United States Patent

Miyake et al.

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[54] VACUUM CLEANER

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[52] **U.S. Cl.**.....**55/288,** 15/323, 15/327, 15/349, 15/412, 55/300, 55/304, 55/305, 55/319, 55/356, 55/366, 55/367, 55/372, 55/379, 55/380, 55/429, 55/433, 55/487, 55/521, 55/529, 55/DIG. 3

[51] **Int. Cl.**.....**B01d 41/02**

[58] **Field of Search** .....55/366–367, 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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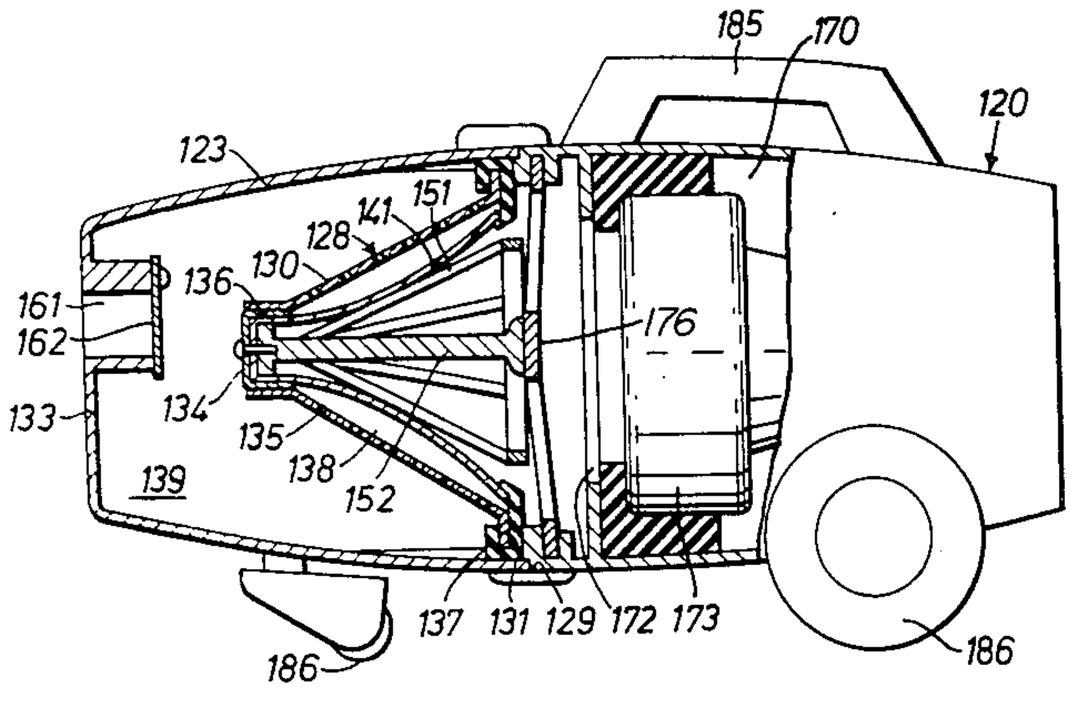
[57] **ABSTRACT**

