Aug. 5, 1969 TSUNEO KOBAYASHI ET AL 3,458,892

ELECTRIC CLEANER

Filed Nov. 20, 1967 2 Sheets-Sheet 1

FIG. 1

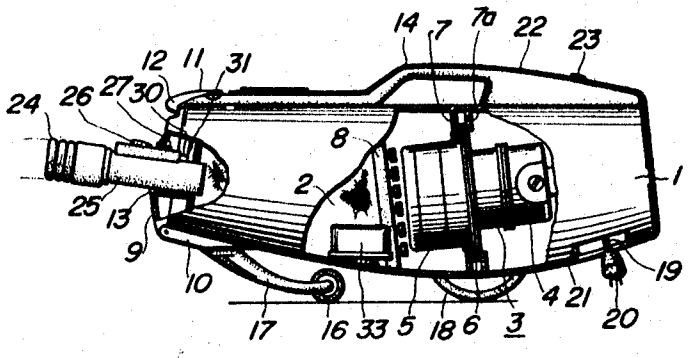
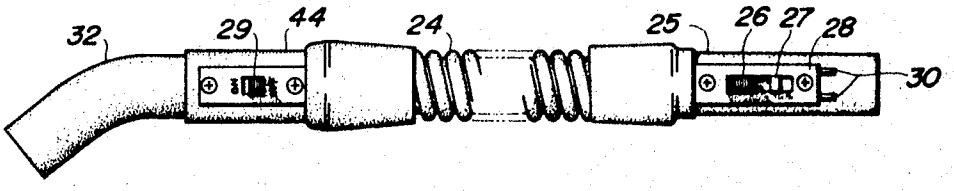


FIG. 2



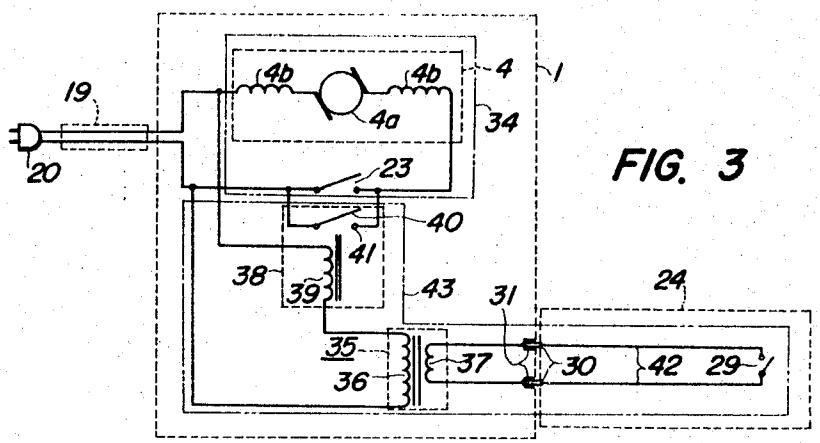
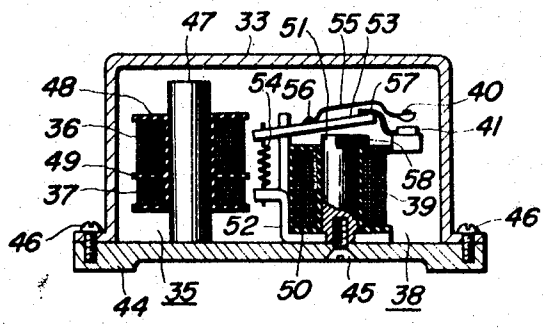


