United States Patent [19]

Hetland

[11] **3,857,076**

[45] **Dec. 24, 1974**

[54] **UPRIGHT VACUUM CLEANER—DRIVE MOTOR CONTROL**

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[73] Assignee: **Whirlpool Corporation**, Benton Harbor, Mich.

[22] Filed: **Jan. 15, 1973**

[21] Appl. No.: **323,780**

[52] **U.S. Cl.** **318/257**, 318/295, 318/345

[51] **Int. Cl.** **H02p 5/16**

[58] **Field of Search** 318/256, 257, 291, 293, 318/295, 313, 345, 260, 271, 276, 305, 416, 436

[56] **References Cited**

UNITED STATES PATENTS

3,402,338	9/1968	Thoresen	318/345
3,461,371	8/1969	Klayman	318/345
3,441,828	4/1969	Henry	318/345
3,475,676	10/1969	Hutson	318/313
3,551,787	2/1970	Walters	318/345
3,582,744	6/1971	Coffey	318/313
3,601,673	8/1971	Mason	318/345
3,628,115	12/1971	Pruitt	318/345
3,753,065	8/1973	Chiles	318/295

Primary Examiner—Robert K. Schaefer
Assistant Examiner—Thomas Langer
Attorney, Agent, or Firm—Hofgren, Wegner, Allen, Stellman & McCord

[57] **ABSTRACT**

A vacuum cleaner structure having self-propelling means. A handle is associated with the vacuum cleaner and the self-propelling means to drive the vacuum cleaner in accordance with force applied forwardly or rearwardly to the handle. The handle is biased to an Off position. The driving force developed by the propelling means varies as a function of the displacement of the handle from the Off position.

11 Claims, 24 Drawing Figures

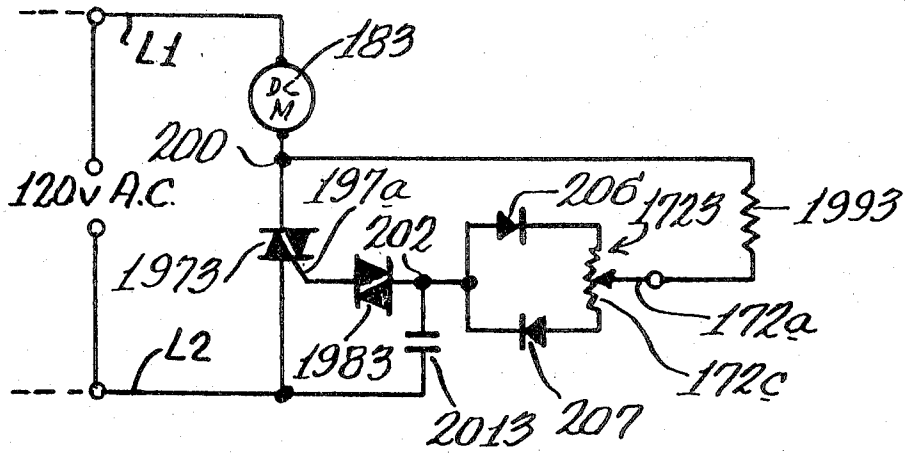


Fig. 1.

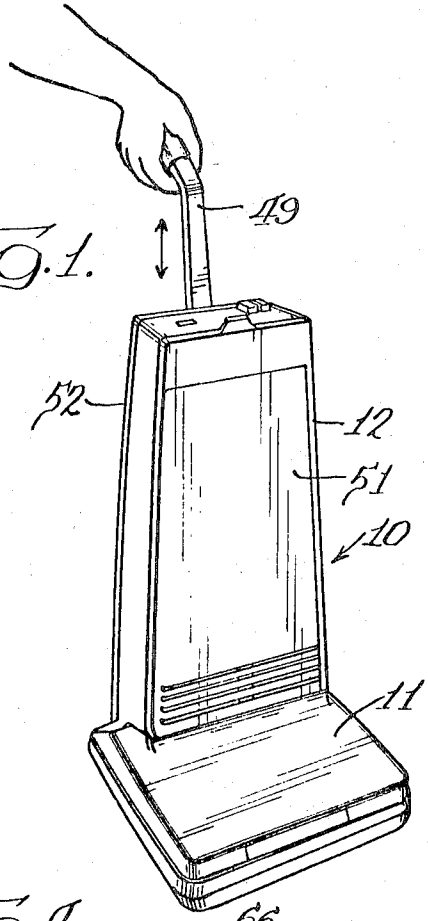


Fig. 3.

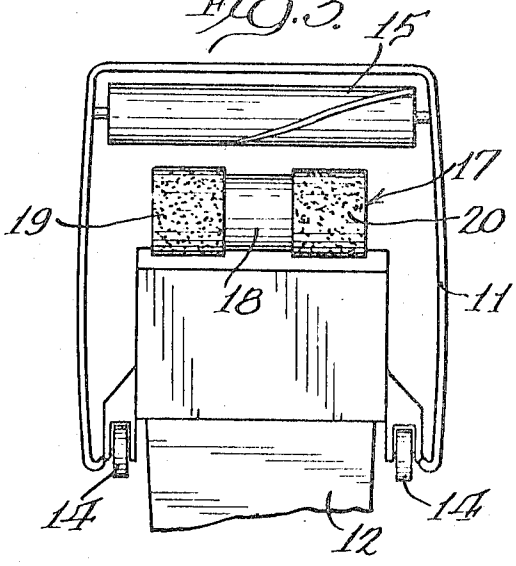


Fig. 2.

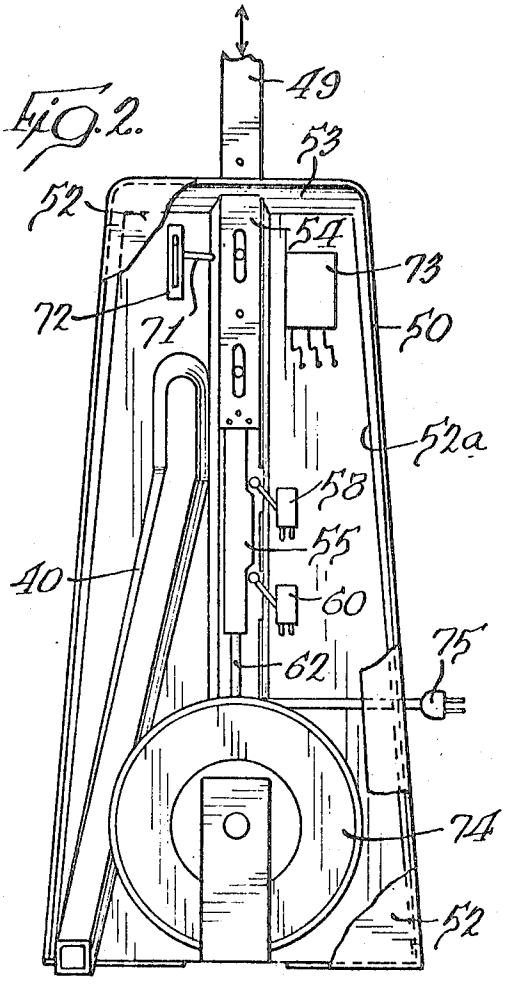


Fig. 4.

