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(54) **Automatic washing machine with rotating drum.**

(57) Described is an automatic washing machine comprising a laundering tub and a drum mounted therein and adapted to be rotated by an electric motor at a low speed during a laundering cycle and at an increased speed during at least one intervening spin-drying phase. For avoiding the excessive formation of foam, a pressure switch is adapted to terminate the spin-drying phase when the pressure within the laundering tub exceeds a predetermined value.

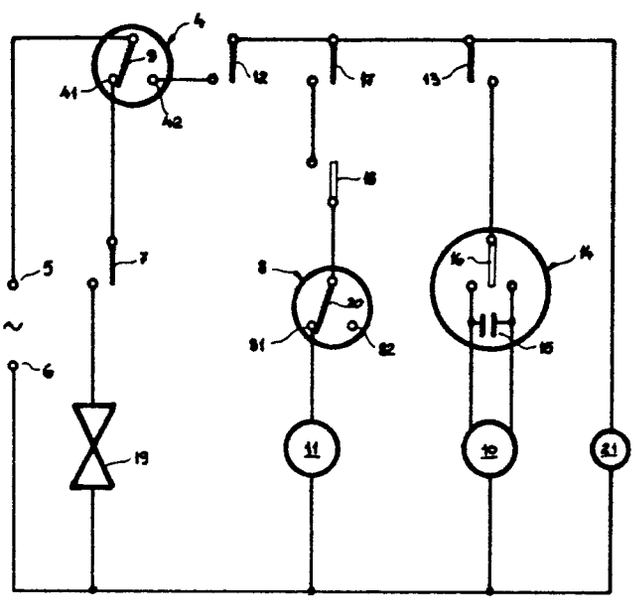

fig. 1

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Automatic Washing Machine with Rotating Drum

The present invention relates to an automatic washing machine operable to carry out washing cycles and spin-drying cycles by means of a rotating drum for containing laundry. Described in Italian Patent Application No.45715 A/85, filed on 5-24-1985 in the name of the present applicant, is a laundry washing machine wherein a laundering liquid collected in a receptacle at the bottom of the laundering tub is recirculated to the interior of a rotating drum for soakening the laundry contained therein. In the course of the laundering cycle the drum is periodically made to rotate at the spin-drying speed for extracting from the laundry a quantity of the laundering liquid sufficient for the operation of the recirculation pump.

This laundry washing machine is particularly advantageous in that it permits considerable savings of water, detergents and electric energy to be obtained. In contrast to the conventional final spin-drying cycle, however, the laundering tub contains not only water, but also detergents during the periodic spin-drying phases.

As a result, these periodic spin-drying phases may give rise, particularly when their duration exceeds a certain value of for instance three seconds, to the formation of an excessive quantity of foam in the tub, which tends to escape from the machine, for instance through the detergent distributor.

This troublesome phenomenon may occur with relative facility due to the tolerances of the components of the machine and to the variability of certain parameters such as the spin-drying speed, the temperature of the laundering liquid and the type of detergent employed.

It is therefore an object of the present invention to provide an automatic washing machine comprising a rotatable drum for carrying out spin-drying of the laundry at periodic intervals during the laundering cycle without giving rise to the excessive formation of foam.

According to the invention, this object is attained in an automatic washing machine comprising a laundering tub and a drum mounted therein for rotation by means of an electric motor for carrying out at least one laundering cycle during which the laundry is soaked with a laundering liquid, and the motor operates at a reduced rotational speed, and at least one intervening phase during which the motor operates at the rotational speed for spin-drying the laundry.

This washing machine is mainly characterized by comprising control means adapted to detect the pressure in the interior of the laundering tub and to terminate the spin-drying phase when said pressure exceeds a predetermined value.

The rotation of the drum at the spin-drying speed during the respective period intervening in the laundering cycle is thus terminated in response to the stabilization within the laundering tub of a pressure limit value determined by a combination of the parameters contributing to the formation of foam.

