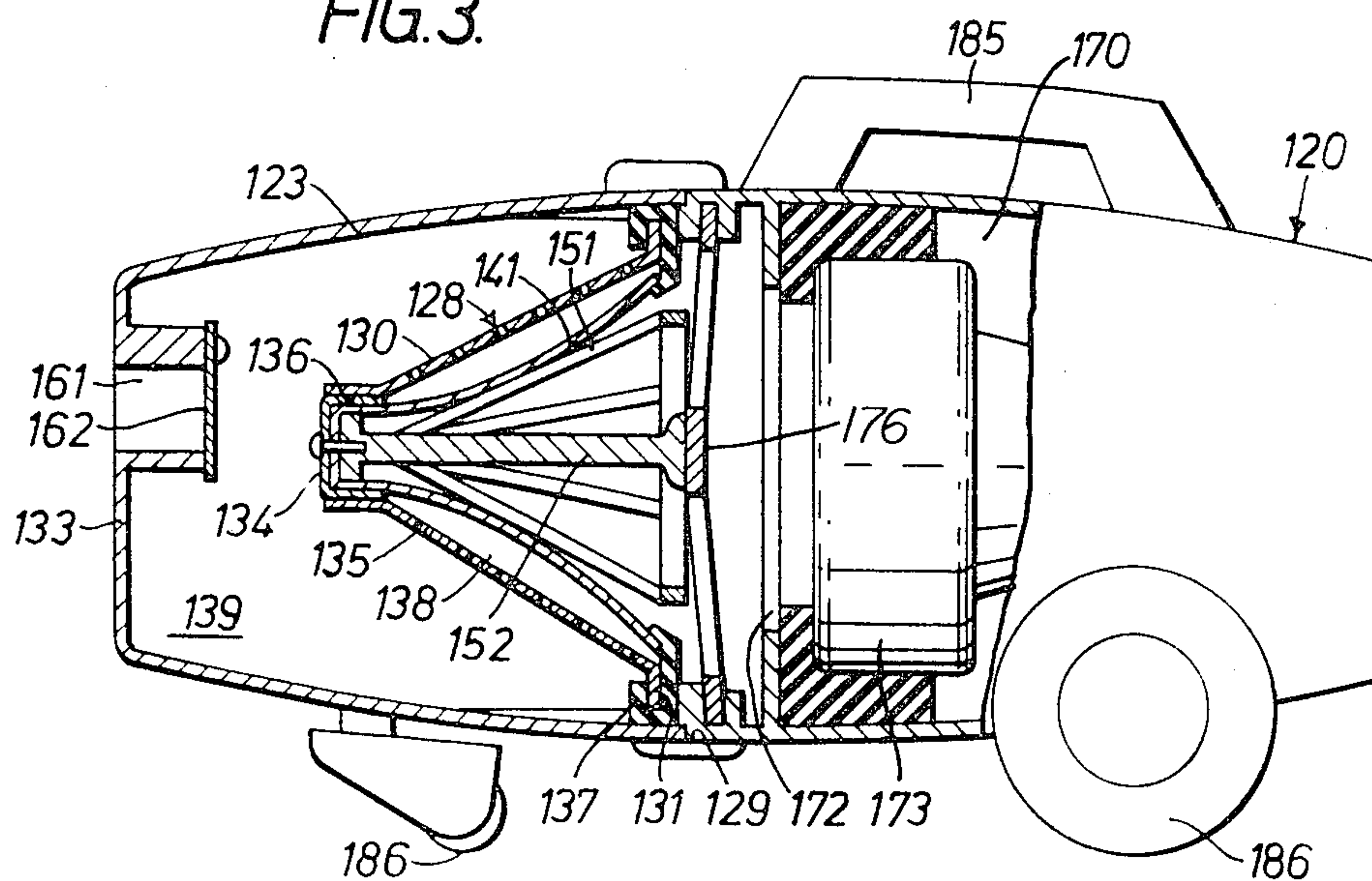
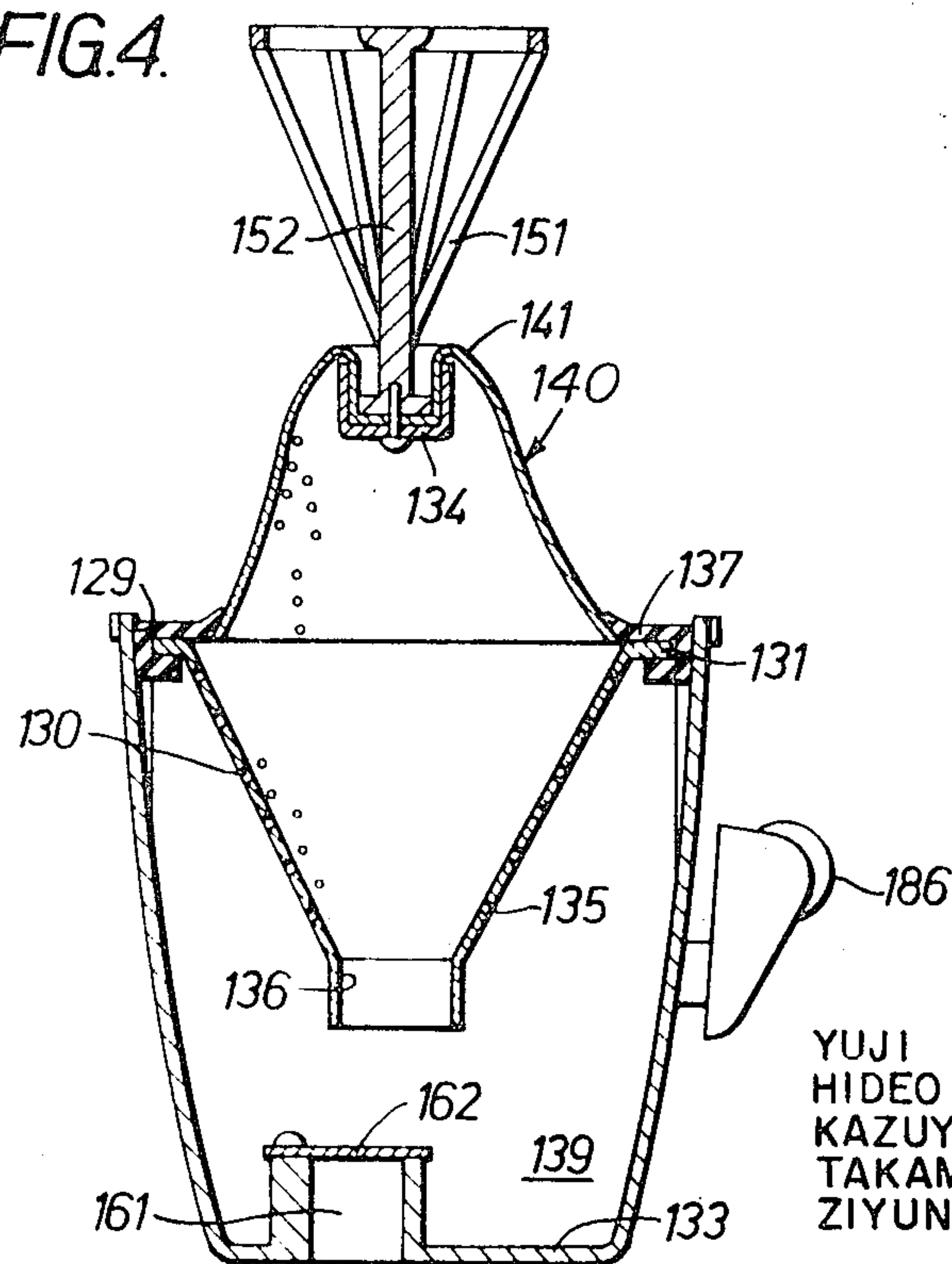


FIG. 4.