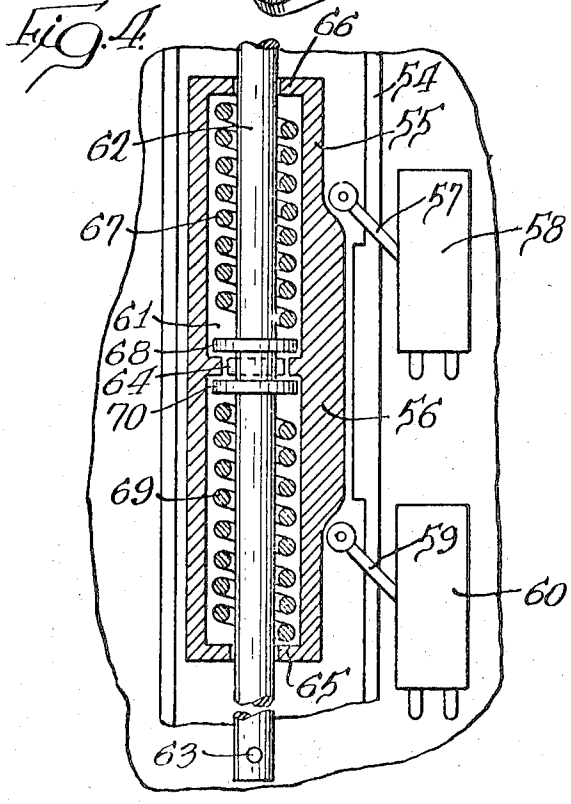


Fig. 5.

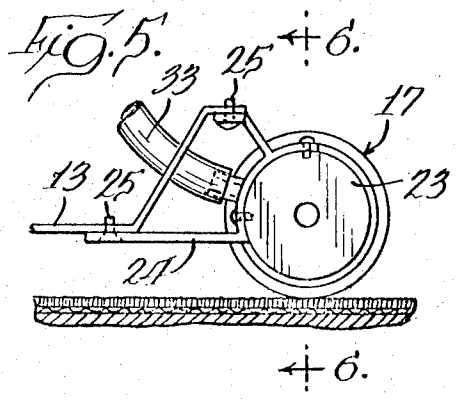


Fig. 6.

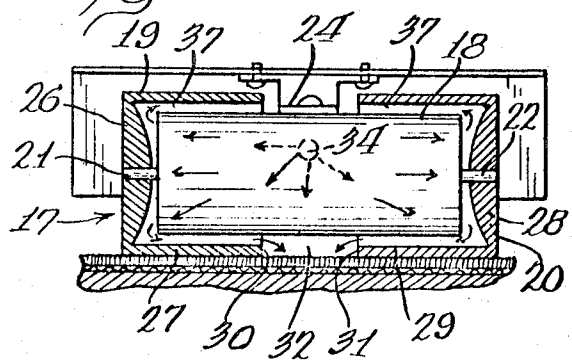


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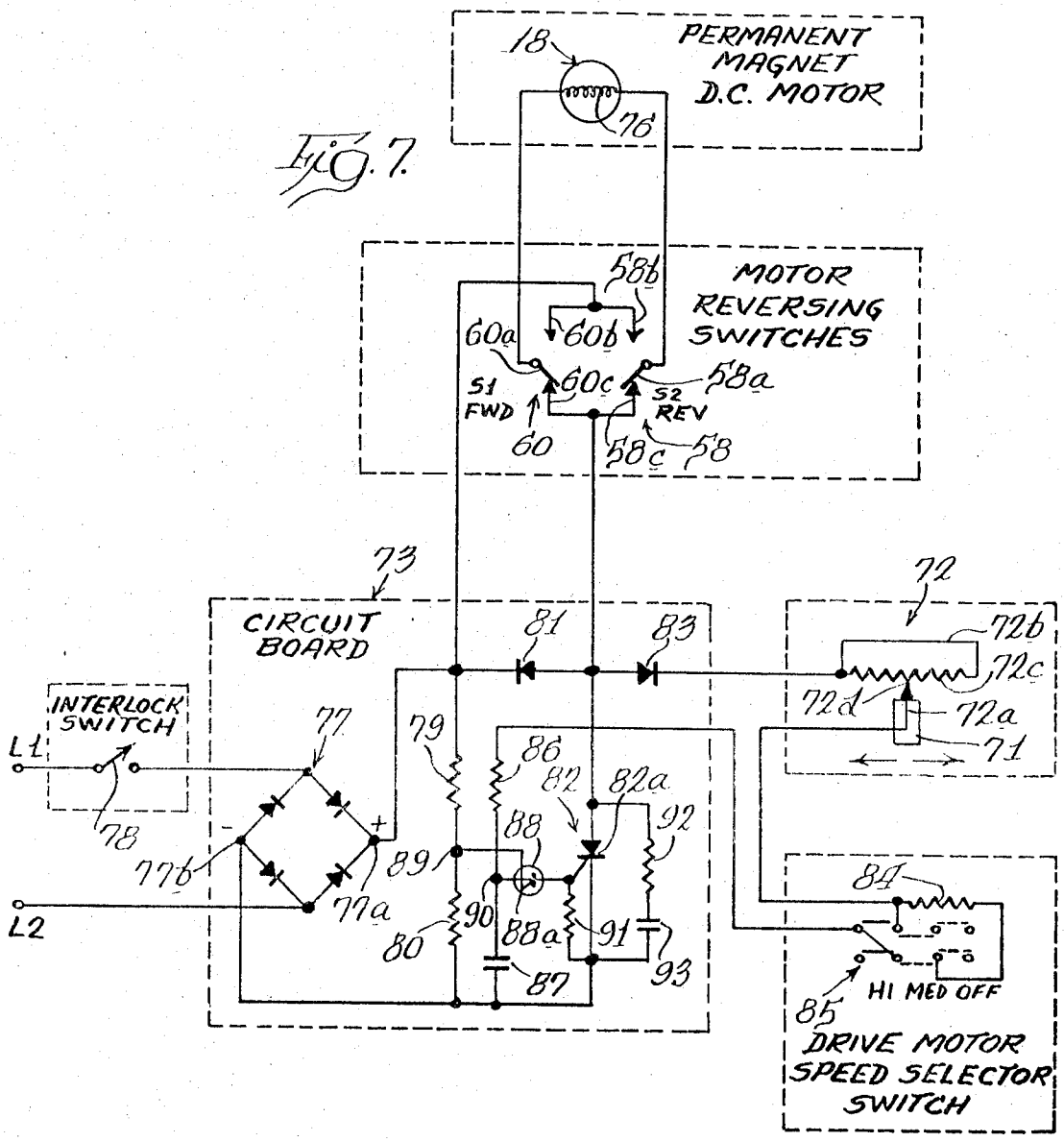
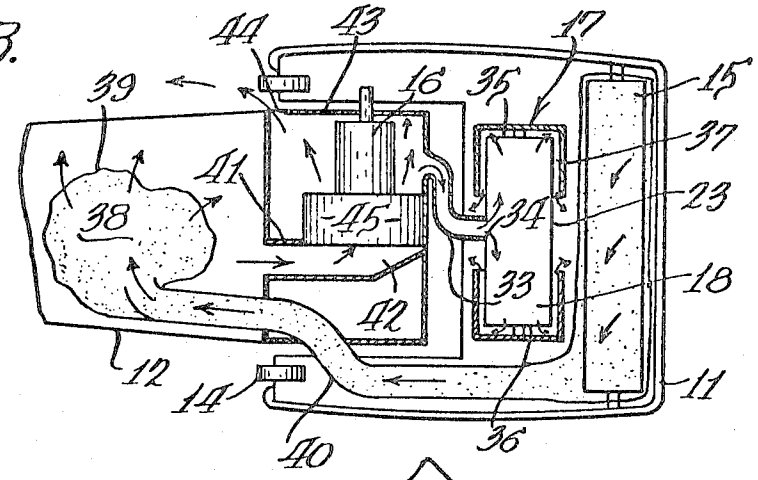


Fig. 8.