FIG. 3

FIG. 4



ELECTRIC CLEANER

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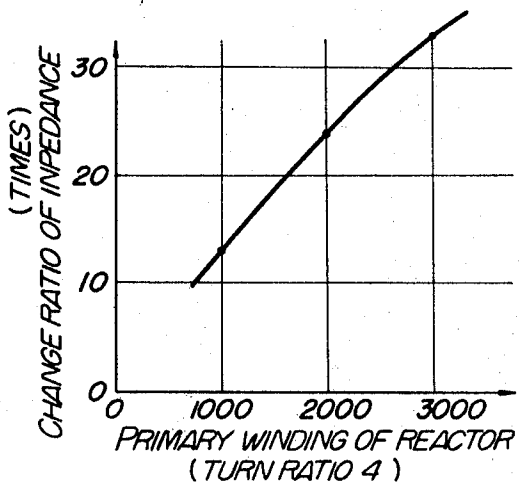
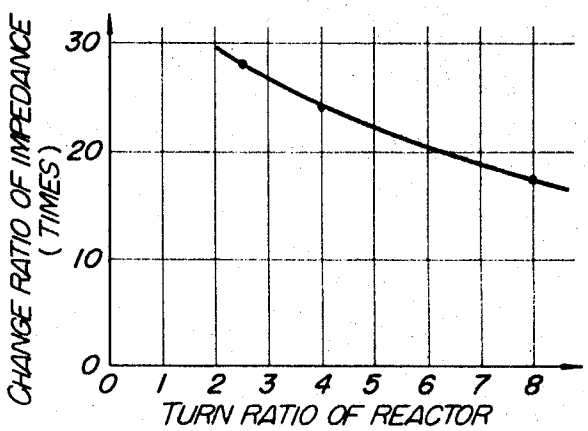


FIG. 5

FIG. 6



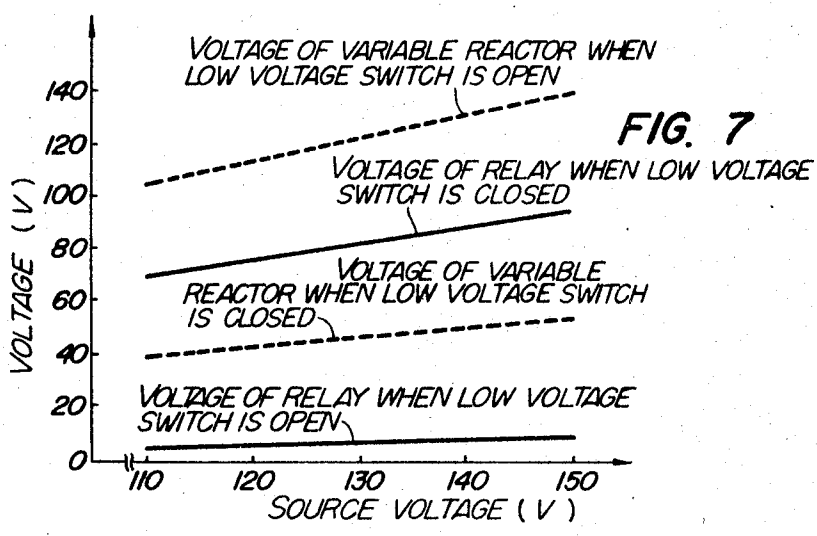


FIG. 7

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ELECTRIC CLEANER

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Int. Cl. A47l 9/28; H01h 3/00
U.S. Cl. 15—327 4 Claims

ABSTRACT OF THE DISCLOSURE

A vacuum cleaner of the type in which a dust bag and an electric blower are provided in a body thereof and the dust sucked into the body of the cleaner through a flexible hose connected to the suction port of the body is collected in said dust bag, said vacuum cleaner being characterized in that a switch provided at the grip portion of said flexible hose is connected to the control winding of a variable reactor in the body of the cleaner through a pair of leads, while a high voltage relay adapted to be actuated by said switch to open and close the main circuit of said electric blower is connected to the main winding of said variable reactor in series, whereby the low voltage circuit of a remote control circuit for a motor including said switch is electrically separated from the main circuit of the electric blower.

Background of the invention

In general, in the use of a vacuum cleaner of the type which comprises a body with a dust bag and an electric blower accommodated therein and a flexible hose removably connected to the suction port of said body at one end and having a floor nozzle connected to the other end, the vacuum cleaner sucks dust into the dust bag and collects the same in said dust bag through the floor nozzle and the flexible hose by the suction of said electric blower while being dragged on the floor by the operator by way of the flexible hose.

In the vacuum cleaners of the type described, it has been a common practice to provide a switch at the grip portion of the flexible hose, in addition to the switch provided on the body of the vacuum cleaner, so as to enable the operator to control the operation of the electric blower remotely at said grip portion without obliging the operator to reach after the switch on the body of the cleaner each time the electric blower is to be set in motion or stopped. Further, in the conventional vacuum cleaners, since the terminal ends of the electric circuit in the body of the cleaner, through which the switch on the flexible hose is electrically connected to said circuit, are exposed when the flexible hose is disconnected from the suction port, a provision is made to drop the voltage in said electric circuit to such a level as not to endanger the operator.