The characteristics and advantages of the invention will become more clearly evident from the following description, given by way of example with reference to the accompanying drawings, wherein:

fig. 1 shows a diagram of a preferred embodiment of a control circuit for the motor provided in the washing machine according to the invention for rotating the drum thereof,

fig. 2 shows the development of the pressure within the tub of the washing machine according to the invention during a laundering cycle, and

fig. 3 shows a modification of the control circuit of fig.1.

The physical construction and the hydraulic system of the washing machine according to the invention are of a per se known type as described for instance in the patent application no. 45715 A/85 quoted above and need therefore not be described in detail. Amongst other components the washing machine comprises a program unit in the form for instance of a timer having a number of cams rotating at different speeds for the operation of associated electric contacts for the combined operation of various functional elements.

With reference to fig. 1, there are only shown certain functional and control elements required for the understanding of the present invention.

The actuator solenoid 19 of a water supply solenoid valve is adapted to be connected between terminals 5 and 6 of an electric power supply via a circuit breaker 7 and a pressure switch 4 connected in series. In particular, the movable contact 9 of pressure switch 4 is adapted to connect terminal 5 to fixed contacts 41 or 42, respectively, when the pressure switch detects an "empty" or "full" state of a liquid collector receptacle provided in the machine.

The washing machine also comprises an electric motor for rotating the drum of the machine; this motor includes a low-speed winding section 10 and a high-speed winding section 11.In particular, low-speed winding section 10 is adapted to be connected between terminals 5 and 6 through a series-connected circuit comprising pressure switch 4 - (when detecting the "full" state), circuit breakers 12

and 13, and a per se known inverter 14 including a phase shift capacitor 15 having two fixed contacts selectively engageable by a movable contact 16 actuated by a fast cam.

The high-speed winding section 11 of the motor on its part is adapted to be connected between terminals 5 and 6 by a series-connected circuit including pressure switch 4 (when detecting the "full" state), circuit breaker 12 and a pair of circuit breakers 17 and 18 actuated respectively by a slow cam and a fast cam of the program unit. According to an aspect of the invention, high-speed winding section 11 is additionally connected to a further pressure switch 8 adapted to detect the pressure in the interior of the laundering tub of the machine. In particular, a movable contact 20 of pressure switch 8 is closed on a fixed contact 81 connected to high-speed winding section 11 as long as the pressure within the laundering tub is below a predetermined value P2 (fig. 2) beyond which there occurs an excessive formation of foam. Pressure switch 8 is positioned and calibrated in such a manner that its movable contact 20 closes on a blind fixed contact 82 when the said pressure value P2 is detected.

The circuit also includes a small electric motor 21 for advancing the timer, this motor being connected between terminals 5 and 6 by the series-connected circuit of pressure switch 4 and circuit breaker 12.

As already noted, the circuit of fig. 1 is to be understood to include further functional components controlled by the program unit, such as a discharge pump, heater elements, a recirculation pump etc., these elements being not shown for the sake of simplification.

The overall operation of the washing machine proceeds substantially as known.

On initiation of a laundering cycle pressure switches 4 and 8 are in their rest positions as shown in fig. 1, circuit breakers 7 and 12 are closed, and circuit breakers 13 and 17 are open.

Solenoid valve 19 is actuated to admit water and detergent to the washing machine until pressure switch 4 detects a predetermined water level, causing its movable contact 9 to close on fixed contact 42 for energizing timer motor 21.

The operation of the timer causes circuit breaker 13 to close for energizing low-speed winding section 10 of the drum motor, so that the drum is rotated at a low speed in alternating directions.

The sense of rotation of the motor is periodically reversed by the per se known actuation of inverter 14.

Also in a known manner, the laundering liquid is concurrently heated and supplied to the interior of the drum so as to soak the laundry therein. As a result, the pressure within the laundering tub is stabilized at a value P1 as shown at t1 in fig. 2, this value remaining substantially constant. In accordance with the selected laundering program, timer 21 at a predetermined instant operates to close circuit breaker 17, so that during an interval between the rotations of the drum in opposite directions as determined by inverter 14 circuit breaker 18 may be closed for energizing high-speed winding section 11 of the drum motor. The laundering drum is thus made to rotate at the speed for spin-drying the laundry, as described in the quoted patent application no. 45715 A/85, with a resultant increase of the pressure within the tub. When this pressure reaches the predetermined value P2, movable contact 20 of pressure switch 8 closes on fixed contact 82 to thereby deenergize high-speed winding section 11 and thus terminate the spin-drying phase t2-t3 before any excessive formation of foam takes place within the laundering tub. At the instant t3 the pressure within the tub thus drops again to the value P1.