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



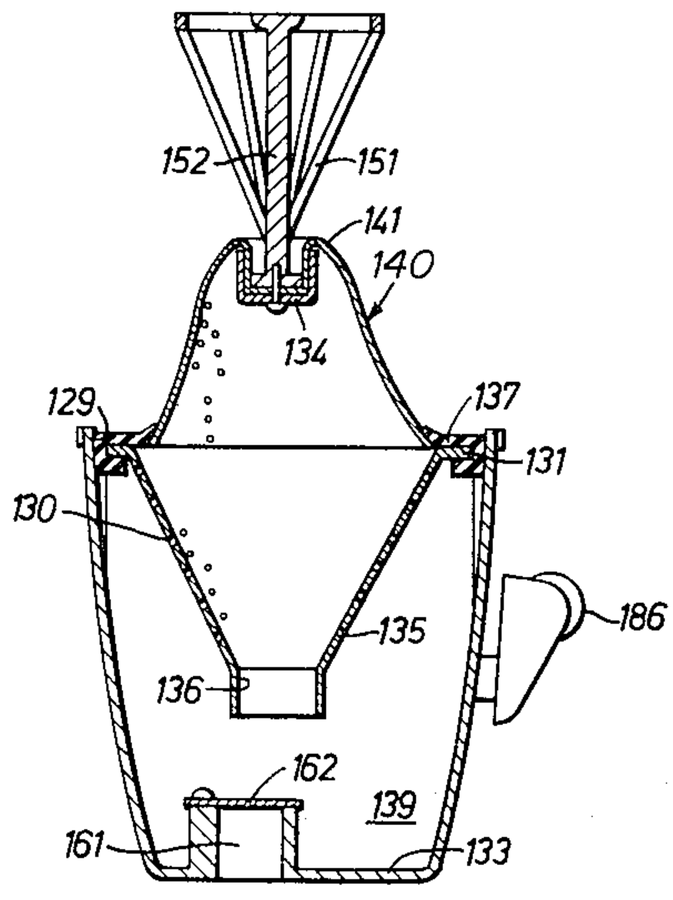


FIG.1

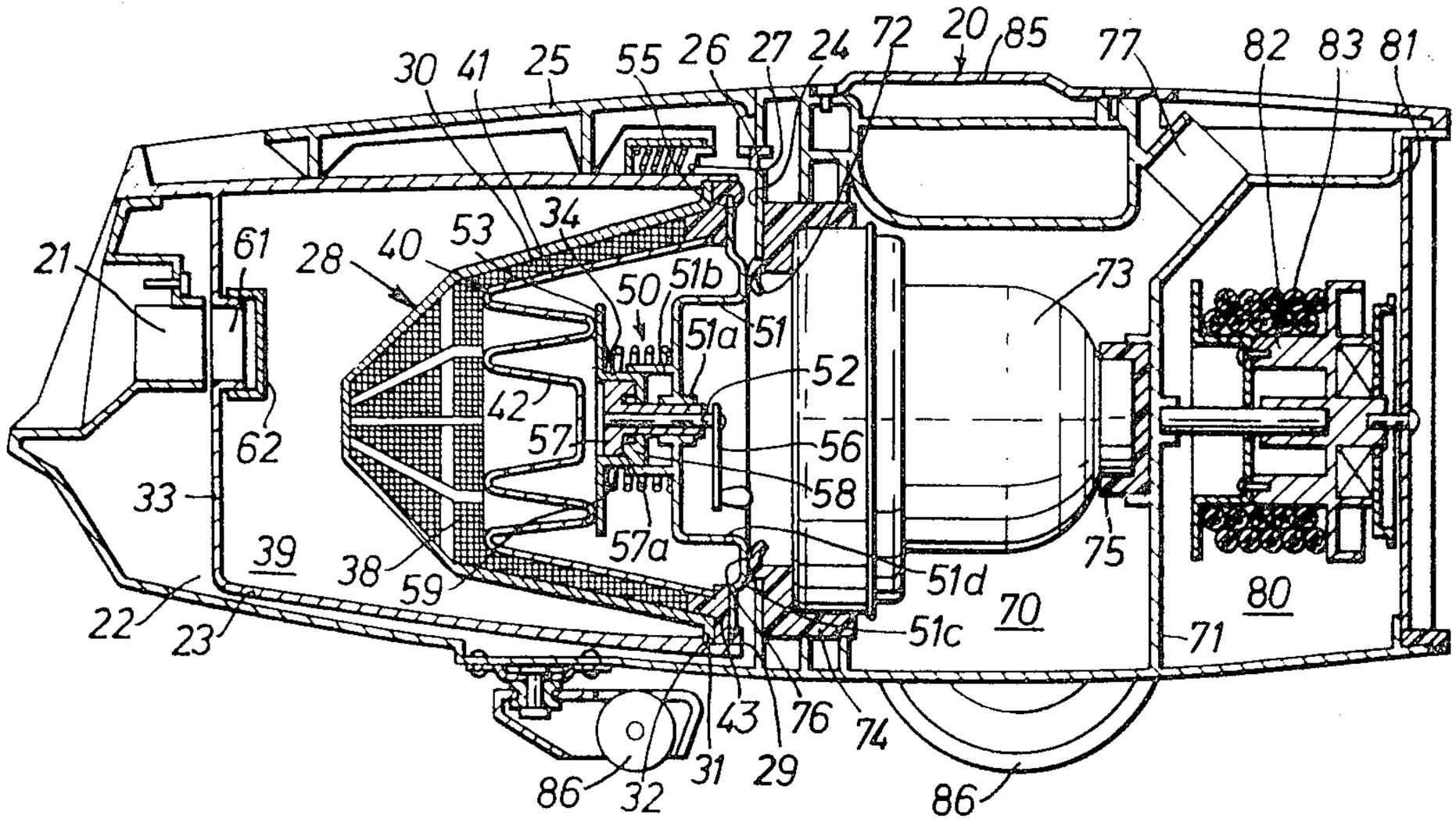