According to the present invention, the remote control circuit comprising leads embedded in the flexible hose and electrically connecting the switch, provided at the grip portion of the flexible hose, with the electric circuit in the body of the cleaner, is partly operated at a low voltage, so as not only to ensure the safety of the operator but also to prevent the high voltage in the main circuit of the electric blower from being impressed on said remote control circuit even when a faulty condition occurs at any portion of said remote control circuit, whereby the safety of the operator is further enhanced.

In the conventional vacuum cleaners of the type described, the switch provided at the grip portion of the flexible hose, adapted to be removably connected to the suction port of the body of the cleaner, is connected to the secondary winding of a step down transformer in the body, through a pair of leads embedded in said flexible hose and a connector provided in the body of the cleaner, and a low voltage relay to open and close the main circuit of the electric blower in the body of the cleaner is connected in series to said secondary winding of the step down transformer, to form a remote control circuit. Thus, the voltage impressed on the remote control circuit, comprising the switch on the flexible hose, the connector in the body of the cleaner, the secondary winding of the step down transformer and the low voltage relay, is dropped to a safety level by the step down transformer. However, such arrangement is not entirely satisfactory because, if the low voltage relay becomes faulty, causing shorting of the main circuit of the electric blower, a serious accident will result. Namely, since the high voltage is impressed on the entire secondary circuit of the step down transformer, there is the danger of the low voltage relay and the secondary winding of the step down transformer being burnt or the operator being struck by electricity due to failure in insulation of the leads in the flexible hose or the switch on said flexible hose.

In order to avoid such a danger, it has been necessary to provide a strong insulation between the contacts of the switch of the low voltage relay to open and close the main circuit of the electric blower and an exciting winding on which a low voltage is impressed. It is for this reason that most of the conventional vacuum cleaners are large in size and expensive.

Another problem of the conventional vacuum cleaners having a remote control circuit of the type described is that, since the secondary winding of the step down transformer and the low voltage relay are connected in series, the current flowing through the low voltage relay is decreased by the impedance of said relay, when the switch on the flexible hose is closed. Therefore, there exists a tendency that the operation of the low voltage relay becomes unstable. In order to obtain a stable operation of the low voltage relay, it is necessary to maintain a high induced electromotive force in the secondary winding but this will result in a high voltage at the connection in the body of the cleaner, giving a detrimental affect on the operation of the cleaner.

Still another problem is that the residual magnetism in the magnetic circuit keeps the main circuit closed even after the switch is opened to interrupt the current flowing through the exciting winding of the low voltage relay. The elimination of such problem has necessitated the use of high quality material for the core or the provision of a short-circuit winding in the magnetic circuit to erase the residual magnetism or the provision of a small space in said magnetic circuit and, as a result, the vacuum cleaner has been rendered complicated in construction and expensive.

Still another drawback of the low voltage relay is that the exciting winding is large in size and costly, because it is required to be operative at a low voltage and, in order to reduce the impedance, it must be formed with a wire with a large diameter wound in a large number of turns.

As described hereinabove, the conventional vacuum cleaners possess a number of shortcomings which all stem from the type of the remote control circuit in which the low voltage relay to open and close the main circuit of the electric blower is connected to the secondary winding of the transformer.

Summary of the invention

The vacuum cleaner of this invention has a remote control circuit for the electric blower, which eliminates a number of drawbacks of the conventional vacuum cleaners as set forth here above.

Namely, according to the present invention, the switch provided at the grip portion of the flexible hose, connected to the suction port of the body of the cleaner, is electrically connected to the control winding of a variable reactor provided in said body through a pair of leads embedded in said flexible hose and the connector in the body, while the high voltage relay to open and close the main circuit of the electric blower in the body upon actuating said switch is electrically connected to the main winding of said variable reactor in series, so as to form a remote control circuit.

Therefore, by properly selecting the number of turns of the main and control windings of the variable reactor, the voltage to be impressed on the control winding can be controlled to a safe level and the operator can handle the vacuum cleaner with much safety, even when the connector between the leads leading to the switch on the flexible hose and the electric circuit in the body of the cleaner is exposed after said flexible hose is disconnected from said body.