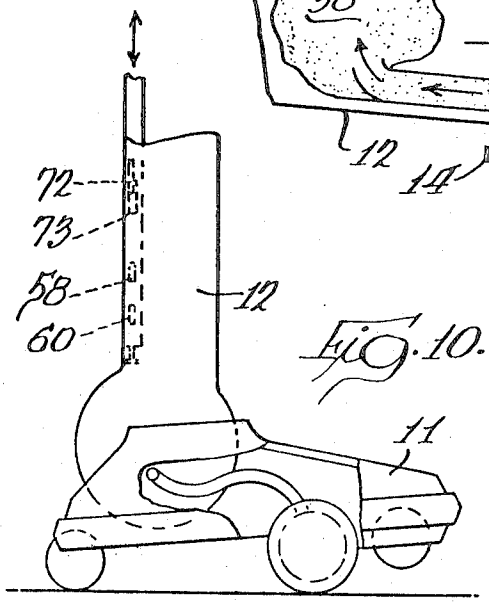


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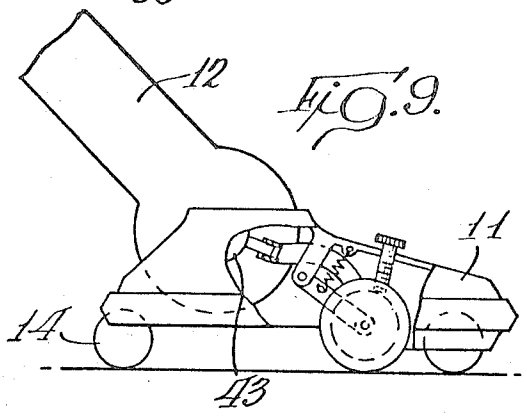
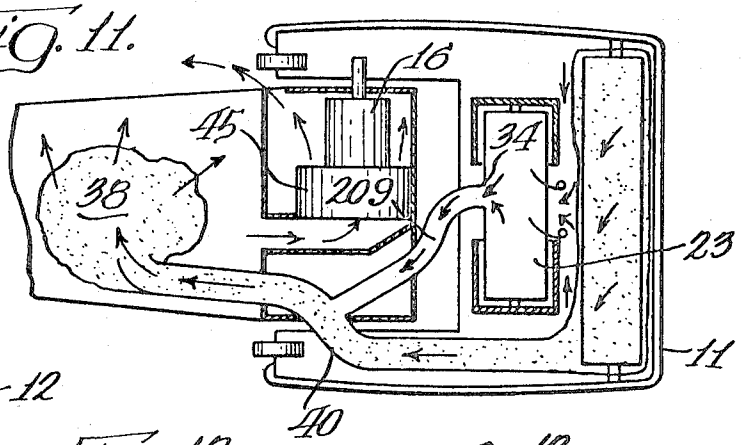


Fig. 9.

Fig. 11.



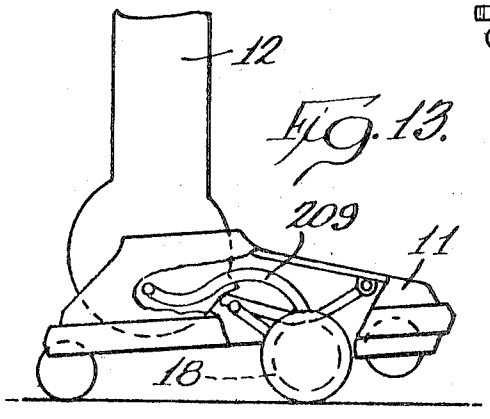


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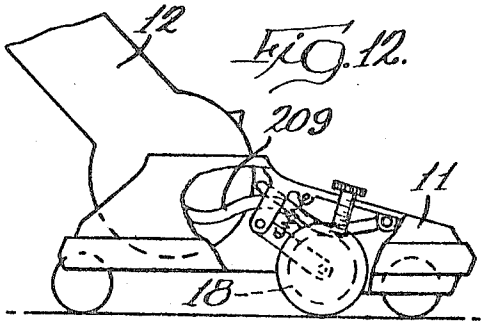


Fig. 12.

Fig. 14.

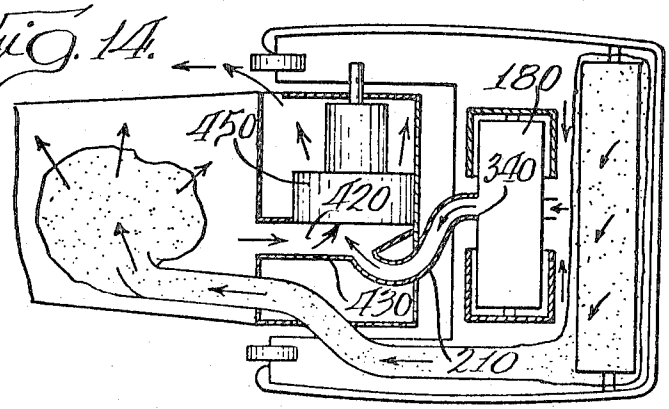


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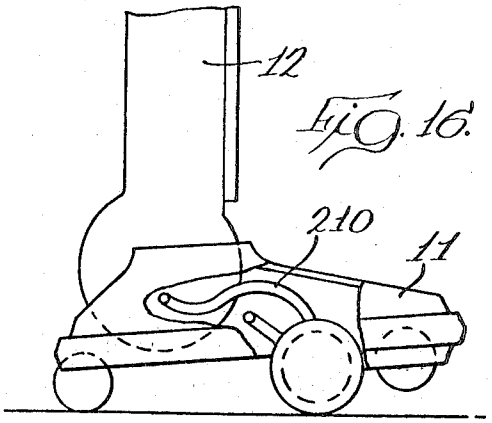


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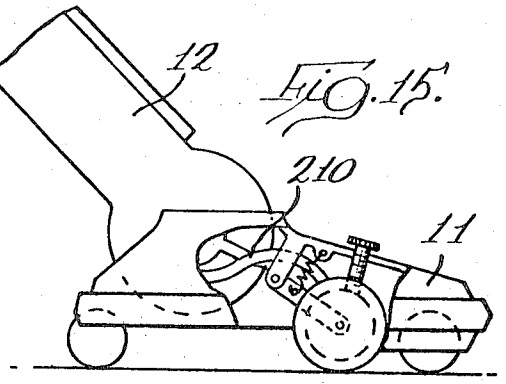


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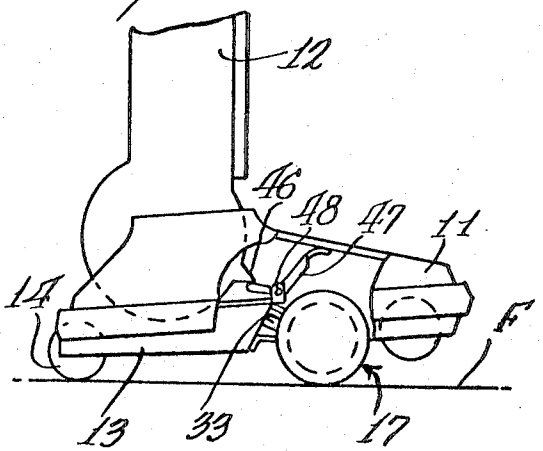
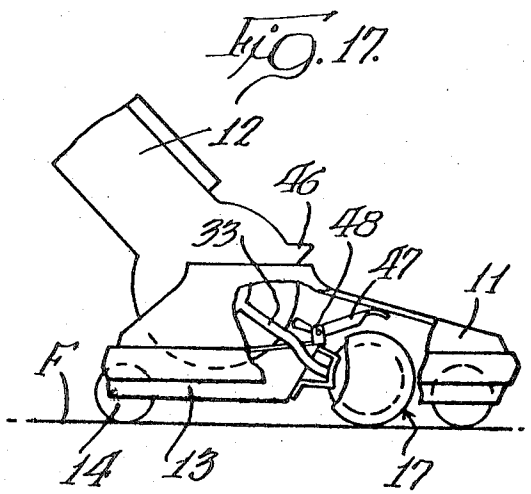


Fig. 17.