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FIG. 5.

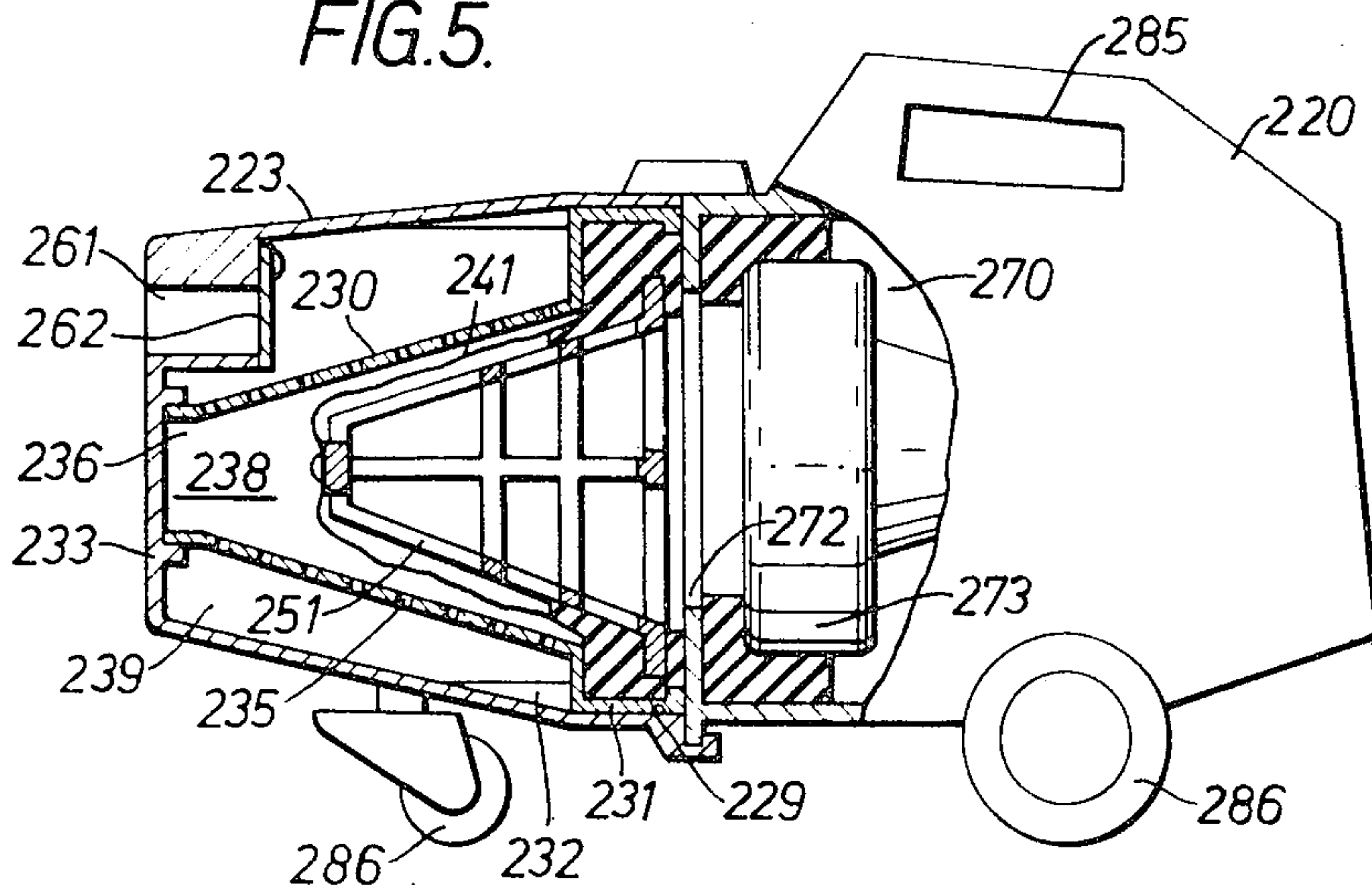


FIG. 6.

