Dec. 18, 1962 O. J. G. HANSEN 3,069,068

VACUUM CLEANER, THE DRIVING MOTOR OF WHICH IS ARRANGED FOR RUNNING AT TWO DIFFERENT VELOCITIES

Filed July 8, 1958

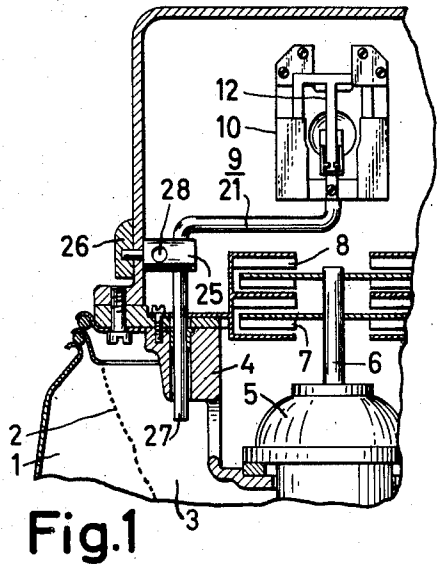

Fig.1

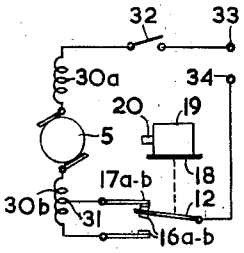

Fig.5

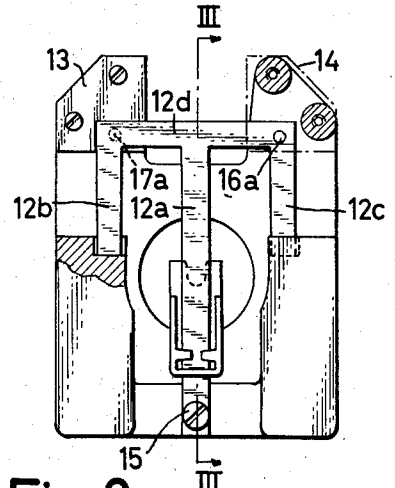

Fig.2

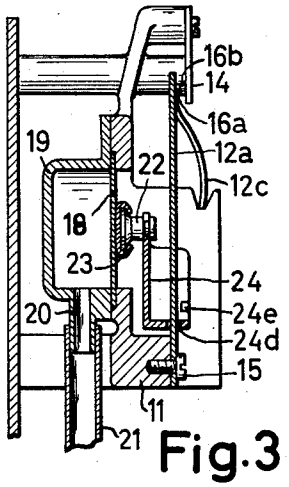

Fig.3

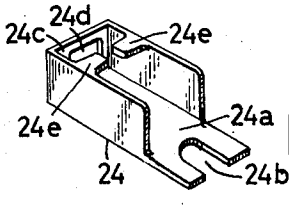

Fig.4

INVENTOR

Ove Johannes Grejsen Hansen

BY

Stevens, Davis, Miller & Mosher

ATTORNEYS

United States Patent Office 3,069,068 Patented Dec. 18, 1962

3,069,068

VACUUM CLEANER, THE DRIVING MOTOR OF WHICH IS ARRANGED FOR RUNNING AT TWO DIFFERENT VELOCITIES

Ove Johannes Grejsen Hansen, Lyngby, Denmark, assignor to Aktieselskabet Fisker & Nielsen, Copenhagen-Frederiksberg, Denmark

Filed July 8, 1958, Ser. No. 747,152
Claims priority, application Denmark July 15, 1957
4 Claims. (Cl. 230—12)

A vacuum cleaner is known, the driving motor of which is arranged for running at two different speeds, and in which the switch-over from one speed to another of the motor is effected by means of a feeler arranged for being actuated by a pressure difference, produced by the fan of the vacuum cleaner, between two different zones inside or outside the vacuum cleaner. This known vacuum cleaner is so arranged that when the vacuum in the suction nozzle of the vacuum cleaner is slight or nil, the feeler is in the position where the motor is set to the highest of the two speeds while at increasing vacuum the feeler will move into its other position where the switch will then switch over to the low motor speed.