Further, according to the present invention, the control winding of the variable reactor is completely independent of the high voltage relay even when the high voltage relay is shorted with the main circuit of the electric blower on which the high voltage is impressed, since said high voltage relay is connected in series to the main winding of the variable reactor which is impressed with a source voltage.

Namely, the remote control circuit composed of the switch on the flexible hose, the connector in the body of the cleaner and the control winding of the variable reactor, can be completely separated from the main circuit of the electric blower electrically under any condition, so that the electrical insulation can be maintained positively and the safety of the operator can be assured.

The primary object of the present invention is to completely eliminate the electric shock from which the operator suffers upon occurrence of a faulty condition in the high voltage relay which opens and closes the main circuit of the electric blower directly, by electrically isolating said high voltage relay from the electric circuit composed of the connector in the cleaner body connected to the control winding of the variable reactor and the switch at the grip portion of the flexible hose electrically connected to said connector.

Another object of the present invention is to enable a high voltage relay to be used in a vacuum cleaner, which can be insulated easily and is compact in size and cheap in price, by connecting said high voltage relay to the main winding of the variable reactor.

Still another object of the present invention is to provide a vacuum cleaner in which the electromotive force for the control winding of the variable reactor is as low as about 20 volts or lower, so that the operator of the cleaner will not be struck by electricity when he inadvertently touches the connector in the body of the cleaner.

Still another object of the present invention is to provide a vacuum cleaner in which the high voltage relay is connected in series to the main winding of the variable reactor and thereby a slight current is maintained in said winding even when the switch on the flexible hose is in an open position, whereby an erroneous operation of the cleaner caused by a residual magnetism is avoided.

Still another object of the present invention is to provide a vacuum cleaner in which the exciting winding of the high voltage relay is connected in series to the main winding of the variable reactor, whereby the voltage impressed on the main winding of the variable reactor is maintained lower than a source voltage and accordingly

the number of turns of the main winding can be reduced, rendering the remote control circuit small in size and low in cost.

The other objects and advantages of the present invention will become apparent from the following detailed description when taken in conjunction with the accompanying drawings.

Brief description of the drawings

FIG. 1 is a side elevation of the vacuum cleaner according to this invention, with the body thereof partly broken away to show a high voltage relay and an electric blower, accommodated in said body and a part of a flexible hose connected to the suction port of said body;

FIG. 2 is a fragmentary plan view, in enlargement, of the flexible hose with an intermediate portion cut away;

FIG. 3 is a wiring diagram of the vacuum cleaner of this invention;

FIG. 4 is a cross sectional view showing a variable reactor and the high voltage relay mounted on a base and enclosed in a casing;

FIGS. 5 and 6 are charts illustrating the operation of the variable reactor; and

FIG. 7 is a chart illustrating the operation of the remote control circuit.

Description of the preferred embodiment

Referring to FIG. 1, the vacuum cleaner generally indicated by **1** has a dust bag **2** disposed in the front portion and an electric blower **3** mounted in the rear portion of the interior thereof. The dust bag **2** is made with an air permeable fabric so as to collect dust only therein by permitting air to pass therethrough, and is mounted in the cleaner in such a manner that it can be taken out from the cleaner **1** when the dust collected therein has reached a certain amount. The electric blower **3** is composed of a series A.C. motor **4** and fan blades (not shown) mounted on the rotary shaft (not shown) of said motor. The fan blades are enclosed in a casing **5** having air passage holes (not shown) bored in the front wall thereof and this casing **5** is supported at its periphery by brackets **7** and **7***a*, projecting inwardly from the peripheral wall of the body **1**, through the intermediary of a cushion member **6** such that it will not vibrate in the body **1**. Between the dust bag **2** and the electric blower **3** is provided a dust bag supporting member **8** which is secured to the inner peripheral wall of the body **1** and serves to prevent the dust bag **2** from being drawn into the air passage holes in the casing **5** binding the fan blades, as well as to provide for smooth passage of air through said air passage holes. The front opening of the body **1** is closed by a front cover **9** through which the dust bag **2** is taken out from the body **1**. The front cover **9** is hinged to the body **1** by a hinge **10** and is held in a closed position by latch means which has one end rotatably secured to the body **1** and formed at the other end with a hook-shaped portion **12** for engagement with the front cover **9**. A suction port **13** is formed in the front cover **9**, through which dust and air are sucked into the body of the cleaner. An arm **17** is connected to the front portion on the underside of the body **1**, said arm having a wheel **16** rotatably mounted to the free end thereof. Rear wheels **18** are rotatably mounted to both sides of the rear portion of the body **1**. A power cord **19** is taken up on a cord winding reel (not shown) and has a plug **20** provided at the free end thereof. The power cord **19** is drawn into or out of the body **1** through an opening **21** formed in said body. A handle **14** is provided with a vent hole **22** and a main switch **23** for the electric blower **3**. A flexible hose **24** has a predetermined length and is provided at one end with a connecting tube **25** which is adapted to be removably connected to the suction port **13** in the body **1**. As shown in FIG. 2, the connecting tube **25** is provided with a case **28** with a press button **26** accommodated therein and a hook **27** is formed integrally with the press button **26**. The arrangement is such that when

