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AUTOMATIC ELECTRONIC CONTROL SYSTEM IN THE CONTINUOUS PRINTING
AND AMMONIA GAS DEVELOPING MACHINE FOR SENSITIVE PAPERS

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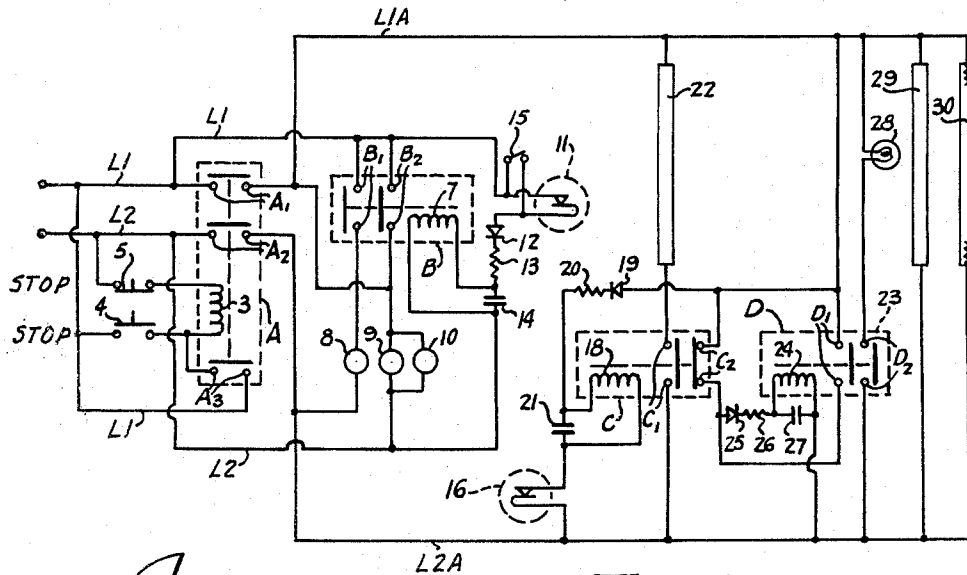


FIG. 1

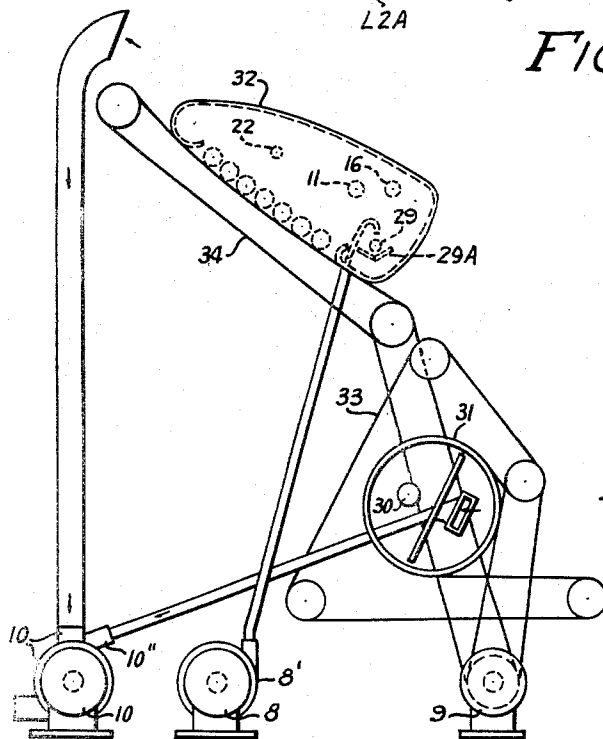


FIG. 2

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**AUTOMATIC ELECTRONIC CONTROL SYSTEM IN
THE CONTINUOUS PRINTING AND AMMONIA
GAS DEVELOPING MACHINE FOR SENSITIVE
PAPERS**

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This invention relates to an automatic electronic system for the combined printing and ammonia gas developing machines for sensitive papers. More particularly, there is provided the system that, by connecting the light source for printing sensitive papers, the heater for evaporating ammonia liquid, the space heater in ammonia gas chamber, motor for supplying ammonia liquid, pilot lamp, drive motor, motor for exhausting ammonia odor and cooling fans, etc., in one circuit. Every section of the machine can be fully automatically controlled and adjusted in due course at the predetermined time after the "On" or "Off" button is only manually pushed when commencing or finishing operation.

The conventional and well known printing and ammonia gas developing machine has a porous plate or a plurality of rollers on one side of its ammonia gas chamber, and a heater for evaporating ammonia liquid, a space heater and an ammonia liquid trough are provided in the ammonia gas chamber having some clearance between the plurality of rollers as ventilators of the ammonia gas vapor. An endless rubber blanket driven through a few rollers is provided on the side of the ammonia gas chamber in close contact with the gas chamber. Ammonia liquid is supplied to the ammonia liquid trough from one side of the trough through an ammonia liquid supplying tube, and the ammonia liquid supplied to the trough, is heated by the ammonia liquid evaporating heater and evaporated into ammonia gas vapor, which is condensed on the sensitized side of sensitive paper while passing through developing section, neutralizes acidity of the chemical and couples with dyestuff of the unexposed portion of the sensitive paper. In doing so, the sensitive paper can be developed.

However, the conventional and well known printing and developing machine mentioned above, has the following defects.