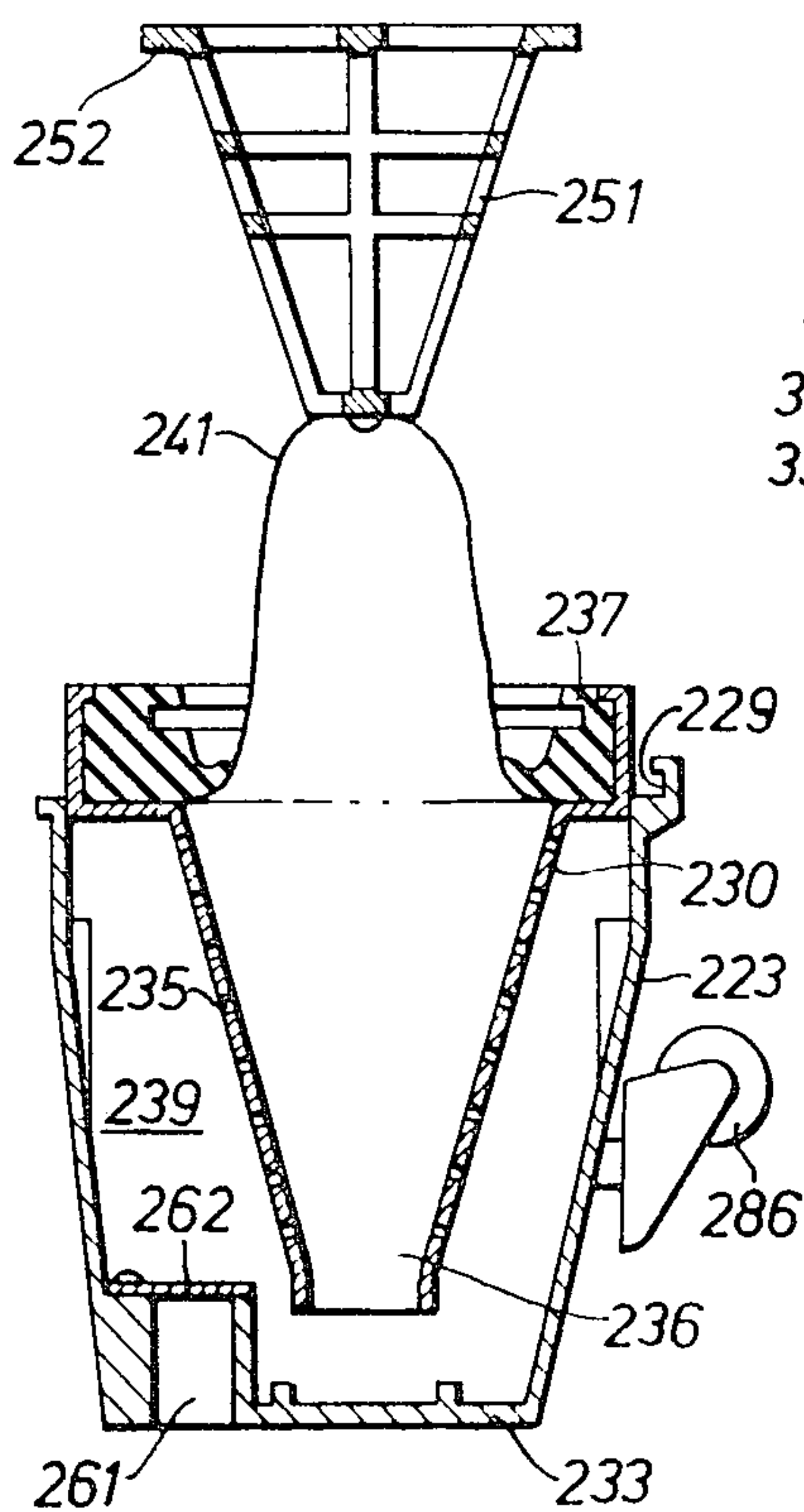
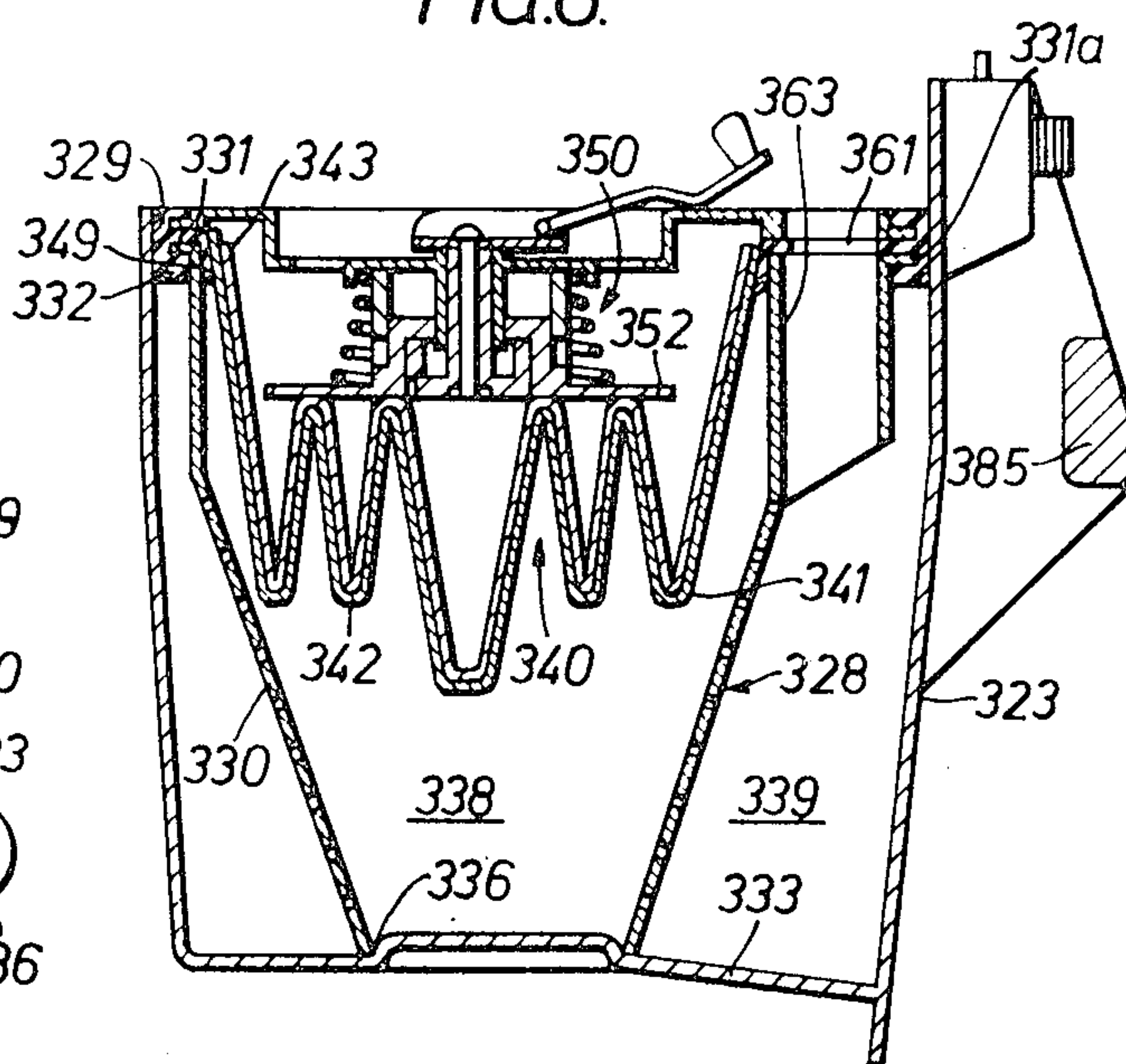


FIG. 8.