the press button 26 is depressed, the hook 27 is retracted in the casing, whereas when the depression is removed from said button, the hook 27 projects above the casing.

In connecting the flexible hose 24 to the body 1 of the cleaner, the connecting tube 25 is inserted into the suction port 13 while having the hook 27 retracted in the case 28 by depressing the button 26 and, upon completion of the insertion, the depression is removed from the button, whereupon the hook 27 projects upwardly to engage the inside wall of the suction port 13 as shown in FIG. 1. A grip member 44 connected to the other end of the flexible hose 24 is provided thereon with a low voltage switch 29 for the electric blower 3. This low voltage switch 29 is connected to a pair of leads embedded in the flexible hose 24 as will be described later, which leads in turn are connected to a connector 30, such as a pair of pins, projecting outwardly from the rear end wall of the case 28. When the connecting tube 25 of the flexible hose 24 is inserted into the suction port 13, the connector 30 is brought into contact with a connector 31 on the cleaner body side as shown in FIG. 1 and thereby the low voltage switch 29 is electrically connected to the electric circuit in the cleaner body 1. The grip member 44 has a flexed tube 32 rotatably connected to the forward end thereof, to which an attachment such as a floor nozzle (not shown) is connected by way of a pipe, etc. (not shown). The cleaner body 1 has a case 33 mounted therein as shown in FIG. 1, in which case are provided a variable reactor and a high voltage relay to be described later, which directly opens and closes the main circuit of the electric blower 3.

Now, the electric circuit of the vacuum cleaner of the present invention will be described with reference to FIG. 3. A high voltage motor generally indicated by 4 comprises an armature 4*a* and field windings 4*b*, 4*b* having one ends connected to said armature and the other ends connected to the terminal ends of a power cord 19 respectively. The main switch 23 on the cleaner body 1 is connected in series to the main circuit 34 of the electric blower 3 which is encircled by the dotted line. The variable reactor 35 has its main winding 36 connected in parallel to the main circuit 34 of the electric blower, so that an extremely low voltage (about 20 v.) and a small current are induced in the control winding 37 by the power source voltage. The control winding 37 is connected to the connector 31 in the cleaner body. The exciting winding 39 of the high voltage relay 38 is connected to the main winding 36 of the variable reactor 35 in series. The high voltage relay 38 keeps the high voltage switch open and is connected to the main circuit 34 of the electric blower 3 in parallel with the main switch 23, said high voltage switch consisting of a movable contact 40 and a cooperating fixed contact 41. The pair of leads 42, encircled by the dotted line, which are embedded in the flexible hose 24, have both ends connected to the connector 30 on the flexible hose and the low voltage switch 29 respectively. The broken line 43 indicates the remote control circuit for the electric blower 3.

Referring now to FIG. 4, a base 44 is made of an electrical insulating material and has the variable reactor 35 and the high voltage relay 38 mounted thereon, said high voltage relay 38 being secured to said base by a screw 45. The case 33 is securely mounted on the base 44 by screws 46 so as to enclose the variable reactor and the high voltage relay therein to keep them from dust. The variable reactor 35 comprises an iron core 47 to form a magnetic circuit, a concentrical coil bobbin 48 mounted on said iron core, and the main winding 36 and the control winding 37 wound on said coil bobbin 48 and insulated from each other by an insulating spacer 49, the number of turns of said control winding being smaller than that of the main winding.