FIG.2

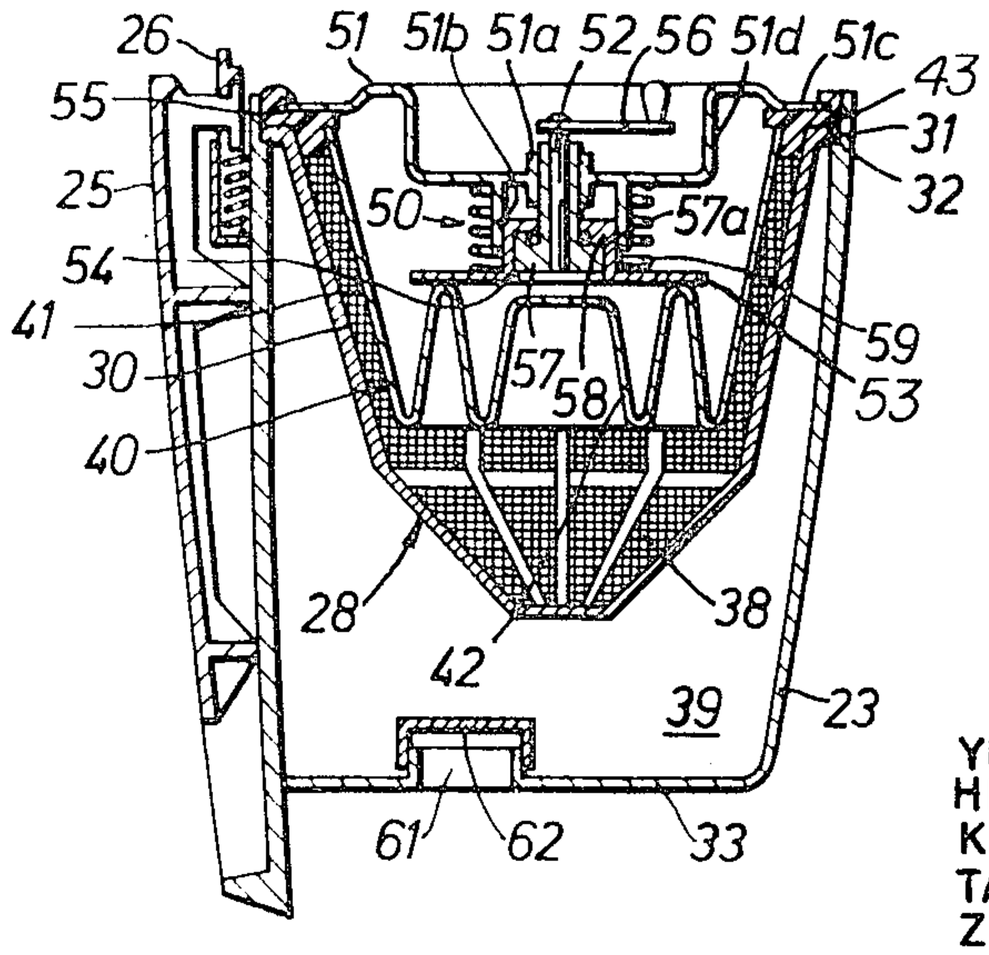


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FIG.3.