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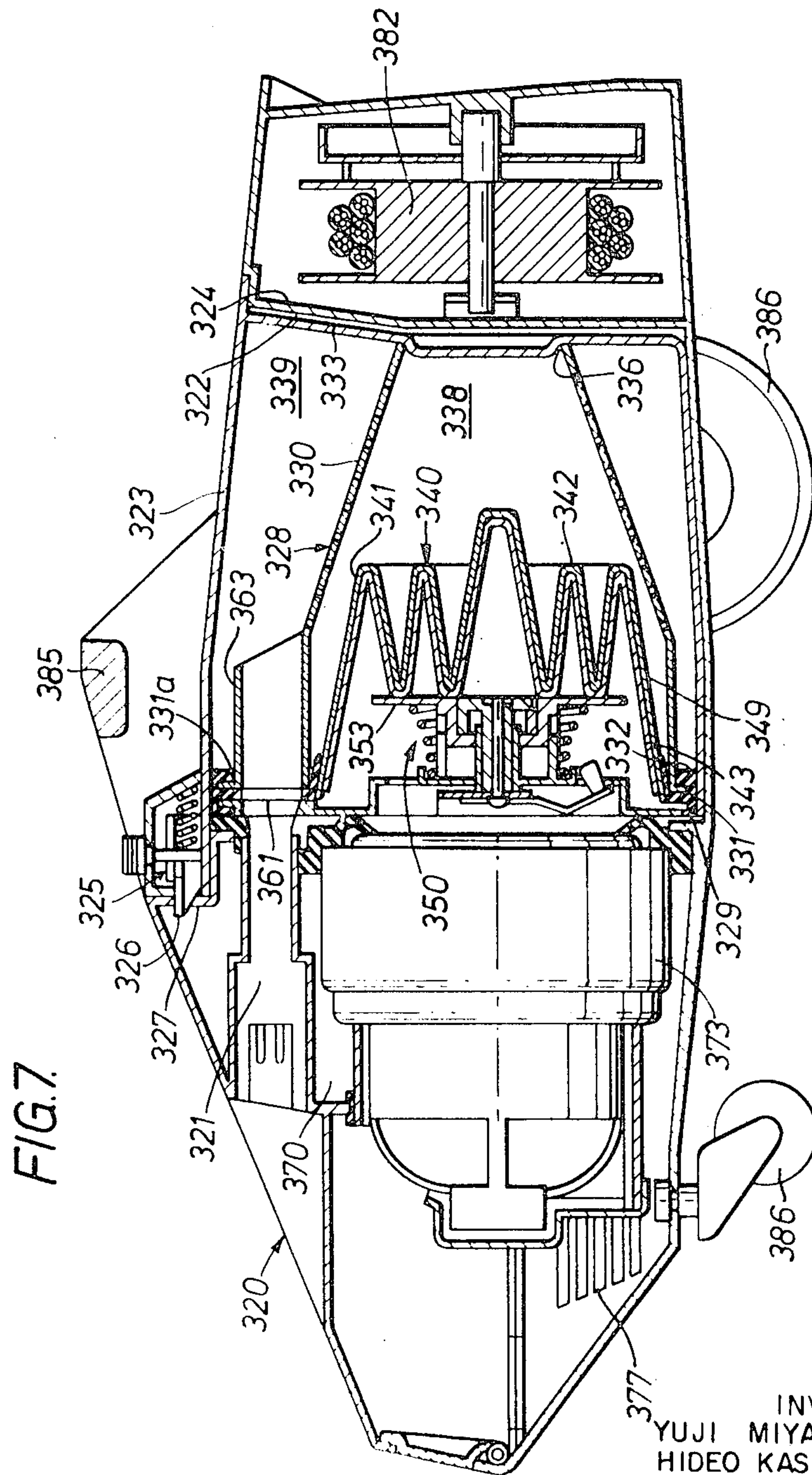


FIG. 7

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VACUUM CLEANER

BACKGROUND OF THE INVENTION

This invention relates to new and improved vacuum cleaner and more particularly to improvements in detachable dust collecting cases for vacuum cleaners.

In conventional vacuum cleaners a cloth bag is employed for filtering air through the cleaner body. Prior to cleaning operation another disposable filter bag made generally of a piece of paper is inserted within the fixed cloth bag which together forms a filtering system. Upon operation of the cleaner, the insucked air passes through the filtering system and almost all of the dust carried with the air stream is collected primarily by the paper bag. As this dust collection proceeds, an incalculable number of fine dust particles stick to the entire inner surface of the paper bag resulting in the clogging of fine filtering apertures in the bag with dust particles. This premature clogging of the paper bag tends to obstruct the free passage of insucked air flow through the cleaner and greatly reduces air suction by the cleaner only minutes after it has been put into operation. As is apparent to those skilled in the art, this reduction of air sucking capability of the cleaner causes, in turn, the reduction of its dust collecting ability. Therefore, in order to maintain the desired dust collecting capability it becomes necessary to change the paper bag with a fresh one well before the old one is substantially filled with the assembled dust. However, frequent replacement of the paper bags is troublesome as well as costly. As a paper bag is fragile in nature, some limitations are placed on the maximum dimensions of the bag, which in turn restricts the maximum space within the bag available for the storage of collected dust and dirt. This also necessitates frequent change of dust bags since such bags can accommodate only a small amount of dust removed from the air stream through the cleaner.

Another important disadvantage with the conventional vacuum cleaners is the difficulty encountered in disposing of the dust collected during operation. It is therefore highly desirable to provide a vacuum cleaner which completely eliminates the above noted shortcomings.

In order to avoid the above mentioned disadvantages, an attempt has been made to utilize a two-stage filtering system and a detachable dust collecting case. The known two-stage filtering system comprises a first dust collecting receptacle having incorporated therein a filtering screen of a relatively large mesh size and detachably positioned within the cleaner body. The known filtering system further includes a second filtering member of fine mesh size located immediately down-stream of the first dust collecting case within the cleaner body with its inlet opening communicating with the outlet opening of the first dust collecting receptacle. With this arrangement, insucked air through the cleaner body passes initially through the first receptacle where dust having a relatively large size is filtered from the air stream by the filtering screen and through the second filtering member where fine dust particles are removed from the air flow. Vacuum cleaners of this type are disclosed in the co-pending U.S. Pat. application, Ser. No. 806,974, entitled "Vacuum Cleaner" filed Mar. 13, 1969, which is assigned to the assignee of the subject application.

The above mentioned two-stage filtering system is however disadvantageous in that it necessitates the provision of a utility chamber for the second filtering member within the cleaner body at a position immediately down-stream of the first dust collecting receptacle. In addition, it is not so easy to remove the collected fine dust particles from the second filtering member which is located in an elongated chamber within the cleaner body.

A primary object of the invention is to provide a new and improved vacuum cleaner in which a two-stage filtering system is entirely enclosed in a detachable dust collecting case in a highly compact manner but without sacrificing dust collecting efficiency.

Another object of the invention is to provide a new and improved vacuum cleaner which greatly facilitates the disposal of all the collected dust and dirt.

A further object of the invention is to provide a new and improved vacuum cleaner in which the desired dust collecting capability thereof is always maintained through its operation.

A still further object of the invention is to provide a new and improved vacuum cleaner in which a detachable dust collecting case further includes a dust removing device therein.

One of the other objects is to provide a new and improved vacuum cleaner in which fine dust particles collected at the second stage can be located in the detachable dust collecting case with collected dust particles having relatively large sizes for facilitating the disposal of them.

SUMMARY OF THE INVENTION

The vacuum cleaner according to the invention comprises a housing including a motor fan unit and a dust collecting case detachably connected to said housing and cooperating with the housing to form a suction system. The dust collecting case is provided with an inlet opening and an outlet opening. According to the invention the outlet opening of the dust collecting case is successively covered by pre-filtering means and main filtering mean. The prefiltering means comprises a substantially conically shaped screen of relatively large mesh which extends into the inside of the dust collecting case. The main filtering means comprises a cloth filter which extends into the inside of the conically shaped screen and is disposed in a spaced defined with said conically shaped screen so as to form a fine dust particle collecting space therebetween.