The high voltage relay 38 comprises a boss 51, a coil bobbin 50, an exciting winding 39 wound on said coil bobbin, an L-shaped fixed member 52 of a ferromagnetic material and a movable member 53. The magnetic circuit formed by said component parts is excited by the exciting winding 39. A spring 54 is provided between one end of the fixed member 52 and the corresponding end of the movable member 53 so as to keep the movable member 53 apart from the boss 51 when the exciting winding 39 is not excited. A contact leaf spring 55 has one end secured to the movable member 53 by a pin 56 and carries at the other end a movable contact 40. The coil bobbin 50 is provided with a fixed contact 41 in opposed relation to said movable contact 40. The movable contact 40 and the fixed contact 41 are engaged with or disengaged from each other as the movable member 53 is attracted to or repulsed from the boss 51, thereby closing or opening the main circuit 34 of the electric blower 3 connected to the motor 4. The upward movement of the movable member 53 is limited by a stopper 57. Reference numeral 58 indicates a shading coil.

Because of the construction described above, when the flexible hose 24 is connected to the suction port 13, the main circuit of the electric blower 3 and the remote control circuit 43 are connected to a power source. If the low voltage switch 29 is open in this case, the impedance of the variable reactor is composed of a reactance component in proportion to the second power of the number of turns and a resistance component substantially in proportion to the eleven-tenth power of the number of turns. However, when the magnetic resistance of the iron core is small, the impedance is generally determined only by the reactance. This value corresponds to the exciting impedance and is extremely large. When the low voltage switch 29 is closed to short the control winding 37, a short-circuit current flows through the control winding 37, whereby the reactance component is erased and the impedance of the variable reactor essentially consists only of the resistance component, the value of the impedance being equal to the sum of the primary resistance and the secondary resistance multiplied by the second power of the turn ratio, and is so small as not to be greater than the one-tenth of the one in the case of the control winding 37 being open.

The chart of FIG. 5 shows how the impedance of the variable reactor varies with the number of turns of the main winding, upon shorting or opening the control winding 37, the turn ratio of the variable reactor is 4. From this chart, it will be seen that the impedance varies largely as the number of turns of the main winding increases. This is because, when the control winding is open, the reactance increases in proportion to the second power of the number of turns.

The chart of FIG. 6 shows how the impedance of the variable reactor varies with the turn ratio (the number of turns of the main winding being constant). It will be understood from this chart that a greater change can be obtained when the turn ratio approaches 1. This is due to the fact that the resistance component in the short-circuit condition decreases.

A practical example of the change in impedance of the variable reactor is given below: namely, when the number of turns of the main winding was 3800 with a resistance value of 1116 ohms and the number of turns of the control winding was 600 with a resistance value of 47.07 ohms, the impedance of the variable reactor was changed from 53,950 ohms when the control winding was open, to 2960 ohms when the control winding was shorted, the change ratio being about 18.

Since the high voltage relay is connected in series to the variable reactor whose impedance varies so sharply as described above, when the impressed voltage is constant in FIG. 3, the voltage impressed on the high voltage relay and the variable reactor vary sharply upon opening or closing the control winding. Namely, when the control winding is open, almost the entire voltage is borne by the variable reactor but, when the control winding is shorted, some degree of voltage is impressed on the high voltage relay since the impedance of the vari-

able reactor decreases. An example is shown in the table below.

Impressed voltage 110 v.	Control winding open	Control winding shorted
Voltage of variable reactor (v.)	105	40
Voltage of high voltage relay (v.)	5	70

From the above, it will be understood that a high voltage relay which is actuated by a voltage of the order of 50 v., will be able to close and open the high voltage switch upon opening and shorting the control winding of the variable reactor.

The chart of FIG. 7 shows how the voltages impressed on the variable reactor and the high voltage relay vary with a power source voltage, upon opening or closing the switch connected to the control winding of the variable reactor.

In order to reduce the voltage to be impressed on the switch to a level not higher than 30 v. so as to eliminate the danger of electric shock, and to suppress the temperature rise of each component part under a low level, it is necessary to properly select the shape and dimensions of the iron core, the number of turns and wire diameter of the main and control winding of the variable reactor, and the number of turns and the wire diameter of the exciting winding of the high voltage relay. By so doing, it is possible to obtain a vacuum cleaner with ease in which remote control is possible even when used with a source voltage of 100 v. to 200 v. or higher.