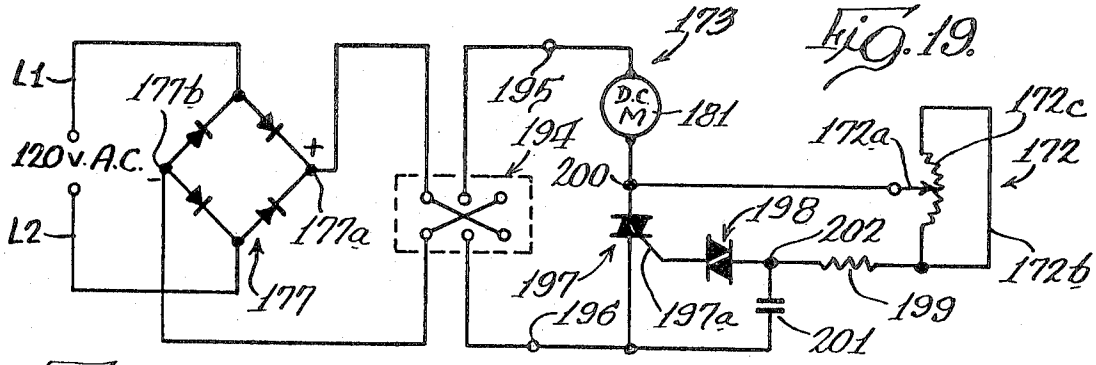


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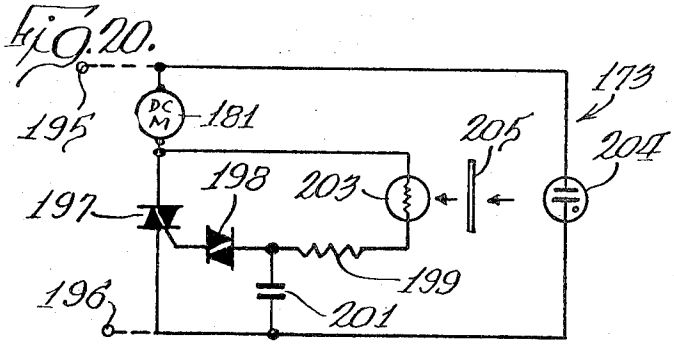


Fig. 20.

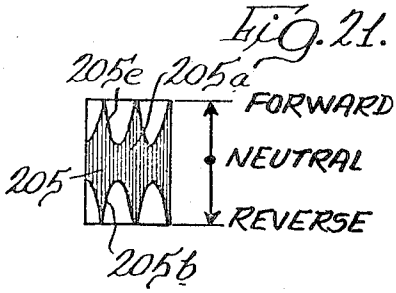


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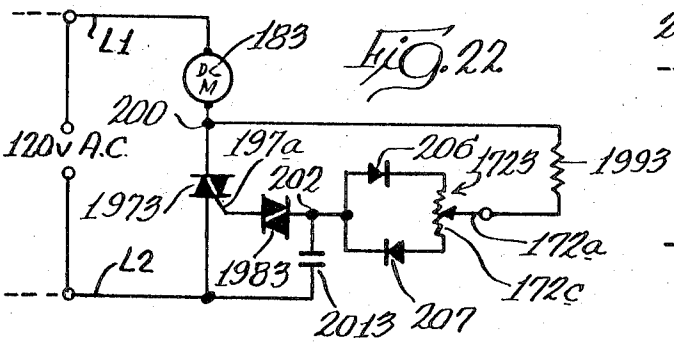


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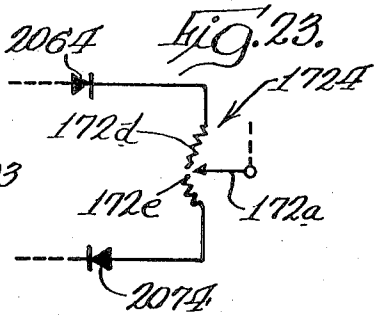


Fig. 23.

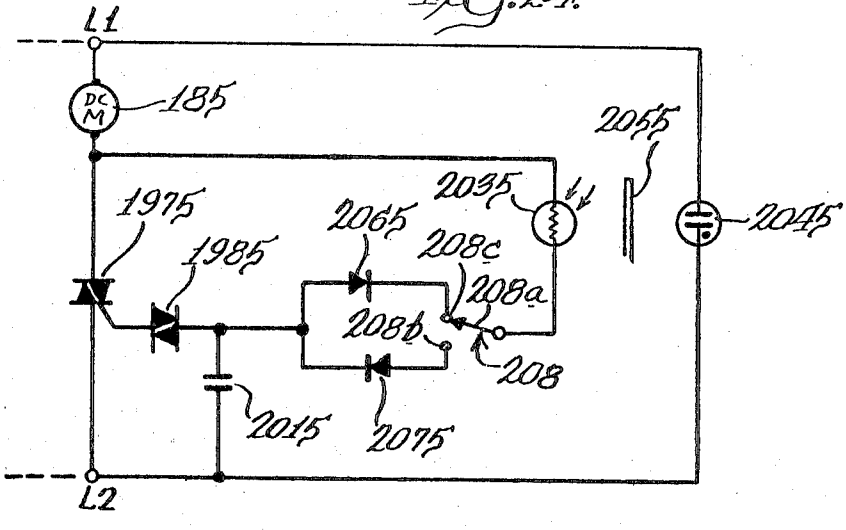


Fig. 24.

UPRIGHT VACUUM CLEANER—DRIVE MOTOR CONTROL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to vacuum cleaners and the like, and in particular to an improved control means for use in propelling vacuum cleaners and the like.

2. Description of the Prior Art

United States Letters Patent which would appear to be pertinent to the present invention are as follows:

716,065	Ledwinka	Automobile
1,076,652	Hoffmann	Driving Mechanism for Vehicles
1,098,849	Smart et al	Switch
1,242,115	Russel	Switch for Dental Instruments
1,723,371	Pieper	Combined Tool Handle and Switch
1,813,856	Klein	Direct Drive for Antifriction Roller Bearing Free Wheels
1,953,340	Doemling	Suction Cleaner
2,041,442	Stinsman	Floor Polishing Machine
2,138,239	Irgens	Self-Propelled Implement
2,348,053	Bowker	Electrically Operated Motor Vehicles
2,706,008	Voigt	Powered Golf Bag Carrier
2,823,411	Kirby	Vacuum Cleaner
2,879,858	Thomas	Battery Energized, Motor-Driven Vehicle
2,937,706	Chandler	Self-Propelled Carts
3,095,534	Cockrell	Circuit for Controlling Energization of a Direct Current Load
3,195,029	Gilbreath	Series Motor Control
3,222,582	Heyman et al	Variable Speed Motor System Utilizing Controlled Rectifiers
3,225,853	Norton et al	Control Handle for Golf Cart
3,354,496	Jonsson	Suction Cleaner Nozzle of the Agitator Type
3,385,077	Marsteller	Air Conditioner
3,475,676	Hutson	Photosensitive Power Control System
3,489,874	Baumann	Control Switch for an Electric Dry Razor

Ledwinka U.S. Pat. No. 716,065 shows an automobile construction utilizing an early propelling means.