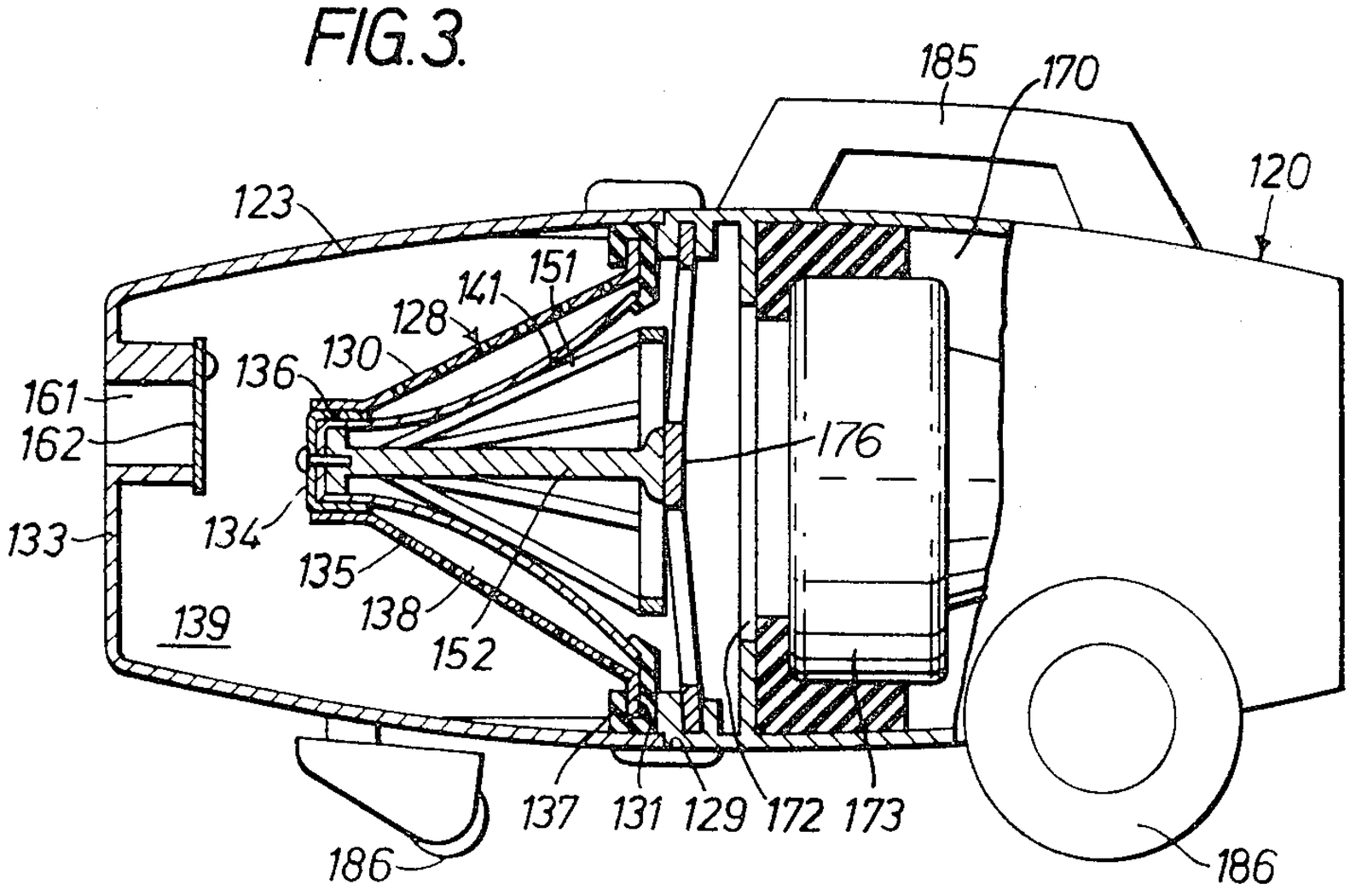

FIG.4.