As will be understood from the foregoing description, according to the present invention, the low voltage switch **29** and the circuit comprising the control winding of the variable reactor can be completely separated from the circuit comprising the main winding of said variable reactor electrically. Therefore, insulation of the circuit comprising the control winding or insulation of the leads **42** embedded in the flexible hose, insulation of the connector **30** on the cleaner body side and the connector **31** on the flexible hose side and insulation of the low voltage switch **29** can be obtained simply.

Even when the high voltage relay **38** is shorted with the main circuit **34** of the electric blower **3** due to a faulty condition occurring in said relay, a high voltage will not be impressed on the circuit comprising the control winding of the variable reactor, i.e. the circuit composed of the connector **30** on the cleaner body side, the connector **31** on the flexible hose side, the leads **42** and the low voltage switch **29**. Therefore, the operator will be able to operate the cleaner safely, without danger of being struck by electricity.

Further, the main winding **36** of the variable reactor **35** will not have a high voltage impressed directly thereon since said main winding **36** has the exciting winding **39** of the high voltage relay connected thereto in series. This further enhances the safety of the vacuum cleaner. Still further, the voltage impressed on the main winding of the variable reactor is reduced somewhat and accordingly the number of turns of the main winding **36** can be reduced. As a result, the entire variable reactor can be reduced in size, necessitating only a small space to be provided in the cleaner body for installation.

Still further, since the exciting winding **39** of the high voltage relay is connected to the main winding **36** of the variable reactor in series, with a voltage always impressed thereon, the residual magnetism remaining in the magnetic circuit of the high voltage relay upon opening the switch is erased by a slight current flowing therethrough and thereby erroneous operation of the high voltage relay can be eliminated. In addition, since the high voltage relay is not required to be operated at a low voltage as is the case in a conventional remote control circuit, a wire with a small diameter can be used for the exciting coil of the relay. This is advantageous in reducing the cost and size of the relay.

We claim:

1. A vacuum cleaner comprising a high voltage motor, a variable reactor having a main circuit and a control circuit, a relay having a high voltage switch for said motor and an exciting circuit to actuate said high voltage switch connected to the main circuit of said variable reactor, and a low voltage switch provided on a flexible hose connected to the cleaner body, said low voltage switch being electrically connected to the control circuit of said variable reactor, whereby, upon opening or closing of the low voltage switch, the high voltage switch in the relay is opened or closed to rotate or stop the high voltage motor.

2. A vacuum cleaner comprising a high voltage motor, a variable reactor having a main circuit and a control circuit, a relay having a high voltage switch to control said motor and an exciting circuit to actuate said high voltage switch, and a low voltage switch provided on a flexible hose connected to the cleaner body, said low voltage switch being electrically connected to the control circuit of said variable reactor to form a low voltage circuit, the exciting circuit of said relay being electrically connected to the main circuit of said variable reactor to form a high voltage circuit, and said low voltage circuit and said high voltage circuit forming a remote control circuit.

3. A vacuum cleaner comprising a high voltage motor, a variable reactor having a low voltage control winding, a high voltage relay having an exciting winding connected to the main winding of said variable reactor to actuate a high voltage switch for said motor, and a manually operative low voltage switch provided at the free end of a flexible hose connected to the cleaner body, said low voltage control winding of said variable reactor being electrically connected to said low voltage switch; and said high voltage motor, said high voltage switch electrically connected to said high voltage motor in series, the exciting winding of said high voltage relay and the main winding of said variable reactor being impressed with a high voltage.

4. A vacuum cleaner comprising a high voltage motor, a variable reactor having a main winding and a control winding, a high voltage relay having a high voltage switch to control said motor and an exciting winding to actuate said high voltage switch, and a low voltage switch provided on a flexible hose connected to the cleaner body, said low voltage switch being electrically connected to the control winding of said variable reactor and the exciting winding of said high voltage relay being electrically connected to the main winding of said variable reactor to have a high voltage impressed thereon, whereby a current is kept flowing through said exciting winding even when the high voltage switch is open holding the motor inoperative.

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