The laundering cycle then proceeds in the conventional manner, with circuit breakers 17 and 18 again opened and further reversals of the rotation of the drum at low speed, and with the possible intervention of further spin-drying phases similar to the one indicated at t2-t3.

The washing machine may be of the combined function type capable of selectively operating with two different liquid levels as described in the quoted patent application no. 45715 A/85.

At the lower liquid level the machine would then operate with recirculation of the liquid and periodic spin-drying phases during the laundering cycle; at the higher liquid level the machine would operate in the conventional manner by agitating the laundry with or without liquid recirculation, but in any case without the intervention of spin-drying phases during the laundering cycle.

In this case the control circuit is the advantageously designed as shown in fig. 3 by the provision of certain modifications of the circuit shown in fig. 1.

In particular, pressure switch 8 is in this case connected between pressure switch 4 and circuit breaekr 12, its movable contact 20 being directly connected to fixed contact 42 of pressure switch 4, while its fixed contact 82 is connected to circuit breaker 12. On the other hand, fixed contact 81 of pressure switch 8 is connected respectively via further circuit breakers 22 and 23 to the junction between circuit breaker 7 and solenoid valve 9, and the junction between circuit breakers 12 and 17. Circuit breakers 22 and 23 are actuated by respective slow cams of the program unit.

The operation of the washing machine during a laundering cycle at the higher water level in the tub proceeds as follows:
At the beginning pressure switches 4 and 8 are in their rest positions shown in fig. 3, while solely circuit breakers 7, 12 and 22 are closed.

Solenoid valve 19 is energized via pressure switch 4 and circuit breaker 7 to admit water to the tub until the liquid attains the lower level, at which point movable contact 9 of pressostat 4 is caused to close on fixed contact 42. Solenoid valve 19 thus continues to be energized via pressure switch 4, pressure switch 8 and circuit breaker 22 until the liquid attains the high level, causing movable contact 20 of pressure switch 8 to close on fixed contact 82. The eventual closing of circuit breakers 13 and 16 during this phase results in low-speed winding section 10 to be energized, whereupon the laundering operation proceeds in the known manner which needs not be described. It is noted in this contect that pressure switch 8 in this case carries out the conventional function of controlling the maximum level of the liquid admitted to the washing machine.

When the machine is to carry out a laundering operation at the lower liquid level, pressure switches 4 and 8 are initially in their rest positions as shown in fig. 3, while solely circuit breakers 7 and 23 are in their closed state.

Solenoid valve 19 is actuated to admit water only until pressure switch 4 is actuated in response to detecting the "full" state; the laundering cycle then proceeds as already described with reference to fig. 1, that is, with recirculation of the laundering liquid to the interior of the drum and alternating rotation of the drum motor resulting from the simultaneous closing of circuit breakers 13 and 16.

Also as already described, the combined closing of circuit breakers 17 and 18 at instant t2 results in the intervention of a spin-drying phase t2-t3. During this intervening phase the laundering tub contains an amount of laundering liquid heated for instance to 60 °C, resulting in a pressure increase up to the value P2. At this instant movable contact 20 of pressure switch 8 is caused to close on fixed contact 82 to thereby interrupt the energization of high-speed winding section 11 and thus terminate the spin-drying phase.

It is noted that in this case pressure switch 8 functions as a safety device effective to prevent the excessive formation of foam within the laundering tub to thus attain the stated object of the invention.

The control circuit shown in fig. 3 thus requires only a single pressure switch 8 connected in series to pressure switch 4 for performing the double function of a conventional control element for the admission of water to the higher level and of a safety device for preventing the excessive formation of foam. This eliminates the necessity of providing an additional component specifically for performing the safety function to attain the object of the invention.