With the above arrangement, the filter screen as a first filtering member can entirely be contained within the dust collecting case since it extends into the inside of the dust collecting case. The conical form of the filter screen is advantageous for increasing the effective filtering area and facilitates forming a space for accommodating the second filtering means therein. With the arrangement of the main filter within the space define by the conical filter screen, the two-stage filtering system can entirely be accommodated in the dust collecting case.

In order to prevent the dust collected in the case to escape therefrom, the inlet opening may be provided with a check valve.

In a preferred embodiment of the invention, the position of the inlet opening of the dust collecting case is offset from the central axis of the conically shaped screen so as to direct the air flow through the inlet opening onto a top surface of the conically shaped screen, whereby the top surface of the screen may always be kept free from clogging. This feature is important to maintain the cleaner in a good dust collecting condition.

The effective filtering area may be increased by shaping it in a truncated cone form having an apex portion which is concentrically waved.

It is preferred to provide the cloth filter with a dust removing device. The dust removing device may be a manually operative vibrator attached to the cloth filter.

In another embodiment of the invention, the conically shaped screen can be provided at its apex portion with an opening which is closed by a detachable plug. The plug may be mounted on the top end of the cloth filter and have a handle rod attached thereto. The opening at the apex portion of the conical screen may alternatively be closed by the end wall of the dust collecting case.

In order to hold the cloth filter in a conical form, a support frame may be used.

It is possible to locate the inlet opening of the dust collecting case at the same side as that where the outlet opening thereof is located. In such the case like this, the air flow is re-directed by substantially 180°, or U-turned, in the dust collecting case.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be fully understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a sectional view of a vacuum cleaner embodying the present invention;

FIG. 2 is a sectional view of the dust collecting case illustrated in FIG. 1, showing the state in which it is detached from the cleaner housing and placed for disposing of the collected dust;

FIG. 3 is a sectional view similar to FIG. 1 of another embodiment of the invention;

FIG. 4 is a sectional view similar to FIG. 3 of the dust collecting case illustrated in FIG. 3;

FIG. 5 is a sectional view similar to FIG. 1 of a further embodiment of the invention;

FIG. 6 is a sectional view similar to FIG. 2 of the dust collecting case illustrated in FIG. 5;

FIG. 7 is a sectional view similar to FIG. 1 of a still further embodiment of the invention; and

FIG. 8 is a sectional view similar to FIG. 2 of the dust collecting case illustrated in FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings and particularly to FIG. 1, there is shown a vacuum cleaner having a detachable dust collecting case embodying the present invention. The vacuum cleaner is illustrated as having a cleaner housing generally indicated by the reference numeral 20. The cleaner housing 20 may preferably be of a horizontally elongated hollow cylindrical configuration.

The cleaner housing 20 is integrally provided at its front end with an inlet fitting 21 adapted to be connected to a suction tubular hose (not shown) of well-known construction. The cleaner housing 20 is formed at the position immediately behind the inlet fitting 21 with an open space or cavity 22 for accommodating a dust collecting case 23. The rear end of the cavity 22 is defined by a partition wall 24 which is integrally formed with the cleaner housing 20 and extends vertically. The top of the cavity 22 is open so that the dust collecting case 23 may be put in and removed from the cavity 22 through its top opening. The dust collecting case 23 comprises a box like case or receptacle open at one end and closed at the other end. More specifically, the dust collecting case 23 is formed as an independent unit having such a substantially cylindrical configuration that when positioned in place within the cavity 22 it fits perfectly thereinto to form an integral part of cleaner housing 20. The dust collecting case 23 is provided at its top with clamping or locking means 25 having a spring operated latch 26 which is engageable with a cooperating opening 27 formed in the partition wall 24.

The dust collecting case 23 made as a separate, detachable unit includes a pre-filtering means 28. The pre-filtering means is detachably mounted to the opening 27 at the rear end of the dust collecting case 23 so as to cover the opening 29. The pre-filtering means comprises a substantially conically shaped rigid screen 30 having a peripheral flange 31 which is engaged with a step 32 formed at the inner periphery of the opening 29. The filter screen 30 may be made of plastic materials, fine metal wires or the like and have a relatively large mesh size.

With the above arrangement, the conical filter screen 30 extends into the case 23 with its front end towards wall 33 while the peripheral flange 31 is supported by step 32 of the inner periphery of the opening 29 at the rear end of the case.

Within the conical filter screen 30 main filtering means 40 is accommodated. Main filtering means comprise a filter cloth 41 shaped in a truncated cone form having a concentrically waved apex portion 42 and a peripheral bottom flange 43. The filter cloth 41 is spaced from the filter screen 30 so that dust may be collected therebetween. The peripheral bottom flange 43 may be made of a packing material so that it may be sup-

ported in a sealing arrangement on the peripheral flange 31 of the conical filter screen 30.

Further within the main filter 40 a dust removing device or vibrator 50 is accommodated. The vibrator 50 may comprise a support frame 51, a driven shaft 52 supported by the support frame 51, a vibrating plate 53 and cam means 57 associated with the driven shaft 52 for actuating the vibrating plate 53. The support frame 51 comprises a bearing portion 51a for carrying the driven shaft 52, a cylindrical portion 51b for carrying the boss portion 54 integrally formed with the vibrating plate 53, a peripheral flange 51c and radial leg portions 51d for connecting the bearing portion 51a and the cylindrical portion 51b to the peripheral flange 51c. The peripheral flange 51c is sealingly supported by the peripheral bottom flange 43 at a circular groove 55 formed therein. The driven shaft 52 is provided at its one end with a handle 56 and at its other end with a cam 57 member having a spiral cam surface 57a which is engaged with a cooperating spiral cam surface 58 formed at the boss portion 54 of the vibrating plate 53. The vibrating plate 53 is in contact with the apex portion 42 of the main filter 40. The reference numeral 59 indicates a spring inserted between the support frame 51 and the vibrating plate. The vibrating plate 53 is axially movable against the force of the spring 59 with the boss portion 54 sliding within the cylindrical portion 51b of the support frame 51.

The bottom wall 33 of the dust collecting case 23 is provided with an opening 61 which is placed in alignment with the inlet fitting 21 of the housing 20 when the dust collecting case is placed in the housing 20. The position of the opening 61 is located upwardly from the central axis of the conical filter screen 30. The reference numeral 62 indicates a check valve attached to the opening 61 so that air can only enter into the case 23 through the opening 61.

An air discharge chamber 70 is formed within the housing 20 between the before mentioned partition wall 24 and another partition wall 71. The partition wall 24 is formed with a large opening 72 confronting the opening 29 at the rear end of the dust collecting case 13. Within the air discharge chamber 70 there is resiliently supported a motor fan unit 73 of conventional construction for causing air to flow rapidly through the cleaner with its suction side confronting the opening 72 of the partition wall 24. The reference numerals 74 and 75 indicate elastic material seats attached to the partition walls 24 and 71, respectively, for supporting the motor fan unit therebetween. The elastic material seat 74 is formed with an extension 76 with which the flange 51c of the support frame 51 of the vibrator 50 can become in contact in a sealing engagement when the dust collecting case 23 is placed in the housing 20. The reference numeral 77 indicates a discharge port through which the filtered air is discharged to the outside.