Hoffman U.S. Pat. No. 1,076,652 shows another form of early drive mechanism for propelling a vehicle.

Smart et al. U.S. Pat. No. 1,098,849 show a switch adapted to be operated by the longitudinal movement of an actuating member.

Russell U.S. Pat. No. 1,242,115 shows a longitudinal movable switch for use in a dental instrument. Pieper U.S. Pat. No. 1,723,371 shows a similar switch.

Klein U.S. Pat. No. 1,813,856 shows a drive having an electric motor for each of a plurality of wheels.

Doemling U.S. Pat. No. 1,953,340 shows a vacuum cleaner wherein an agitator is driven from an actuating motor separate from the fan motor.

Stinsman U.S. Pat. No. 2,041,442 shows a floor polishing machine having a fan for ventilating the motor elements.

Irgens U.S. Pat. No. 2,138,239 shows a self-propelled powered lawnmower having a handle grip for controlling forward and rearward movement of the lawnmower.

Bowker U.S. Pat. No. 2,348,053 shows a battery operated motor vehicle having a dynamotor within each wheel.

Voigt U.S. Pat. No. 2,706,008 shows a powered golf bag carrier having a worm gear arrangement providing increased power under heavy loading conditions and braking means to secure the carrier in a stationary position.

Kirby U.S. Pat. No. 2,823,411 shows a vacuum cleaner with the fan motor also driving a brush in the nozzle.

Thomas U.S. Pat. No. 2,879,858 shows a battery driven vehicle wherein the current supplied to the drive motor is varied in accordance with the tension applied to the handle thereof.

Chandler U.S. Pat. No. 2,937,706 shows a self-propelled cart having a handle controlling the electric drive motor thereof with the amount of pull on the handle varying the force developed by the motor.

Cockrell U.S. Pat. No. 3,095,534 shows a circuit for controlling energization of a direct current load utilizing a controlled rectifier in controlling the current to the motor armature. Gilbreath U.S. Pat. No. 3,195,029 shows a series motor control using a controlled rectifier in similarly controlling the current to the motor armature. Heyman et al. U.S. Pat. No. 3,222,582 shows a motor system utilizing controlled rectifiers.

Norton et al. U.S. Pat. No. 3,225,853 show a control handle for a golf cart providing adjustable power as a function of the magnitude of the applied force.

Jonsson U.S. Pat. No. 3,354,496 shows a vacuum cleaner nozzle having an agitator driven by an electric motor.

Marsteller U.S. Pat. No. 3,385,077 shows an air conditioner wherein modulation of the air flow is controlled by an optical system utilizing a photocell. Hutson U.S. Pat. No. 3,475,676 shows a photosensitive power control system utilizing similar optical means.

Baumann U.S. Pat. No. 3,489,874 shows a control switch for an electric razor having an operating knob which is selectively slidable, pivotable, or rockable in the casing.

Thus, the prior art shows the concept of propelling means such as automobiles, lawnmowers, golf bag carriers, and golf carts by self-contained motor driven power means. The art further shows the use of push-pull, longitudinally movable controls such as in electric switches, dental instruments, lawnmowers, and golf carts.

The prior art further shows the use of vacuum cleaners having motor driven suction fans and motor driven agitators. Still further, it is known to use direct current motors for reverse driving of devices and to use controlled rectifier means for controlling the current flow to such a motor for varying the speed and torque thereof.

SUMMARY OF THE INVENTION

The present invention comprehends a vacuum cleaner construction having new and improved control means for effecting controlled self-propelling thereof. The movement of the vacuum cleaner is effected by application of force to the handle thereof for controlling the drive motor through the new and improved control means.

More specifically, the control effects rectification of an alternating current power supply to permit use of a direct current motor as the propelling drive means.

The propelling means includes wheels carried on the oppositely projecting shaft ends of the drive motor. The wheels may define means for deflecting cooling air against the motor. The wheeled drive may be mounted to the carriage of the vacuum cleaner or to the nozzle

in different embodiments of the invention. The cooling air may be drawn through the motor by the vacuum cleaner suction fan or may be delivered to the motor under pressure from the suction fan in different embodiments of the invention. The cooling air may comprise air from which dirt has been removed by the vacuum cleaner. Alternatively, the cooling air may comprise atmospheric air drawn by the suction fan concurrently with the drawing of the dirt laden air to the dirt separating means. The cooling air may be passed through the interior of the motor housing through suitable openings therein and may also be directed against the exterior of the housing by deflecting means such as the drive wheels as discussed above.

The drive wheels may comprise cup-shaped elements partially surrounding the motor housing while leaving a passage therebetween intermediate the ends of the motor housing for passing cooling air therethrough.

The means for controlling the operation of the propelling motor may include an electronic switch phase controlled to vary the current to the motor as a function of the position of the handle means. The control may function to provide power during each half cycle of the alternating current power supply. Alternatively, the control may function to provide current only during similar polarity half cycles of the alternating current power supply to selectively reversely operate the motor as a function of the selected polarity.

The phase controlled electronic switch may comprise a controlled rectifier. In one form, the rectifier comprises a bidirectional triode thyristor. In another embodiment, the rectifier comprises a silicon controlled rectifier. In one embodiment, the means for controlling the control gate of the controlled rectifier comprises a bidirectional trigger diode. In another embodiment, the means for controlling the control gate comprises a silicon unilateral switch.

Phase control of the controlled rectifier may be provided by varying a resistance in the control circuit thereof. In one embodiment, the variable resistance comprises a potentiometer. The potentiometer may have a gap in the mid-portion of the resistor thereof to provide an Off condition. In another embodiment, the variable resistor comprises a photocell and means for varying the amount of light striking the photocell from a light source for providing a low cost, long life adjustable resistance means. The means for varying the transmitted light may comprise a suitable mask positioned by the handle of the vacuum cleaner.

In another embodiment of control wherein the motor is operated only on similar polarity half cycles of the alternating current power supply, the variable resistance is connected to the means for triggering the controlled rectifier through a parallel inverse diode circuit. Selection of the polarity of the motor operating current may be obtained by connecting a potentiometer resistor across the parallel circuit with the slider of the potentiometer connected to the motor. Alternatively, selection of the polarity may be effected by a selector switch having the moving contact selectively engageable with fixed contacts connected one each to the different inversely connected diodes.

More specifically, the present invention comprehends the provision in a vacuum cleaner having an operating handle and a wheeled drive including an electric drive motor and wheels driven by said motor, of control means for controlling the propelling of the vacuum cleaner by the wheeled drive comprising a direct current motor, a full wave rectifier for supplying direct current to said motor from an alternating current power supply, an electronic switch in series with the motor having a control gate element, and means responsive to the position of the operating handle relative to an Off position thereof for controlling the control gate element and correspondingly providing phase controlled conduction of direct current through the motor during each half cycle of the alternating current power.

Further more specifically, the electronic switch thereof may comprise a bidirectional triode thyristor and the means responsive to the position of the operating handle for controlling the thyristor may include a bidirectional trigger diode having one terminal connected to the control gate element, parallel, inverse diodes connected to the other terminal of the trigger diode, a capacitor connected between the other terminal of the trigger diode and the power supply, and resistance means adjustably connected to the inverse diodes.

Further more specifically, alternatively, the invention comprehends the provision in a vacuum cleaner having an operating handle and a wheeled drive including an electric drive motor and wheels driven by the motor, of control means for controlling the propelling of the vacuum cleaner by the wheeled drive comprising a direct current motor, adjustable phase controlled means for providing current to the motor only during similar polarity half cycles of the alternating current power, and means for selecting the half cycle polarity during which the current is provided for selective reversible operation of the motor.