The described washing machine may of course be variously modified within the purview of the invention.

Motor 10, 11 may thus be of any other type suitable for this purpose. The program unit may similarly be of any other type to meet specific requirements. In addition, the spin-drying phase, or phases, t2-t3 may intervene at any suitable time other than the laundry washing cycle under suitable control by the program unit.

Claims

1. An automatic washing machine comprising a laundering tub and a drum mounted therein and adapted to be rotated by an electric motor for carrying out at least one laundering cycle during which the laundry is soaked with a laundering liquid and said motor operates at a reduced rotational speed, and at least one intervening phase during which said motor operates at a speed for spin-drying the laundry, characterized by comprising control means (8) adapted to detect the pressure within the laundering tub and to terminate said spin-drying phase (t2-t3) when said pressure exceeds a predetermined value (P2).

2. An automatic washing machine according to claim 1, characterized in that said control means comprises at least one first pressure switch (8) connected in series to said electric motor (11) and including a normally closed electric contact (20) adapted to open when the pressure within said laundering tub exceeds said predetermined value (P2).

3. An automatic washing machine according to claim 2 characterized in that the movable contact (20) of said first pressure switch (8) is normally also connected in series to a water supply solenoid valve (19), a further pressure switch (4) having a movable contact (9) normally connected in series to said solenoid valve (19) and adapted to be series-connected to said movable contact (20) of said first pressure switch (8) in a per se known manner when said pressure attains a predetermined value below said predetermined value (P2).

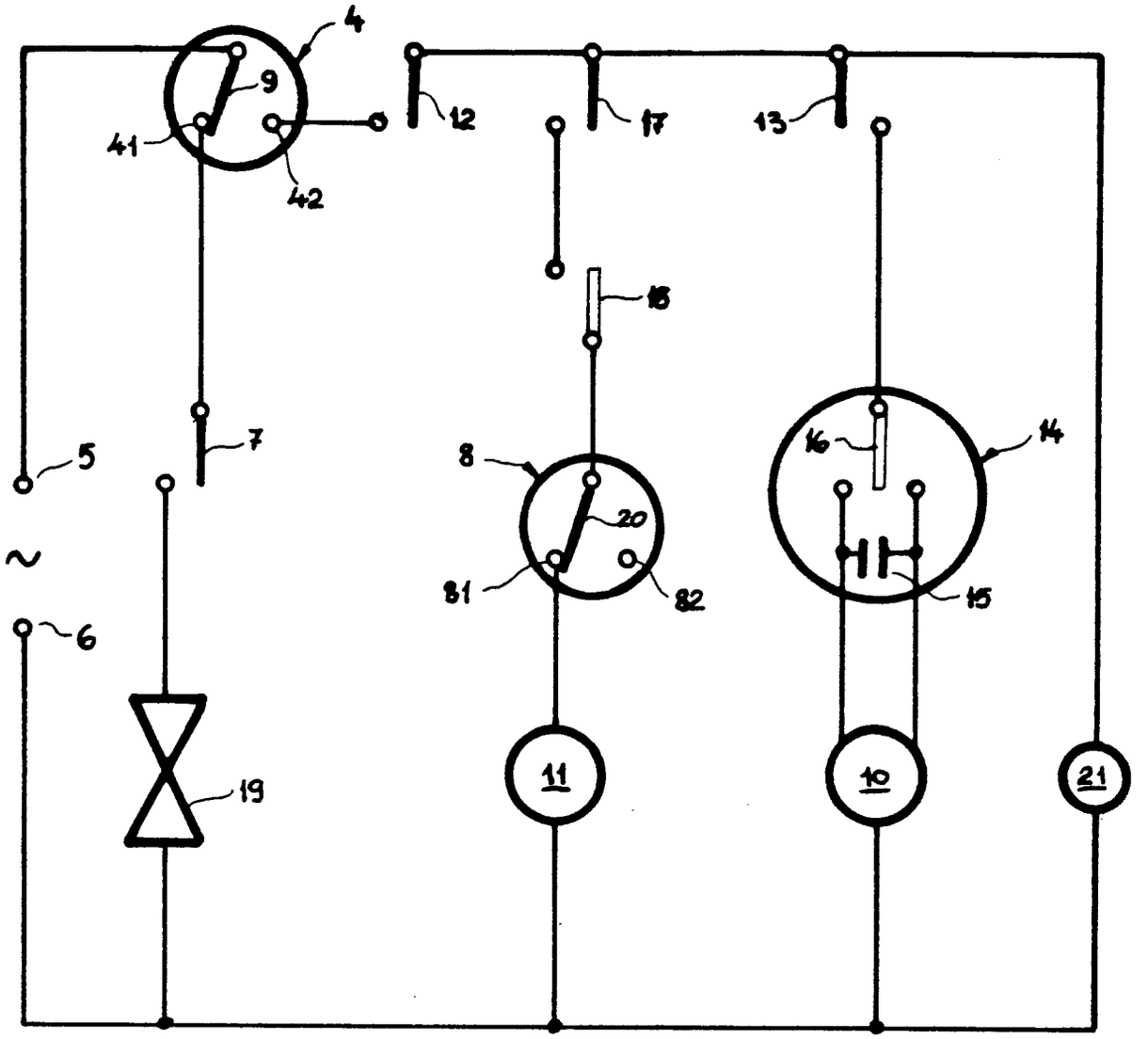
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Fig. 1