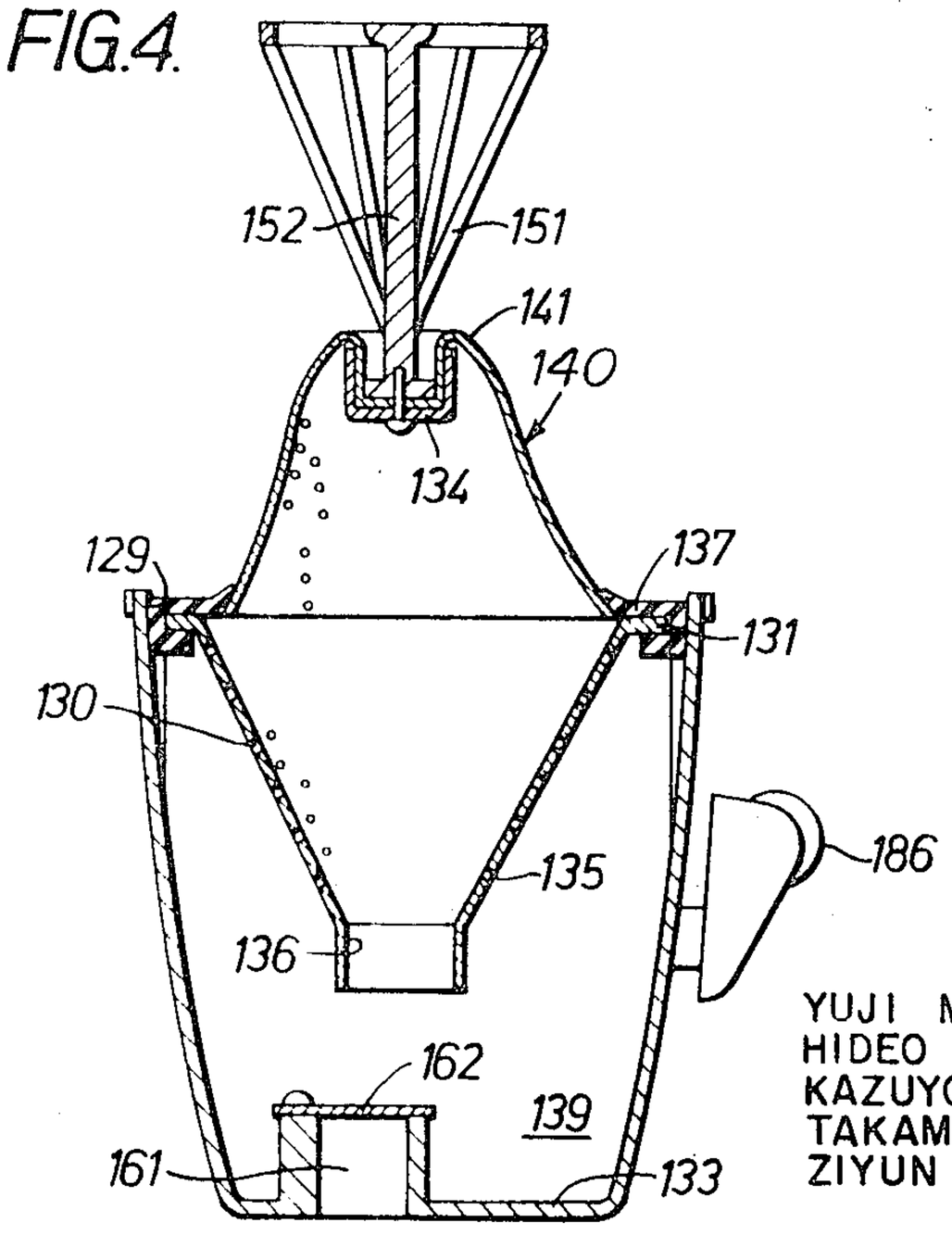

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FIG.5.