Another space or chamber 80 is formed within the housing 20 between the partition wall 71 and a rear end cover 81 for containing a reel 82 for winding up a predetermined length of electric cord 83 which supplies electric power to the motor fan unit 73 of the cleaner from a suitable AC power supply line.

In FIG. 1, the reference numeral 85 indicates a handle for carrying the cleaner housing and the reference numeral 86 indicates wheels for rolling the cleaner housing.

The operation of the vacuum cleaner constructed as above in accordance with the present invention is next explained in detail. With the dust collecting case 23 fitted and locked in place within the housing 20 and a suction tubular hose (not shown) connected to the inlet fitting 21 by inserting it into the fitting, the motor fan unit 73 is energized to initiate suction of air into the cleaner for effecting vacuum cleaning. During operation of the motor fan unit 73, air carrying dirt and dust away from the surface to be cleaned rushes through the inlet fitting 21 and the opening 61 into the dust collecting case 23. This air flow through the opening 61 passes through conical filter screen 30 and then through the cloth filter 41. Air then flows through the opening 72 into the discharge chamber 70 to be discharged to the outside through the discharge port.

During this passage dust and dirt of relatively large mass or size, such as rags or torn pieces of cloth and paper and the like, carried by the air stream into the cleaner are filtered from the air by the conical screen 30 having relatively large filtering meshes. This dust of large size filtered or trapped by the conical screen 30 accumulates under the cone 30 in layer upon layer until the space defined by the conical screen 30 and the dust collecting case 23 is completely filled up. As the trapped dust and dirt gathers on the conical screen 30 it is compacted by the high pressure jet of air and following dust mass impinging thereon. Thus, an efficient use of the available space within the dust collecting case 23 become possible i.e., a relatively large amount of dust can be packed in the predetermined space of the dust collecting case. Further, as the pieces or particles of larger size are piled and compressed tightly on the screen 30 in layers along a bottom generation line of the cone, this compacted body of dirt serves as an additional filtering medium which remove comparatively smaller size dust particles including fine particles from the air stream entering the chamber 39. If the dust covers the entire area of the screen 30 and the thickness of the dust layer becomes sufficiently great, the flow resistance will be greatly increased and filtering efficiency will be inevitably lowered before the space 39 becomes fully occupied with dust and dirt. According to the invention, however, the screen 30 is formed in a conical shape so that the effective filtering area is greatly enlarged. In addition, the inlet opening 61 is displaced upwardly from the extension of the central axis of the conical screen so as to direct the air flow through the opening 61 onto the top surface of the cone 30, thereby to blow in the direction of a top generation line of the cone 30 and keep that area free of any dust accumulation even when the remaining filtering surface of the cone becomes encircled by a progressively piled up body of dust. Therefore, it will be apparent that the upper surface of the cone 30 remains as the only area free of dirt accumulation until substantially all of the available space in the chamber 39 is filled with the collected dust, which maintains good filtering effect of the screen 30 until such time.

The air then passes through the main filter 41 made of cloth. At this stage, substantially all of the fine dust particles which were not trapped by the conical screen 30 of large meshes are filtered by the main filter 41 from the entering air before it moves through the motor fan unit 73. Only dust free air is exhausted by the motor fan unit 73 through the chamber 70 and through the discharge port 77 out of the cleaner housing 20.

According to the invention, the main filter 41 is formed in a truncated cone having an apex portion 42 which is concentrically waved so that the effective filtering surface is enlarged to the utmost extent, thereby to increase the filtering capacity.

Thus, with the improved vacuum cleaner of the invention, a two step dust filtering or collection from the insucked air through the cleaner is effected which assures efficient as well as high speed and large volume of dust entrapment. In actual practice, almost all of the dust and dirt, including fine particles, sucked into the cleaner is initially retained by the conical screen 30 which forms the first filtering stage and a comparatively small amount of fine dust particles pass through the cone 30 to be filtered by the cloth filter 41 which constitutes the second filtering stage.

For disposing of the dust body and fine particles collected in the spaces 39 and 38, respectively, the dust collecting case 23 is detached from the cleaner housing 20 by releasing the locking element 25 from its cooperating member 26. The detached case 23 is put in an upright position with the bottom wall 33 resting on the floor as shown in FIG. 2. The vibrator 50 is then operated by rotating the shaft 52. The rotation of the shaft 52 causes the vibrating plate 53 to be vibrated in axial directions along shaft 52 due to the cooperating action between the two cam elements 57a and 58. The vibration of the vibrating plate is in turn transmitted to the cloth filter 41 at its apex portion 42, whereby the dust particles which have been attached to the cloth filter 41 are shaken off. Thereafter, the main filtering means 40 with the vibrator 50 is removed

from the pre-filtering means 28 and the pre-filtering means 28 is removed from the case 23 so that the respective dust layers collected in the chamber 38 and 39 may be disposed of.

It will be appreciated that prefiltering means, main filtering means and the dust removing device are accommodated within a detachable dust collecting case in an extremely compact form and in such a manner that the dust collecting and disposing operation can be carried out efficiently and speedily.

FIGS. 3 and 4 illustrate another embodiment of the invention in which the dust collecting case is mounted at the front end of the cleaner housing. Referring to FIG. 3, the vacuum cleaner illustrated therein comprises a housing 120 containing a motor fan unit 173 and a dust collecting case 123 which is mounted at the front end of the housing 120.

The dust collecting case 123 may preferably be of a hollow cylindrical, or square or polygonal configuration extending in a horizontal direction. The dust collecting case 123 is provided at its opposite ends, namely, at its front and rear ends, with a relatively small inlet opening 161 and a large outlet opening 129. The inlet opening 161 is adapted to be connected to a tubular suction hose (not shown) of well known construction and is provided with a check valve 162. The outlet opening 129 is covered by a filter assembly generally indicated by the reference numeral 128. The filter assembly comprises a substantially conically shaped filter screen 130 and a cloth filter 141. The conically shaped filter screen 130 is a pre-filter and the cloth filter is a second and main filter. The filter screen 130 may preferably be made of a plastic material and provided with a number of apertures 135 having a relatively large diameter. The filter screen 130 is supported at its peripheral bottom flange 131 by a peripheral packing 137 attached to the inner periphery of the opening 129 and extends inwardly of the case 123. The filter screen 130 is provided at its top end with an opening 136. The top end opening 136 of the filter screen 130 is closed by a plug 134 which is fixed to the top end of the cloth filter 141. The cloth filter 141 extends within and along the conically shaped screen 130 but it is so spaced from the screen 130 that a space 138 is formed therebetween. The bottom end of the cloth filter 141, which also is of a substantially conical shape, is fixed to the peripheral packing 137. In order to keep the cloth filter in a spaced relationship from the filter screen 130, a support frame 151 is connected to a handle rod 152 for the plug 134 at the top end of the cloth filter 141.