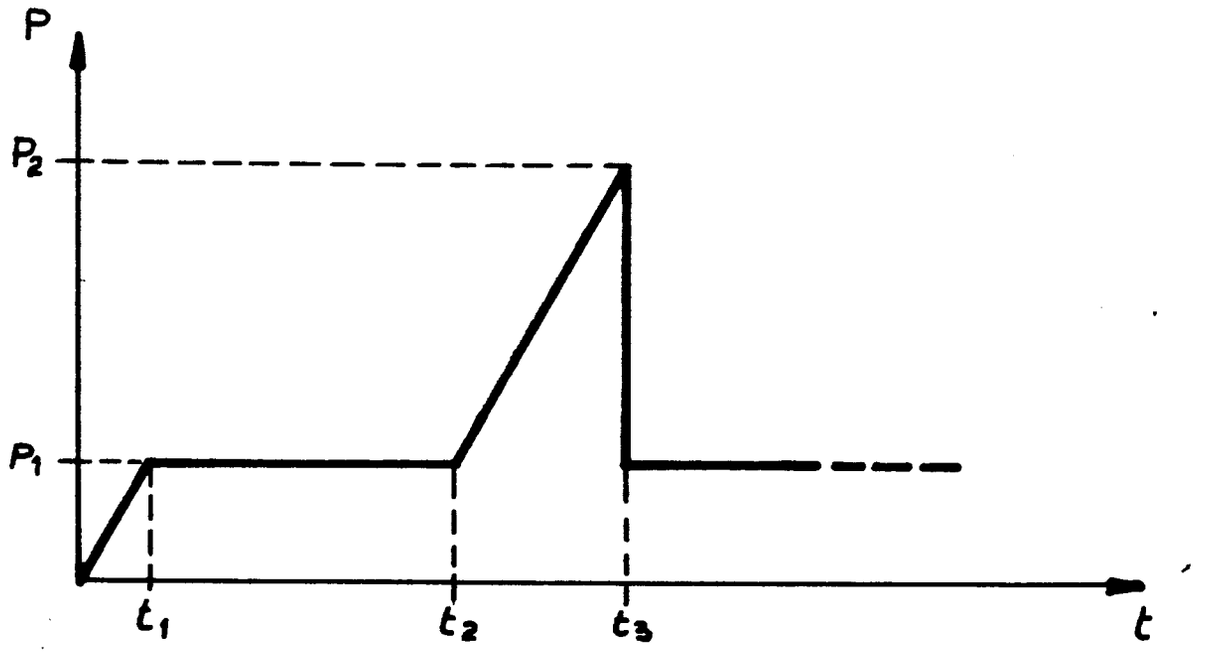
P
P2
P1
t1
t2
t3