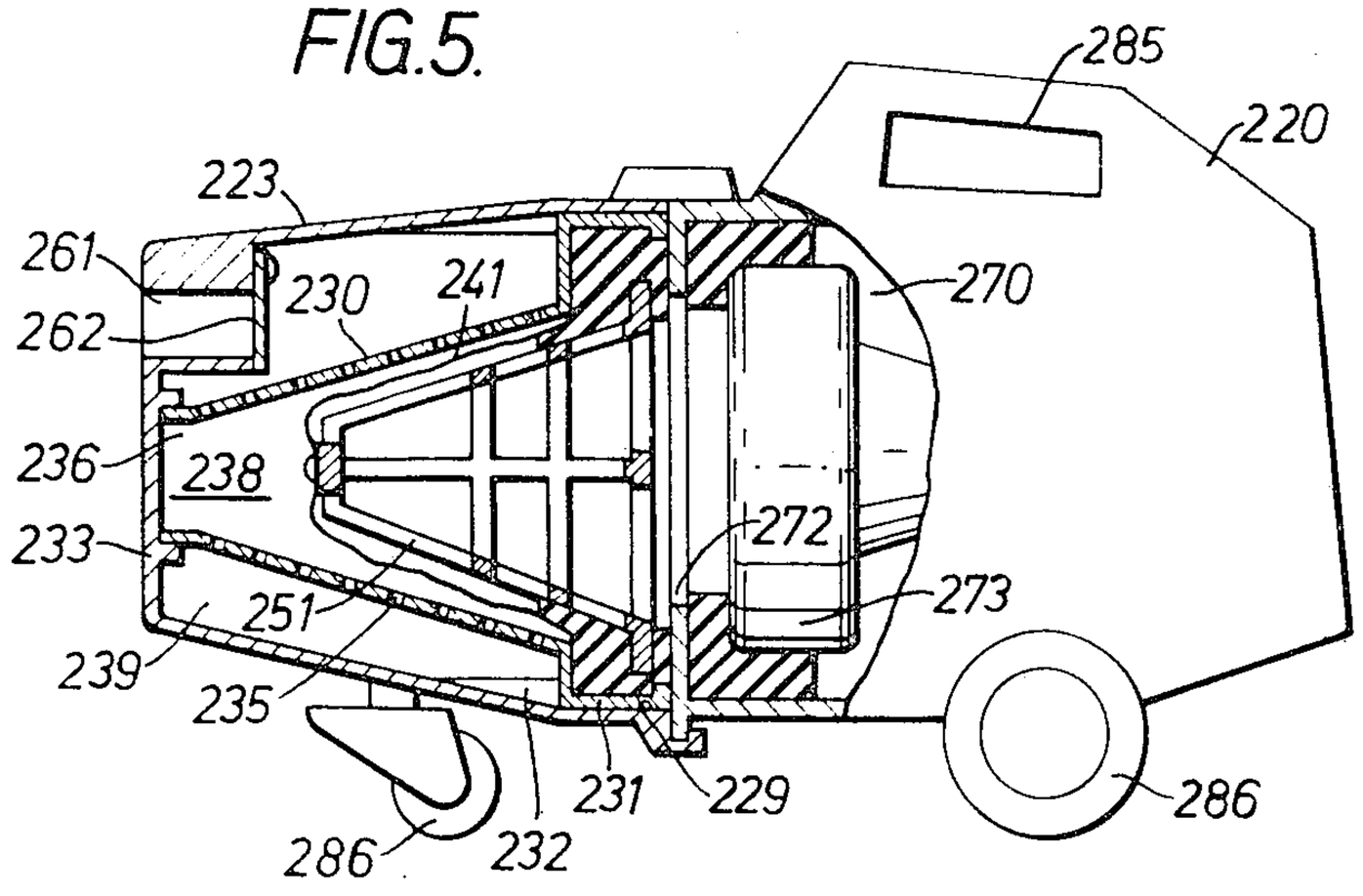


FIG.6.