BRIEF DESCRIPTION OF THE DRAWING

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIG. **1** is a perspective view of a vacuum cleaner embodying the invention;

FIG. **2** is a fragmentary rear elevation thereof with portions of the rear cover of the bag enclosure removed to illustrate details;

FIG. **3** is a fragmentary bottom plan view thereof;

FIG. **4** is a fragmentary enlarged vertical section illustrating the handle switch control means;

FIG. **5** is a fragmentary vertical section illustrating the propelling means mounted to the carriage of the vacuum cleaner;

FIG. **6** is a diametric section taken substantially along the line **6—6** of FIG. **5**;

FIG. **7** is a schematic wiring diagram of the electric drive control;

FIG. **8** is a fragmentary plan view with portions broken away illustrating one embodiment of the invention wherein cooling air is delivered from the suction fan to the drive motor;

FIG. **9** is a fragmentary side elevation thereof;

FIG. **10** is a fragmentary side elevation thereof with the nozzle in a raised position;

FIG. **11** is a plan view illustrating another embodiment of the invention wherein cooling air is sucked through the drive motor to pass with dirt laden air to the dirt separating means;

FIG. **12** is a fragmentary side elevation thereof;

FIG. 13 is a fragmentary side elevation thereof with the nozzle in a raised position;

FIG. 14 is a plan view illustrating another embodiment of the invention wherein cooling air is drawn through the drive motor to the suction inlet of the fan;

FIG. 15 is a fragmentary side elevation thereof;

FIG. 16 is a fragmentary side elevation thereof with the nozzle in a raised position;

FIG. 17 is a fragmentary side elevation of the vacuum cleaner construction of FIG. 5;

FIG. 18 is a fragmentary side elevation thereof with the nozzle in a raised position;

FIG. 19 is a schematic wiring diagram of a modified form of electrical control of the drive means;

FIG. 20 is a schematic wiring diagram illustrating a still further modified control;

FIG. 21 is an elevation of a mask for use in the control of FIGS. 20 and 24;

FIG. 22 is a schematic wiring diagram of yet another modified form of control;

FIG. 23 is a fragmentary schematic wiring diagram illustrating a modification of the control of FIG. 22; and

FIG. 24 is a schematic wiring diagram of yet another drive control embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the exemplary embodiments of the invention as disclosed in the drawing, a vacuum cleaner generally designated **10** is shown to comprise an upright vacuum cleaner having a nozzle **11** and an upstanding bag enclosure **12** provided with a front closure **51.** The nozzle is mounted to a carriage **13** herein provided with rear wheels **14.** A brush and beater bar **15** is mounted at the front of the nozzle to be driven from the suction fan motor **16** by suitable means (not shown). Herein the vacuum cleaner is driven by a propelling means generally designated **17** comprising a drive motor **18** and a pair of drive wheels **19** and **20** secured to the oppositely projecting shaft ends **21** and **22** of the drive motor. As shown in FIGS. **5** and **6,** the housing **23** of the drive motor may be secured to the carriage **13** by a suitable bracket **24** and screws **25.**

Wheels **19** and **20** define cup-shaped elements facing toward each other coaxially of the motor as illustrated in FIG. **6.** Thus, wheel **19** defines an end wall **26** and a cylindrical side wall **27,** and wheel **20** defines an end wall **28** and a cylindrical side wall **29.** The distal end **30** of wheel side wall **27** is spaced longitudinally from the distal end **31** of side wall **29** to define a space **32** therebetween for passing cooling air.

As illustrated in FIGS. **5, 6, 8, 17** and **18,** cooling air may be delivered from the suction fan **45** through a duct **33** to the interior of motor housing **23** through an inlet opening **34** in the housing. After passing through the housing, the cooling air may exhaust through the opposite ends **35** and **36** of the housing. As shown in FIGS. **6** and **8,** the cup-shaped wheels are spaced axially and circumferentially from the housing to define flow paths **37** whereby the air deflected by the wheels is delivered to the space **32** to exhaust to the atmosphere. As shown in FIG. **8,** the dirt laden air is conducted to bag **39** by means of a duct **40** extending from the nozzle **11** into the enclosure **12** wherein the bag is received. A duct **41** connects the enclosure **12** to the suction inlet **42** of the fan **45.** The shroud **43** extending about the fan motor **16** is provided with a discharge opening **44** for discharging air from the fan **45** to atmosphere. As shown in FIG. **8,** the duct **33** opens through the shroud **43** for receiving a portion of the air delivered from fan **45** for delivery to the drive motor.

As shown in FIGS. **17** and **18,** the nozzle **11** may be pivoted on the carriage **13** by means of a projection **46** on housing **12** engaging a lever **47** pivotally mounted on a bracket **48** carried by the carriage **13.** Thus, the wheel drive **17** is maintained in engagement with the subjacent floor F while the nozzle may be pivoted to space the brush and beater bar above the floor level by suitable pivoting of the enclosure **12** on the carriage. Duct **33** maintains the connection between the suction fan and motor **18** in the different relationships of the nozzle and carriage, as illustrated in FIGS. **17** and **18.**

Vacuum cleaner **10** is propelled on the subjacent floor by suitable energization of drive motor **18** as a result of pressure applied to a handle **49** upstanding from the bag housing **12,** as illustrated in FIG. **1.** As shown in FIG. **2,** bag enclosure **12** includes a rear portion **50.** Removal of rear closure **52** of housing **12** provides access to the space **52***a* within the rear portion **50.** Handle **49** extends through the top wall **53** of the housing portion **50** and is provided with a slide tube **54** internally carrying a housing **55** defining a cam **56** selectively engageable with the actuator **57** of a first switch **58** and the actuator **59** of a second switch **60.** The switches are carried on the rear housing portion **50.** A centering device generally designated **61** is mounted in housing **55** for centering the cam **56** between the actuators **57** and **59,** as shown in FIG. **4.**

More specifically, the centering device includes a rod **62** fixedly secured to the housing portion **50** by a pin **63.** Rod **62** is provided with a pin **64** intermediate the ends **65** and **66** of housing **55.** A first coil spring **67** extends coaxially about rod **62** to a washer **68** slidably mounted on the rod adjacent pin **64.** A second coil spring **69** extends from housing end **65** to a washer **70** slidably mounted on rod **62** oppositely adjacent pin **64.** Slide tube **54** further is provided with an actuator **71,** as shown in FIG. **2,** for controlling the setting of a potentiometer **72** carried on the housing portion **50.** As further shown in FIG. **2,** a control **73** is mounted on the housing portion **50** adjacent upper wall **53** and a cord reel **74** is mounted to the housing portion **50** at the lower opposite end with a power supply cord **75** extending from reel **74** outwardly through the housing for connecting the vacuum cleaner to a power source such as a conventional wall receptacle (not shown).