t

Fig. 2

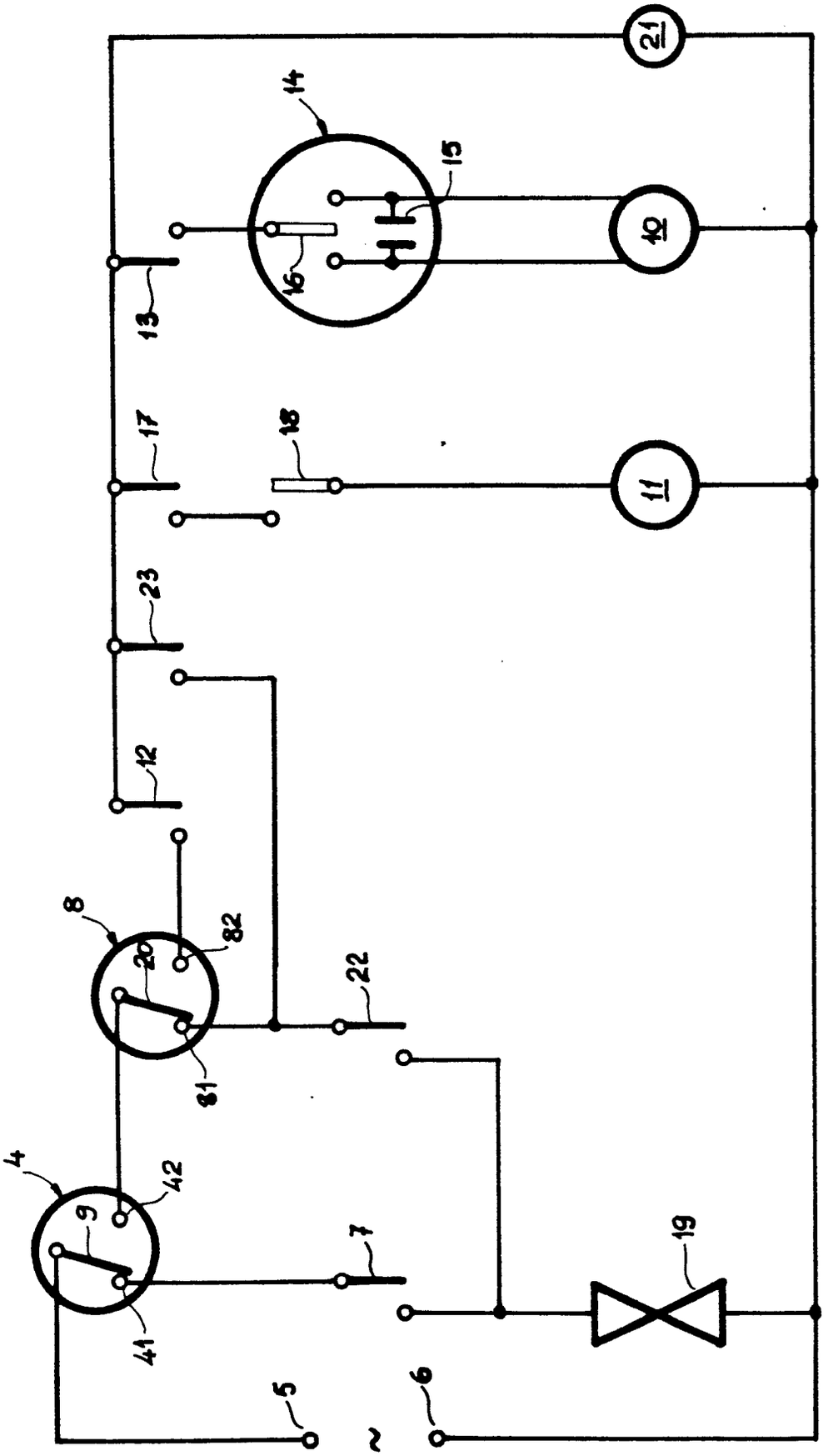

Fig. 3