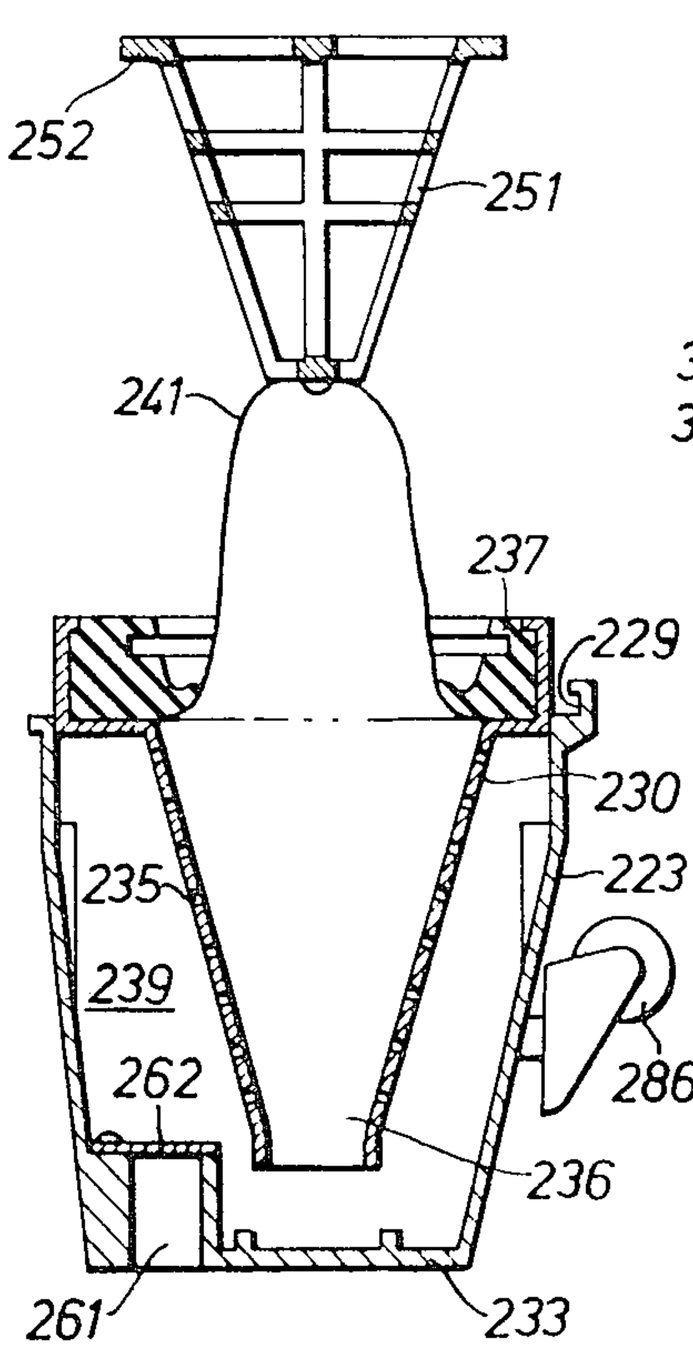
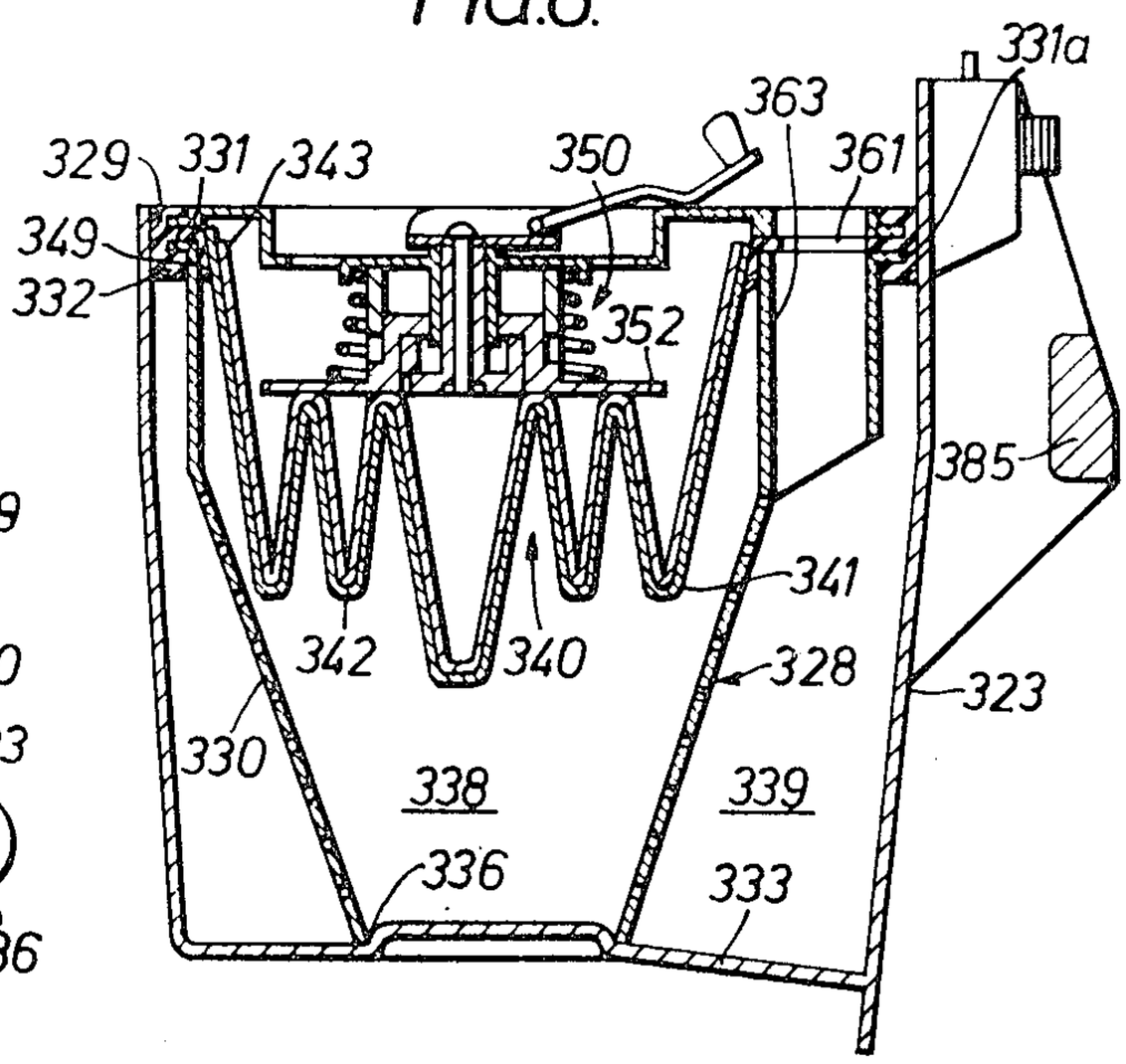


FIG.8.