This known vacuum cleaner is particularly intended for the vacuum cleaning of carpets in the special way that the carpet is lifted by the suction nozzle, the edge of the latter being in contact with the carpet and forming a sealing for air. Dependent on the weight and closeness of weaving of the carpet the motor of the vacuum cleaner adjusts itself to a speed and a suction effect deriving therefrom which are adapted to the carpet that is being cleaned. This known vacuum cleaner will, however, be unsuited for the vacuum cleaning of light and open fabrics, such as curtains, as due to the ample amount of air passing through such fabrics there will only be a slight vacuum in the suction nozzle, for which reason the switch will switch over to the high motor speed so that still more air will be sucked through the open and not very resistant fabric which may be torn thereby. The known vacuum cleaner has the further drawback that the motor starts at its highest speed, and hereby the size of the motor and thereby the maximum capacity of the vacuum cleaner are limited out of regard to the permissible current pulse at the start of the motor.

The invention aims at remedying the said drawbacks and providing an improved vacuum cleaner with a high maximum suction capacity and in which the suction capacity and the quantity of air sucked through the vacuum-cleaned objects can be regulated easily and reliably. There will, for example, in the case of the vacuum cleaning of carpets and furniture be aimed at attaining the highest possible pressure difference between the pressure and vacuum sides of the fan unit simultaneous with the greatest attainable quantity of air sucked through the object, while in the vacuum cleaning of small light rugs and similar objects it will be desirable to be able to reduce the suction capacity of the vacuum cleaner in order to prevent the objects to be vacuum-cleaned from being sucked on to the nozzle and carried along with the latter.

In the case of vacuum cleaning of particularly light objects, for example thin curtains, it will also be convenient to be able to reduce the quantity of air sucked through them as explained above.

In known, universally applicable vacuum cleaners these facts have necessitated a solution by compromise which limits the maximum suction capacity of the vacuum cleaner while at the same time the user of the vacuum cleaner must take particular care when vacuum cleaning light curtains etc.

With a view to gaining the aims stated, the invention relates to an arrangement in vacuum cleaners of the type

referred to by way of introduction, and the characteristic feature of the invention is that the feeler is arranged for switching the motor to the low speed when the said pressure difference is very slight or nil, and for switching to the high speed at the pressure difference occurring when the vacuum cleaner operates with full opening.

Hereby it is attained that at the start of the motor of the vacuum cleaner, when the fan is stopped and hence the pressure difference is nil, the motor will be set to the low speed so that its starting current will be reduced, while at the same time the mechanical stresses on the motor and the fan are reduced, and this has a favourable influence on the lifetime of the whole unit. Due to the reduced starting current the vacuum cleaner may be provided with a larger motor and thereby a more powerful fan than would be the case if the motor were to start at its maximum speed. During the vacuum cleaning, the motor will automatically be switched over to the high speed, which gives the maximum suction capacity, due to the pressure drop caused by the passage of the air sucked in through the objects that are being vacuum cleaned. When the motor and thereby the fan are stopped at the ordinary main circuit breaker, the feeler will at once switch the motor to the low speed used at the start.

A known vacuum cleaner having a dust separation filter is provided with a feeler which reacts on the pressure drop across the filter. At a certain degree of obstruction of the filter resulting in a rise in the pressure drop this feeler causes the switching in of a mechanical cleaning mechanism for removing the dust from the filter, and at the same time the rotational speed of the vacuum cleaner motor is increased. In this known vacuum cleaner the switching of the motor speed is, however, effected as a link in a special operation during which the normal functioning of the vacuum cleaner is interrupted. There is only one motor speed at disposal for the vacuum cleaning, and the capacity of the vacuum cleaner is, as was the case with the vacuum cleaner first referred to, limited by the motor always starting at its normal operation speed. Therefore, also in the case of this vacuum cleaner there is no possibility of regulating the suction capacity with due regard to the work to be performed.