Operation of the vacuum cleaner may best be understood by reference to the schematic electrical wiring diagram of FIG. **7.** As shown, drive motor **18** illustratively comprises a permanent magnet direct current motor having an armature **76** connected between the moving contacts **60***a* of switch **60** and contacts **58***a* of switch **58.** Direct current power is delivered to the motor **18** from alternating current power supply leads L1 and L2 connected to a full wave bridge rectifier **77** through a single pole, single throw interlock switch **78.** The positive output terminal **77***a* of the full wave bridge rectifier is connected to fixed contacts **60***b* and **58***b* of switches **60** and **58,** respectively. A resistor **79** and a resistor **80** are connected in series between terminal **77***a* and the negative terminal **77***b* of rectifier **77.** Diode

81 is connected between terminal 77*a* and second fixed contact 60*c* of switch 60 and second fixed contact 58*c* of switch 58 and through a silicon controlled rectifier 82 to negative terminal 77*b*. Diode 81 is further connected through a second inversely related diode 83 to the potentiometer 72, having its slider 72*a* connected to a fixed resistor 84 and a drive motor speed selector switch 85. Switch 85, in turn, is connected through a fixed resistor 86 and a capacitor 87 to power terminal 77*b*. A silicon unilateral switch 88 has its gate 88*a* connected to terminal 89 between resistors 79 and 80. Switch 88 is connected from a terminal 90 between resistor 86 and capacitor 87 to the gate 82a of the silicon controlled rectifier 82. A resistor 91 is connected from rectifier gate 82*a* to power terminal 77*b* and a series connection of a resistor 92 and capacitor 93 is connected across the rectifier gate 82*a*. A jumper 72*b* is connected to the opposite ends of the resistor 72*c* of potentiometer 72.

As discussed above, longitudinal movement of handle 49 by the application of force thereto by the user's hand, as shown in FIG. 1, causes a corresponding movement of cam 56, as shown in FIG. 4, to actuate either forward switch 60 or reverse switch 58 as a function of the direction of force application to the handle. Further, the amount of longitudinal handle movement effected controls the positioning of the slider 72*a* of potentiometer 72 to control the silicon unilateral switch 88 and thereby control the amount of current passed by the controlled rectifier 82 thereby to control the speed and torque of the motor 18. As shown in FIG. 7, when forward switch 60 is closed, i.e., by a downward movement of cam 56 (FIG. 4), moving contact 60*a* closes with fixed contact 60*b* to provide power from positive power supply terminal 77*a* through motor armature 76, switch 58 and through the silicon controlled rectifier to negative terminal 77*b*. Phase control of silicon controlled rectifier 82 is effected by the setting of slider 72*a* relative to resistor 72*c* of potentiometer 72 so as to vary the amount the current passed by rectifier 82 depending on the amount of displacement of slider 72*a* from the center position 72*d* of resistor 72*c*.

Reversely, similarly, where the handle is moved rearwardly so as to move cam 56 upwardly to close switch 58, positive power supply terminal 77*a* is connected through moving contact 58*a* of switch 58 to motor armature 76 and through switch 60 and silicon controlled rectifier to the negative power terminal 77*b* causing a reverse operation of the motor 18 under the speed control of potentiometer 72.

Electrical components of one control found to provide excellent functioning as described above, are as follows:

18 Motor	American Lincoln PM DC
72 Potentiometer	0 to 1 Megohm
79 Resistor	220 Kilohms
80 Resistor	2.2 Kilohms
81 Diode	1N1694
82 Silicon Controlled Rectifier	GE C22B
83 Diode	1N1694
84 Resistor	330 Kilohms
86 Resistor	1 Kilohm
87 Capacitor	0.8 mfd.
88 Silicon Unilateral Switch	GE 2N4987
91 Resistor	100 Ohms
92 Resistor	33 Ohms
93 Capacitor	0.01 mfd.

Modified controls suitable for use in controlling the operation of a motor corresponding to motor 18 are illustrated in FIGS. 19–24. As shown in FIG. 19, a control generally designated 173 is shown to include a full wave rectifier 177 connected to the alternating current power supply leads L1 and L2. A selector switch 194 is connected to the output terminals 177*a* and 177*b* of the power supply for selectively connecting power supply terminal 177*a* to a motor terminal 195 or a terminal 196 and power supply terminal 177*b* concurrently to terminal 196 or terminal 195 as a function of the position of the vacuum cleaner handle. The means for controlling current through the motor 181 comprises a controlled rectifier illustratively comprising a bidirectional triode thyristor, or triac, 197 having its gate 197*a* controlled by a bidirectional trigger diode, or diac, 198 connected in series with a fixed resistor 199 and a potentiometer 172 to a terminal 200 connected between motor 181 and triac 197. Triac 197 is connected between motor 181 and terminal 196 and a capacitor 201 is connected from a terminal 202 between diac 198 and resistor 199 and terminal 196 and the resistor 172*c* has its opposite ends connected by a jumper 172*b*.

Thus, current flow to motor 181 is controlled by the triac 197 under the phase control of diac 198 which, in turn, is controlled by the setting of potentiometer slider 172*a* and switch 194 by the vacuum cleaner handle to provide selectively reversible operation of the vacuum cleaner wheeled drive motor at different speeds and torques as desired.

As shown in FIG. 20, the portion of the control 173 connected to terminals 195 and 196 may be modified to utilize a photocell 203 in lieu of potentiometer 172 as a variable resistance for controlling the diac 198. A neon lamp 204 may be connected between terminals 195 and 196 for directing light to the photocell 203. A mask 205 carried for movement with the vacuum cleaner handle 49 is interposed between lamp 204 and photocell 203 to control the resistance of the photocell. As shown in FIG. 21, the mask 205 includes an opaque portion 205*a* defined by downwardly opening cusps 205*b* and upwardly opening cusps 205*c* for varying the amount of light received by the photocell as a function of the movement of the mask from a centered position under the control of the vacuum cleaner handle. The control of FIG. 20 thus provides an improved long life control as frictional wear of control elements is avoided.

Referring to FIGS. 22–24, further modified control means for controlling a wheeled drive motor 183 of the vacuum cleaner are shown to provide such control under half wave voltage conditions. More specifically, as shown in FIG. 22, motor 183 may be connected through a triac 1973 across the alternating current power supply leads L1 and L2. The triac is phase controlled by a diac 1983 connected to its gate 197*a*. A capacitor 2013 is connected from power supply lead L2 to terminal 202. A fixed resistor 1993 is connected from terminal 200 to the slider 172*a* of potentiometer 1723 having its resistor 172*c* connected between parallel inverse diodes 206 and 207 which, in turn, are connected to terminal 202. Resistor 172*c* preferably has a relatively high value, such as 4 or 5 megohms, and thus prevents triggering of the triac 1973 when in the center position, as shown in FIG. 22. However, when the vacuum cleaner handle is moved in either direction to correspondingly move the slider 172*a*, the triac is triggered

during similar half cycles of the alternating current power supply. Thus, illustratively, when the slider **172***a* is moved upwardly, as seen in FIG. **22**, the triac is triggered on positive half cycles and when the slider is moved downwardly, the triac is triggered on negative half cycles. Further, as the total resistance of the circuit through the diode varies as the amount of movement of the slider **172***a*, motor **183** is controlled not only as to direction of movement, but also as to speed and torque by the phase control of triac **1973** by diac **1983.**

As shown in FIG. **23**, the potentiometer may be provided with a modified resistor **172***d* having a gap **172***e* at the center portion so that when the slider **172***a* is in the center position, the control will be in an Off condition as no current can flow to the diac **1983** from terminal **200.**

Referring now to FIG. **24**, a further modified control is shown to comprise a control similar to that illustrated in FIG. **22** but wherein the variable resistance is provided by photocell **2035** in lieu of the potentiometer **172** and the switching function is provided by a selector switch **208** having its moving contact **208***a* connected in series with the photocell **2035**, one fixed contact **208***b* connected to diode **2075**, and a second fixed contact **208***c* connected to diode **2065.** The resistance of photocell **2035** is controlled by lamp **2045** and mask **205** as described above relative to the control of FIG. **20.** Switch **208** is operated by handle **49** concurrently with the moving of mask **205** to provide the desired reverse operation of vacuum cleaner drive motor **185** concurrently with the speed and torque control thereof by the control of the variable resistance of photocell **2035.** The control of FIG. **24** is similar to the control of FIG. **22** in that the operation of the motor **185** is by similar polarity half cycles of the alternating current power supply by means of the inverse parallel diodes **2065** and **2075.**