As mentioned before, the dust collecting case 123 is detachably connected to the front end of the housing 120 containing a motor fan unit 173. The housing 120 is provided at its front end with an opening 172 which confronts the outlet opening 129 when the dust collecting case 123 is connected to the housing 120 as shown in FIG. 3. The reference numeral 176 indicates a support on which the bottom end of the handle rod 152 rests when the case 123 is connected to the housing 120. The housing 120 defines a discharge chamber 170 and is provided with a discharge port (not shown) through which the filtered air is exhausted to the outside. In FIG. 3 the reference numeral 185 indicates a handle for carrying the housing 120 and the reference numeral 186 indicates wheels for rolling the dust collecting case 123 and the housing 120 when those are connected to each other as shown in FIG. 3.

The operation of the vacuum cleaner illustrated in FIG. 3 is similar to that illustrated in FIG. 1. With the dust collecting case 123 being connected to the housing 120 and a tubular hose (not shown) being connected to the inlet fitting 161 of the dust collecting chamber, the motor fan unit 173 is energized to initiate suction of air into the cleaner for effecting vacuum cleaning. During operation of the motor fan unit 173, air carrying dirt and dust away from the surface to be cleaned passes through the inlet fitting 161 into the dust collecting chamber 139 which is defined by the case 123 and the conically shaped filter screen 130. This air flow passes successively through the conically shaped filter screen 130 of relatively large mesh and the finer mesh cloth filter 141. The filtered air

then flows through the opening 172 into the discharge chamber 170. During this passage dust and dirt of relatively large mass or size, such as rugs or torn pieces of cloth and paper and the like, carried by the air stream into the cleaner are filtered from the air by the filter screen 130 having relatively large filtering meshes before it enters into the space 138. This dust and dirt of larger size pieces filtered or trapped by the screen 130 accumulates in successive layers. As the trapped dust mass gathers on the screen, it is compacted by the high pressure jet of air and following dust mass impinging thereon. As the dust of larger size is piled and compressed tightly on the screen 130 in layers, this compacted body of dirt serves as an additional filtering medium which remove comparatively smaller sizes of dust particles, including fine particles, from the air stream through the chamber 139.

The air then passes through the main filter 141 made of cloth. At this stage, almost all of the fine dust particles which could not be trapped by the conical screen 130 of large meshes are filtered by the main filter 141 from air before it moves through the motor fan unit 173. Only dust free air is exhausted by the motor fan unit 173 through the chamber 170 and through the discharge port (not shown) out of the cleaner housing 120.

For disposing of the compacted dust body and fine particles collected in the spaces 139 and 138, respectively, the dust collecting case 123 is detached from the housing 120. The detached case 123 is put in an upright position with the bottom wall 133 resting on the floor as shown in FIG. 4. The handle rod 152 with the support frame 151 is then pulled upwardly with the plug 134 being removed from the opening 136 thus gravitating dust from filter 141 into chamber 139.

The embodiment illustrated in FIGS. 3 and 4 is advantageous in that fine dust particles can also be collected in the chamber 139 as well as dust particles and other pieces of material having relatively large sizes. In this embodiment it is not necessary to remove the main filter 141 from the pre-filter 130, as in the embodiment of FIGS. 1-2.

A further embodiment of the invention is illustrated in FIGS. 5 and 6. Referring to FIG. 5 the vacuum cleaner illustrated therein comprises a housing 220 containing a motor fan unit 273 and a dust collecting case 223 which is mounted at the front end of the housing 220.

The dust collecting case 223 may preferably be of a hollow cylindrical, or square, or polygonal configuration extending in a horizontal direction. The dust collecting case 223 is provided at its opposite ends, namely, at its front and rear ends, with a relatively small inlet opening 261 and a large outlet opening 229. The inlet opening 261 is adapted to be connected to a suction tubular hose (not shown) of conventional construction and is provided with a check valve 262. The outlet opening 229 is covered by a filter screen 230. The filter screen 230 may preferably be made of a plastic material and provided with a number of apertures 235 having a relatively large diameter to form a screen having relatively large meshes. The filter screen 230 is substantially conically shaped and is supported at its peripheral bottom flange 231 by a step 232 formed at the inner periphery of the opening 229 of the case. The conically shaped filter screen 230 is provided at its apex portion with an opening 236 which is engaged with and closed by the front wall 233 of the case 223 as shown in FIG. 5. A dust collecting chamber 239 is thus defined by the case 223 and the filter screen 230. Within the conically shaped filter screen 230 a cloth filter 241 is placed in a spaced relationship with respect to the filter screen 230 so as to form a fine dust particle collecting chamber 238 therebetween. The cloth filter 241 is maintained in a substantially conical form by a support frame 251. The bottom hem of the cloth filter 241 is fixed to the peripheral flange 231 of the filter screen 230 by means of a ring-shaped packing 237. The free top end of the cloth filter is connected to the top of the conical frame 251, the bottom flange 252 is supported at the packing 237.

The dust collecting case 223 is detachably connected to the front end of the housing 220 containing a motor fan unit 273.

The housing 220 is provided at its front end with an opening 272 which confronts the outlet opening 229 when the dust collecting case 223 is connected to the housing 220 as shown in FIG. 5. The housing 220 defines a discharge chamber 270 and is provided with a discharge port (not shown) through which the filtered air is exhausted to the outside. In FIG. 5 the reference numeral 285 indicates a handle for carrying the housing 220 and the reference numeral 286 indicates wheels for rolling the dust collecting case 223 and the housing 220 when those are connected to each other as shown in FIG. 5.

The operation of the vacuum cleaner illustrated in FIG. 5 is similar to those illustrated in FIGS. 1 and 3. The conically shaped filter screen 230 and the conical cloth filter 241 function as a prefilter and a main filter as in the previously disclosed embodiments of FIGS. 1 and 3.

For disposing of the dust body and fine particles collected in the spaces 239 and 238, respectively, the dust collecting case 223 is detached from the housing 220. The detached case 223 is put in an upright position with the bottom wall 233 resting on the floor as shown in FIG. 6. The filter screen 230 is then upwardly moved so as to release the end of screen 230 defining opening 236 from the bottom wall 233 of the case 220. The support frame 251 with the cloth filter 241 is pulled upwardly as shown in FIG. 6 and shaken to remove the dust particles so that they fall down through the opening 236 to the chamber 239.

FIGS. 7 and 8 illustrate still another embodiment of the invention. Referring to FIG. 7 the vacuum cleaner is illustrated as having a cleaner housing generally indicated by the reference numeral 320. The cleaner housing 320 may preferably be of a horizontally elongated hollow cylindrical configuration.