In an expedient embodiment of the invention a three-way cock is provided, by means of which one side of the feeler can alternately be brought into connection with two different zones inside or outside the vacuum cleaner, one of which may be the zone which is in connection with the other side of the feeler. With such a three-way cock it is possible manually to put the feeler out of action, so that the motor constantly runs at one of the two possible speeds, in particular the low speed, desirable in the vacuum cleaning of light objects requiring reduced suction capacity and air passage. The feeler is advantageously according to the invention a diaphragm clamped along its periphery, and its motion is transmitted through a one-armed lever to the switch which is preferably designed as a quick-break switch. The diaphragm can be made exceedingly sensitive to small differences in pressure, and the use of a one-armed lever between the diaphragm and the switch permits a conversion of a comparatively large travel of the diaphragm at a small force into a small travel and a comparatively large force at the switch, so that the position into which it is switched is very well-defined.

According to the invention the feeler and the switch are conveniently mounted inside part of the vacuum cleaner, so that one side of the feeler is in direct contact with the air in this part of the vacuum cleaner, while the other side of the feeler is by a tubing connected with another zone inside or outside the vacuum cleaner. By this mounting, all problems in connection with a sealing

around the movable parts, which transmit the motion of the feeler to the switch, are avoided.

In an embodiment of the invention the driving motor of the vacuum cleaner is a universal motor with taps on the field coil for obtaining the two different speeds. This gives a no-loss regulation of the speed, and the motor can be used for alternating current as well as for direct current.

The invention will in the following be described with reference to the accompanying purely diagrammatical drawings which show an embodiment of the invention and where:

FIG. 1 is a part section through a vacuum cleaner according to the invention,

FIG. 2 is an illustration on a larger scale of a combined feeler and switch for a vacuum cleaner according to the invention,

FIG. 3 is a section on line III—III in FIG. 2,

FIG. 4 is a perspective illustration of a detail of the vacuum cleaner according to the invention, and

FIG. 5 is a schematic diagram of the electric motor circuit.

The dust container of the vacuum cleaner is designated by 1. It is by a filter 2 separated from the suction chamber 3. An electric motor 5 is by clamping means, not shown, secured to a motor carrier 4 secured internally in the suction chamber. The shaft 6 of the motor carries a number of vanes 7 which together with stationary guide vanes 8 form the fan unit of the vacuum cleaner. During its operation, the fan sucks air from the suction chamber 3 and blows it into the pressure chamber 9 which is provided with an exhaust branch, not shown, to the surroundings.

Internally in the pressure chamber a combined feeler and switch 10 is secured, which is shown in detail in FIGS. 2 and 3. On a common base 11, which is made of an electrically non-conducting material, a switch is secured consisting of a central, resilient contact member 12 and two stationary contact members 13 and 14, of which the member 13 is located below the central contact member 12, while the contact member 14 is located above the latter. The central contact member 12 is T-shaped with a long stem 12*a* and two shorter branches 12*b* and 12*c* parallel to the stem. The said three parts are held together by a transverse member 12*d*.

The contact member 12 is made of an electrically conductive and at the same time resilient material, as e.g. copper. It is secured to the base 11 at the end of the long stem 12*a* with at least one screw 15 which at the same time can serve as supply terminal for the current supply. The two side branches 12*b* and 12*c* are curved and supported by the base 11 in such a way that they can perform a limited angular turning in the point of support, and the side branches and their supports are furthermore so designed that, when the contact member 12 is not subjected to an outer stress, they keep it with a suitable resilience against the stationary contact member 14, so that there is contact between a contact point 16*a* on the contact member 12 and a contact point 16*b* on the contact member 14.

The contact member 13 carries a corresponding contact point 17*b*, as shown in FIG. 5, which can get into electric contact with a contact point 17*a* on the contact member 12, when the switch is in its other extreme position.

On the underside of the base 11 an elastic diaphragm 18 is mounted which is clamped along its periphery by means of a box 19 secured under the base, which box together with the diaphragm forms a chamber that is sealed air-tight from the pressure chamber. The box 19 is provided with a branch 20 on which a flexible tube 21 is slid so as to fit air-tight around the branch. The box 19 may expediently be pressed from sheet metal, and the branch 20 may be brazed to the box or may be made integral with the latter. The flexible tube may e.g. be made of extruded plastic.