Illustrative circuit components for the elements of the controls of FIGS. **19–24** are as follows:

172	potentiometer	0–1 Megohm
177	Full wave rectifier	200 Volt PRV, 4 amp.
181	Motor	American-Lincoln PM DC
194	Selector switch	DPDT
197	Triac	GE, SC 40B
198	Diac	GE, ST-2
199	Resistor	30 Kilohms
201	Capacitor	0.1 mfd
182	Motor	American-Lincoln PM DC
1972	Triac	GE, SC 40B
1982	Diac	GE, ST-2
1992	Resistor	30 Kilohms
2012	Capacitor	0.1 mfd
203	Photocell	Vactec VT-101H
204	Lamp	Signalite Neon
1723	Potentiometer	0–1 Megohm
183	Motor	American-Lincoln PM DC
1973	Triac	GE, SC 40B
1983	Diac	GE, ST-2
1993	Resistor	30 Kilohms
2013	Capacitor	0–1 mfd
206	Diode	1N 1694
207	Diode	1N 1694
1724	Potentiometer	0–1 Megohm
2064	Diode	1N 1694
2074	Diode	1N 1694
185	Motor	American-Lincoln PM DC
1975	Triac	GE, SC 40B
2035	Photocell	Vactec VT-101 H
2065	Diode	1N 1694
2075	Diode	1N 1694
2045	Lamp	Signalite Neon

The modified controls of FIGS. **19–24** function in the vacuum cleaner structure similarly to the control **73** except as otherwise noted above.

Referring now to FIGS. **11–16**, the vacuum cleaner construction may include modified means for effecting the delivery of cooling air to the drive motor **18** by means of the suction fan **45.** Thus, as shown in FIGS. **11–13**, a duct **209** may be connected between the motor housing opening **34** and the suction duct **40** leading from the nozzle **11** to the dirt collecting chamber **38.** Thus, the suction pressure effected by fan **45** serving to draw dirt laden air into the vacuum cleaner concurrently serves to draw air through the motor housing **23** to cool the drive motor by sucking the air therethrough to the dirt separating chamber.

Referring now to FIGS. **14–16**, a further modified form of vacuum cleaner construction embodying the invention is shown to include a duct **210** connecting the motor housing opening **340** directly to the suction inlet **420** of the fan **450** defined by the shroud **430.** Thus, the cooling air sucked through the drive motor **180** is delivered directly to fan **450** rather than through the dirt separating chamber as in the embodiment of FIGS. **11–13.** In all other respects, the vacuum cleaner constructions of FIGS. **11–16** are similar to the vacuum cleaner construction illustrated in FIGS. **8–10** and similar elements thereof are identified by related reference numerals.

Thus, the vacuum cleaner constructions of the present invention provide an improved facilitated propelling of the vacuum cleaner over the surface to be cleaned. The drive motor of the propelling means and the suction fan of the vacuum cleaner are cooperatively associated for improved efficiency and low cost of the unit. Improved trouble-free, long life control means are provided for effecting desired reversible driving of the propelling means. The vacuum cleaner constructions of the present invention are extremely simple and economical of manufacture while yet providing the highly desirable features discussed above.

The foregoing disclosure of specific embodiments is illustrative of the broad inventive concepts comprehended by the invention.

I claim:

1. In a vacuum cleaner having a selectively positionable operating handle and a wheeled drive including an electric drive motor, conductor means for connecting the vacuum cleaner to an alternating current power supply, the wheels driven by said motor, control means for controlling the propelling of the vacuum cleaner by said wheeled drive comprising: a direct current motor; a bidirectional triode thyristor in series with said motor and said conductor means and having a control gate element; and means responsive to the position of said operating handle relative to an "Off" position thereof for controlling said control gate element and correspondingly providing phase controlled conduction of direct current through said motor during similar polarity half cycles of the alternating current power, including a bidirectional trigger diode having one terminal connected to said control gate element, parallel connected inverse diodes connected to the other terminal of said trigger diode, a capacitor connected between said other terminal of the trigger diode and said conductor means, and adjustable means including adjustable resistance means electrically connected in series with said inverse diodes and said trigger diode, and to said con-

ductor means, said adjustable resistance means including a first resistance portion having a terminal connected to one of said diodes, a second resistance portion having a terminal connected to the other of said diodes, and means interconnecting said resistance portions opposite from said terminals to said conduction means, the adjustable resistance means being adjusted in response to positioning of said handle relative to said Off position and providing preferential current flow through a selected one of said diodes depending on the direction of movement of said handle from said Off position.

2. In a vacuum cleaner having a selectively positionable operating handle and a wheeled drive including an electric drive motor, conductor means for connecting the vacuum cleaner to an alternating current power supply, and wheels driven by said motor, control means for controlling the propelling of the vacuum cleaner by said wheeled drive comprising: a direct current motor; a first, bidirectional electronic switch means in series with said motor and said conductor means and having a control gate element; and means responsive to the position of said operating handle relative to an Off position thereof for controlling said control gate element and correspondingly providing phase controlled conduction of direct current through said motor during similar polarity half cycles of the alternating current power to operate said drive motor selectively in either a forward driving direction or a rearward driving direction, including a bidirectional trigger diode connected to said control gate element, parallel connected inverse diodes connected in series with said trigger diode, and manually operable adjustable means electrically connected in series with said inverse diodes and said trigger diode, and to said conductor means, said adjustable means being responsive to the direction and magnitude of displacement of said handle from said Off position for causing preferential conduction of current through a corresponding selected one of said inverse diodes for causing said second electronic switch means to control said first electronic switch means to effect said selective controlled operation of said drive motor.

3. The vacuum cleaner means of claim **2** wherein said control means includes biasing means urging said handle to said Off position when the handle is released.

4. The vacuum cleaner control means of claim **2** wherein said adjustable means includes variable resistance means.

5. The vacuum cleaner control means of claim **4** wherein said resistance means comprises a potentiometer having its resistor connected between the inverse diodes, and its slider connected to a fixed resistor.

6. The vacuum cleaner control means of claim **4** wherein said resistance means comprises a potentiometer having its resistor connected between the inverse diodes and its slider connected to said motor through a fixed resistor.

7. The vacuum cleaner control means of claim **4** wherein said resistance means comprises a potentiometer having its resistor connected between the inverse diodes and its slider connected to said motor, the resistor of said potentiometer having a gap at the center thereof for defining an Off arrangement when the slider is positioned at said gap.

8. The vacuum cleaner control means of claim **2** wherein said adjustable means comprises photocell means and means for varying the amount of light striking the photocell means as a function of the position of said handle.

9. The vacuum cleaner control means of claim **2** wherein said adjustable means comprises photocell means, light source means for actuating the photocell means, and mask means interposed between the photocell and light source means for varying the amount of light falling on said photocell means from said source means as a function of the position of said handle for causing said photocell means to control operation of the motor.

10. The vacuum cleaner control means of claim **9** wherein said adjustable means further comprises selector means for selectively connecting the photocell means alternatively to either of said inverse diodes comprising a double throw switch arranged to be operated by said handle.

11. The vacuum cleaner control means of claim **2** wherein said bidirectional trigger diode has one terminal connected to said control gate element, said inverse diodes being connected to the other terminal of the trigger diode, said means for controlling the control gate element further including a capacitor connected between said other terminal of the trigger diode and said power supply, and said adjustable means comprises resistance means.

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