The cleaner housing 320 is integrally provided at its front top with a longitudinally extending inlet fitting 321 adapted to be connected to a tubular suction hose (not shown) of conventional construction. The housing 320 defines beneath the inlet fitting 321 a discharge chamber 370 containing a motor fan unit 373. The cleaner housing 320 is formed at the position immediately behind the inlet fitting 321 and the discharge chamber 370 with an open space or cavity 322 for accommodating a dust collecting case 323. The rear end of the cavity 322 is defined by an upright partition wall 324 which is integrally formed with the cleaner housing 320. The top of the cavity 322 is open so that the dust collecting case 323 may be put in and removed from the cavity through its top opening.

The dust collecting case 323 comprises a box like case or receptacle open at one end and closed at the other end. More specifically, the dust collecting case 323 is formed as an independent unit having such a substantially cylindrical configuration that when positioned in place within the cavity 322 it fits perfectly thereinto to form an integral part of the cleaner housing 320. The dust collecting case 323 is provided at its top with locking means 325 having a spring operated latch 326 which is engageable with a cooperating opening 327 formed in the housing 320.

The dust collecting case 323 made as a separate, detachable unit includes a pre-filtering means 328. The pre-filtering means comprises a substantially conically shaped screen 330 which extends from the open front end of the case 323 to the closed rear end of the case 323 to partition the inside of the case 323 into two chambers 339 and 338. The conically shaped filter screen 330 has openings 329 and 336 at its opposite ends, namely, at the front and rear ends, respectively. The filter screen 330 is provided at its front end with a peripheral flange 331 which is engaged with an inner peripheral packing 332 attached to the inner periphery of the front opening 329 of the case 323. The rear end opening 336 of the filter screen 330 is closed by the rear end wall 333 of the case 323. The filter screen 330 may be made of plastic materials, fine metal wires or the like and have a relatively large mesh size.

Within the conical filter screen 330 main filtering means 340 is accommodated. Main filtering means comprises a filter

cloth 341 shaped as a truncated cone having a concentrically waved apex portion 342 and a peripheral bottom edge portion 343 which is fixed to the peripheral packing 332. The filter cloth 341 is spaced from the filter screen 330 so that dust may be collected therebetween.

Further within the main filter 340 a dust removing device or vibrator 350 is accommodated. The vibrator illustrated in FIG. 7 is substantially the same as that illustrated in FIG. 1. No further explanation is, therefore, necessary for the vibrator 350.

The peripheral flange 331 of the filter screen 330 has an extension 331a having an opening 361 which is in alignment with the inlet fitting 321 so that the air carrying dirt and dust may flow through the opening 361 into the chamber 339. The reference numeral 363 indicates a guide channel for directing the air flow toward the top surface of the conical filter screen 330. In FIG. 7 the reference numeral 377 indicates the discharge port for the cleaner which is in the form of slits, the reference numeral 385 indicates a handle for carrying the housing 320, the reference numeral 386 indicates wheels for rolling the housing 320 and the reference numeral 382 indicates a reel for winding up an electrical cord for supplying electric power to the motor fan unit 373.

The operation of the vacuum cleaner illustrated in FIG. 7 is substantially the same as any of the vacuum cleaners illustrated in FIGS. 1, 3, and 5 except that the air flow is re-directed by substantially 180° (U-turned) in the case 323. This embodiment can dispense with the provision of a check valve at the inlet opening 361 because the rear end wall 333 of the dust collector housing 222 is completely closed.

For disposing of the dust body and fine particles collected in the spaces 339 and 338, respectively, the dust collecting case 323 is detached from the cleaner housing 320 by releasing the lock element 326 from its cooperating member 327. The detached case 323 is put in an upright position with the bottom wall 333 resting on the floor as shown in FIG. 8. The vibrator 350 is then operated to vibrate the cloth filter 341 whereby the dust particles which have been attached to the cloth filter 341 are removed and fall down toward the bottom of the case 323. The combination of the filtering means 328 and 340 with the dust removing device 350 is then removed from the dust collecting case so that the dust collected in the case may in turn be emptied from the case.

We claim:

1. A vacuum cleaner comprising a housing including a motor fan unit, a dust collecting case detachably connected to said housing and cooperating with said housing and said motor fan unit to form a suction system, said dust collecting case being formed with an inlet opening and an outlet opening, a filter unit, said filter unit including pre-filtering means, main filtering means and a dust removing device, said pre-filtering means including a generally conically shaped screen having relatively large meshes which extends into the inside of said dust collecting case, closure means movable with respect to the apex of the screen for normally closing the apex end of the screen, said main filtering means including a cloth filter within said screen and disposed in a spaced relationship therewith to form a fine dust particle collecting space therebetween, means for detachably mounting said filter unit to cover said outlet

opening and to have air with dust and dirt particles entrained therein impinge upon said filter unit, and said dust removing device comprising manually operable means for aiding in the removal of dust from said main filtering means, said manually operable means being in contact with said main filtering means and being manually operable when the dust collecting case is detached from said housing and said pre-filtering and main filtering means are still part of said filter unit.

2. A vacuum cleaner according to claim 1, wherein said cloth filter has an apex portion which is concentrically waved and said dust removing device is a vibrator mounted as part of said filter unit to contact said apex portion of said cloth filter.

3. A vacuum cleaner according to claim 1, further comprising a support frame located within said filter screen for maintaining said cloth filter in substantially conical form, said cloth filter being attached to said support frame and said frame being removable from within said filter screen with the cloth filter attached thereto to serve as said means for aiding in the removal of dust from said cloth filter.

4. A vacuum cleaner according to claim 3 wherein said closure means for closing the opening at the apex end of said filter screen comprises a detachable plug to which said frame and said cloth filter means are also attached, removal of the plug permitting the frame and cloth filter to be withdrawn from within the filter screen so that the dust can be removed from said cloth filter and pass into the dust case through the open apex end of the filter which is detachably mounted to screen.

5. A vacuum cleaner as in claim 4 further comprising means for detachably mounting the filter unit to the dust collecting case.

6. A vacuum cleaner according to claim 4 further comprising a handle rod attached to said plug to facilitate removal of the cloth filter which is detachably mounted to said filter screen apex said filter screen.

7. A vacuum cleaner as in claim 1 wherein said closure means for closing the apex end of the filter screen comprises a plug which is detachably mounted to said filter screen apex end and to which a portion of the cloth filter is also attached, said plug being removed to open the apex end of the filter screen when said means for aiding in the removal of dust from said cloth filter is operated.

8. A vacuum cleaner as in claim 7 further comprising a handle rod attached to said plug to facilitate the removal of the cloth filter from within said filter screen.

9. A vacuum cleaner according to claim 1 wherein the wall of said dust collecting case is formed with said closure means closing the open apex end of said filter screen, said closure means located on the wall of said dust collecting case facing said outlet opening so that said apex opening of said filter screen is closed when said filter unit is mounted over said outlet opening of said dust collecting case.

10. A vacuum cleaner according to claim 9, further comprising a support frame located within said filter screen for maintaining said cloth filter in substantially conical form, said cloth filter being attached to said support frame and said frame being removable from within said filter screen with the cloth filter attached thereto to serve as said means for aiding in the removal of dust from said cloth filter.

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