To the outwards-facing side of the diaphragm 18 a pin 22 is secured, e.g. as shown by the bending over around a collar on the pin 22 of a number of tongues on a reinforcing disc 23 glued on to the middle of the diaphragm. In the vicinity of its outer end the pin 22 is provided with an annular construction, with which a one-armed lever 24 engages which is shown perspectively and on a larger scale in FIG. 4.

The lever 24 has the form of an inequilateral angle, the long side 24*a* of which runs substantially parallel to the diaphragm 18 and the contact member 12*a*. In its front end the side 24*a* is provided with a U-shaped notch 24*b* which fits across the annular constriction on the pin 22, so that the lever can be slid radially across the pin, but in the axial direction of the latter is substantially secured by the constriction.

The short angle side 24*c* of the lever 24 has a closed slit 24*d* which can be slid over the contact member 12*a*. Close to the side 24*c* two bent-over tongues 24*e* are provided, which, one from either of the edges of the side 24*a*, extend over the contact member 12*a*.

The tube 21 is led to a three-way cock 25 which is secured to the wall of the pressure chamber 9 of the vacuum cleaner. Its shank is carried air-tight out through the wall and on the outside carries an operation knob 26. From the cock 25 a tube 27 passes air-tight through the motor carrier 4 down into the suction chamber 3, and the cock is furthermore provided with a transverse bore 28 which opens into the pressure chamber.

The driving motor 5 is a series-wound universal motor. Its field coil 30*a*, 30*b*, see FIG. 5, has a tapping 31, whereby the motor can rotate at two different speeds dependent on the current supply being connected to either the terminal of the coil portion 30*b* or the tapping 31. The tapping 31 of the field coil portion 30*b* corresponding to the higher motor speed is connected to contact point 17*b* on contact member 13 of the switch, and the terminal of the coil portion 30*b* is connected to contact point 16*b* on contact member 14. A current supply source may be connected to terminals 33 and 34 which are connected to the terminal of the coil portion 30*a* and the terminal screw 15 on contact member 12, respectively, a main circuit breaker 32 being inserted at a suitable point of the electrical circuit.

During normal operation of the vacuum cleaner the three-way cock 25 is set so as to permit passage from the tube 21 to the tube 27, which means that the chamber under the diaphragm 18 is in communication with the suction chamber 3. When the motor is stopped, there is no difference in pressures between the suction chamber and the pressure chamber, and the diaphragm is in its position of rest, in which the contact member 12 is held against the contact member 14 by the springs 12*b* and 12*c*.

When the current is closed by operating the main circuit breaker, the motor will start at its lowest speed. Hereby a certain vacuum is produced in the suction chamber 3, so that the diaphragm 18 is sucked inwards in the box 19. The pin 22 exerts a pull in the lever 24, and the latter will bear with its tongues 24*e* against the upper side of the contact member 12*a*, while the short angle side 24*c* moves upwards, until the underside of the closed slit 24*d* bears on the underside of the contact member 12*a*.

The lever 24 thus actuates the contact member 12 against the springs 12*b* and 12*c*, and at a certain value of the pull in the diaphragm the contact member will momentarily snap over so as to get into electric connection with the stationary contact member 13, and hereby the speed of the motor is switched over to its highest value, as shown in FIG. 5.

The switching described occurs at a vacuum which the

fan produces at full opening. Thereby the motor will, when the knob **26** is in the said position, run at its highest speed, and the vacuum cleaner operates at its highest capacity. When the current is interrupted at the main circuit breaker, and the motor stops, the pressure difference on the two sides of the diaphragm **18** is eliminated, so that the contact member **12***a* is by the springs **12***b* and **12***c* returned to the position shown in FIG. 3, and a restart of the motor will therefore always occur at the lowest speed, so that the start current pulse is limited.

When the operation knob **26** of the three-way cock is turned 90°, the tube **21** is put into communication with the transverse bore **28** of the cock, while the tube **27** from the suction chamber is blocked. Both sides of the diaphragm **18** are now in communication with the pressure chamber **9**, so that no pressure difference can occur here, and when the motor is started, the contact member **12***a* will therefore remain in contact with the contact member **14**, so that the motor will continue running at the low motor speed and with reduced suction capacity. It will be seen that it is possible during the operation of the vacuum cleaner to alternate optionally between the two motor speeds by operating the knob **26**.