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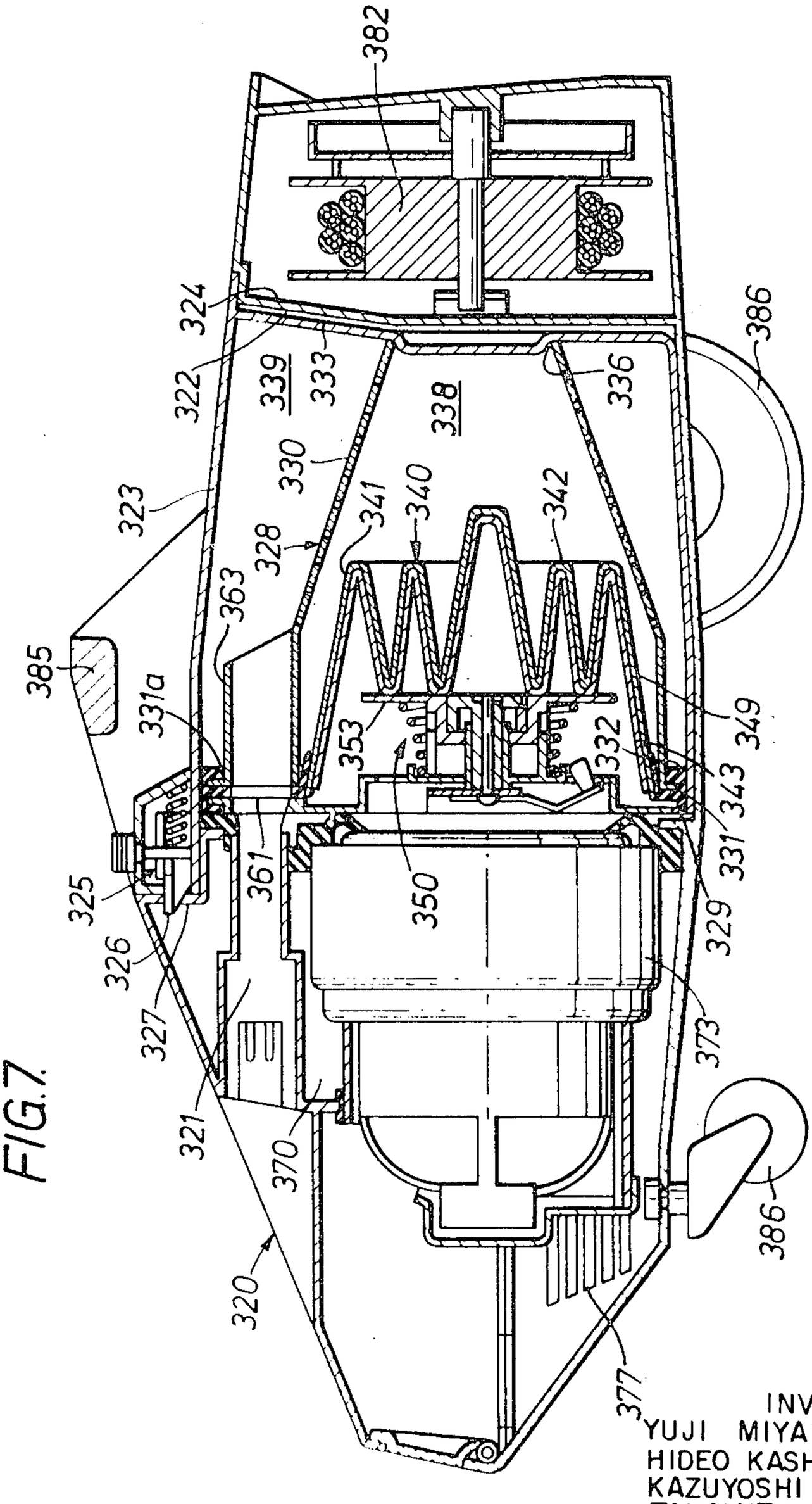

FIG. 7.

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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 redirected 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** though 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 supported 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 **51***a* for carrying the driven shaft **52**, a cylindrical portion **51***b* for carrying the boss portion **54** integrally formed with the vibrating plate **53**, a peripheral flange **51***c* and radial leg portions **51***d* for connecting the bearing portion **51***a* and the cylindrical portion **51***b* to the peripheral flange **51***c*. The peripheral flange **51***c* 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 **57***a* 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 **51***b* 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 **51***c* 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 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 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 **57***a* 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 though 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**. Refering 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 receptable 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 redirected 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 detacably 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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