The invention is not limited to the embodiment shown, but may be varied in different ways within the scope of the invention. The switch **10** may for example be mounted in the suction chamber or possibly on the outside of the vacuum cleaner, and one side of the diaphragm may be in communication with the surroundings. The switch may also be designed in other ways than that here described, the sole condition being that it has a well-defined switching point between the two positions.

I claim:

1. A vacuum cleaner comprising a housing having an air inlet and an air outlet, a fan disposed within said housing, a two-speed electric motor drivingly connected to said fan, electric switch means connected to said motor for causing said electric motor to rotate at either of its two speeds, pressure responsive means in communication with the air inlet and air outlet and being responsive to the pressure rise across said fan, means mechanically connecting said pressure responsive means to operate said switch means so as to set the motor to rotate at the lower speed thereof when said pressure rise is substantially zero, and to set the motor to the higher speed thereof when said pressure rise assumes a value corresponding to the normal operational conditions of the fan, said switch means being normally in its low speed setting, and manual means selectively operable to render said pressure responsive means inoperative so as to maintain said switch means in the position of the lower motor speed.

2. A vacuum cleaner as claimed in claim 1, in which said last-mentioned means comprises a manually operable three-way cock arranged to provide a communication across the pressure responsive means and to disconnect it from the air inlet.

3. A vacuum cleaner comprising a housing having a suction chamber and a pressure chamber, an air inlet to said suction chamber and an air outlet from said pressure chamber, a fan disposed within said housing between said suction chamber and said pressure chamber, a two-speed electric motor mounted in said housing and drivingly connected to said fan, said motor having a first winding for a lower motor speed and a second winding for a higher motor speed, means defining an air-tight box located within one of said two chambers and including a diaphragm, means for establishing a communication alternately from the interior of said box to either of said two chambers, a pivotally mounted lever operatively connected to said diaphragm, first and second movable contact means secured to either side of said lever, first fixed contact means arranged to engage said first movable contact means when the pressures on either side of said diaphragm are substantially equal, second fixed contact means arranged to engage said second movable contact means at a pressure difference between the two sides of the diaphragm corresponding to normal operation of the vacuum cleaner at full opening, electric connections from said first set of contact means to a current supply and to said first winding of said electric motor, respectively, and electric connections from said second set of contact means to a current supply and to said second winding of said electric motor, respectively.

4. A vacuum cleaner comprising a housing having a suction chamber and a pressure chamber, an air inlet to said suction chamber and an air outlet from said pressure chamber, a fan located within said housing between said suction chamber and said pressure chamber, a two-speed electric motor drivingly connected to said fan, said motor having a first winding for a lower motor speed and a second winding for a higher motor speed, means defining an air-tight box located within one of said two chambers and including a diaphragm, a manually operable three-way cock, communication means from the interior of said air-tight box to the inlet opening of said three-way cock, communication means from the first outlet opening of said three-way cock to the other of said two chambers and communication means from the second outlet opening of said three-way cock to the first of said two chambers, a pivotally mounted lever operatively connected to said diaphragm, first and second movable contact means secured to either side of said lever, first fixed contact means arranged to engage said first movable contact means when the pressures on either side of said diaphragm are substantially equal, second fixed contact means arranged to engage said second movable contact means at a pressure difference between the two sides of the diaphragm corresponding to normal operation of the vacuum cleaner at full opening, electric connections from said first set of contact means to a current supply and to said first winding of said electric motor, respectively, and electric connections from said second set of contact means to a current supply and to said second winding of said electric motor, respectively.

References Cited in the file of this patent

UNITED STATES PATENTS

1,904,973	Smellie	Apr. 18, 1933
2,046,675	Daiger	July 7, 1936
2,140,143	Sellers	Dec. 13, 1938
2,439,239	Crever	Apr. 6, 1948
2,570,222	Ell	Oct. 9, 1951
2,588,301	Snyder	Mar. 4, 1952
2,758,670	Doughman	Aug. 14, 1956
2,789,660	Brown	Apr. 23, 1957