(1) It requires reasonable skill to judge whether the temperature within the ammonia gas chamber has reached to the extent of the predetermined proper degree. If the ammonia liquid is supplied into the ammonia liquid trough and evaporated before the temperature within the gas chamber has not reached yet to the extent of the predetermined degree, the ammonia gas vapor may be condensed on the wall of the chamber and on the conveyor unit of the developing section, and the wall of the chamber and the conveyor unit will be moistened with dew. Under this condition, if the sensitive paper is fed into the developing section, the paper will be stained with the dew, and no clear and sharp copies can be obtained.

(2) After the temperature within the gas chamber has once reached to the extent of the predetermined degrees, the operator must take care that the space heater is cut off, and the ammonia liquid is supplied dripping into an ammonia liquid trough and evaporated by the ammonia liquid evaporating heater, then the developing operation is commenced. However, during the operation, the temperature within the gas chamber will go down. In this case, it is very inconvenient to require reasonable skill to judge the condition whether the space heater should be turned on or off at the proper time in order to keep the temperature within the gas chamber within the scope of the predetermined degrees.

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(3) In case that the machine comes to a full stop immediately after the developing operation is finished, the air within the operating room will be contaminated by the ammonia gas which has leaked out from the gas chamber because the exhausting fan is also turned off. It is unhealthful. Furthermore, if the machine comes to a full stop immediately after the operation is finished, the endless rubber blanket of the developing section and the endless printer bands of the printing section are damaged by the extremely heated ammonia gas chamber and glass cylinder.

To avoid these defects mentioned above, in the conventional and well known printing and developing machine, such device is provided that the fan motor and drive motor are still in motion for a while even after the light source and heaters have been turned off. In the device, there are two ways in this system; one is conducted by a manually operated "On" and "Off" switch, and another is conducted by a time switch which is set "On" manually in advance and can be automatically put "Off" at the predetermined time. However, it is very inconvenient that both of them should be operated manually immediately after the main switch of the machine is turned off, and one is apt to forget to turn on the fan motor and drive motor. If the fan motor and the drive motor should not be in motion for a while after the machine has been turned off, the operating room may be contaminated by the ammonia gas leaked out from the gas chamber, and the endless rubber blanket and the endless printer bands may be damaged by the extremely heated gas chamber and the glass cylinder.

(4) When the main switch of the machine is turned off after the developing operation is finished, the ammonia liquid supplying source should be closed manually to stop the ammonia liquid supplying simultaneously with turning off the main switch. There is also a liability to forget to close the ammonia liquid supplying source. In this case, there is not only waste of the ammonia liquid, but also ammonia odor can not be completely exhausted even though the exhausting fan is in motion after the operation is finished, and it is bad for the machine. Therefore, it is very inconvenient to manually close the ammonia liquid supplying source and to turn off the main switch respectively.

(5) When sensitive paper is printed and developed with such a machine as mentioned above, it is very important for efficient operation to judge the condition that the mercury vapor lamp as a printing light source comes in the sufficient printing intensity, that the ammonia gas chamber has been filled with proper quantity of the ammonia gas vapor, and that the temperature within the gas chamber has reached the predetermined degrees, in order to make clear and sharp copies. However, as described in paragraphs 1 and 2 above, the conventional machine requires reasonable skill to operate it under proper condition.

Therefore, this invention is devised with the following objects in order to avoid the defects of the conventional machine mentioned above.

(1) When the operation is commenced, by only manually pushing the "On" button of the relay A, the light source, ammonia liquid evaporating heater, space heater, drive motor, and motor for exhausting and cooling fans are turned on, but motor for ammonia liquid supplying pump and pilot lamp are still off.

(2) The machine of this invention is provided with two thermostats; one is thermostat 11 which is normally open when the machine is below 80 degrees C. and which comes on when the temperature within the ammonia gas chamber has reached about 80 degrees C., and another is thermostat 16 which is normally closed when the machine is below 80 degrees C. and which comes off when the

temperature within the gas chamber has reached about 100 degrees C. Therefore, when the temperature within the gas chamber has reached about 80 degrees C. which is proper to evaporate ammonia liquid into ammonia gas vapor, the motor for ammonia liquid supplying pump is turned on by the action of the thermostat 11 and the pump starts to supply ammonia liquid dripping into an ammonia liquid trough provided within the gas chamber. At this time, the pilot lamp is still off and it indicates that ammonia gas vapor has not yet filled the gas chamber, and the machine is not yet in proper condition to carry out the sensitive paper developing operation.

(3) When the temperature within the gas chamber has risen to about 100 degrees C. by the action of the ammonia liquid evaporating heater and the space heater mentioned above, the space heater is turned off, and the pilot lamp is turned on by the action of the thermostat 16 and indicates that the gas chamber has been filled with ammonia gas vapor produced by the ammonia liquid evaporating heater and that the temperature within the gas chamber has reached the predetermined proper degrees for developing sensitive papers.

(4) During the developing operation, it repeats such action so that the thermostat 16 comes on and the space heater is turned on when the temperature within the gas chamber has fallen down below 100 degrees C., and also the thermostat 16 comes off and the space heater is turned off again when the temperature within the gas chamber has risen to about 100 degrees C. so that the proper temperature within the gas chamber can be automatically kept at all times. However, while the thermostat 16 continues the on or off operations, the pilot lamp is continuously lighted and indicates the condition that the machine remains in condition for developing sensitive papers.

(5) When the operation is finished, by manually pushing the "Off" button, the light source, the ammonia liquid evaporating heater, the space heater, the motor for ammonia liquid supplying pump and the pilot lamp are turned off, but the drive motor and the motor for exhausting and cooling fans are still in motion for a predetermined period and are automatically turned off when the temperature within the gas chamber has fallen down to about 80 degrees C., by the action of the thermostat 11.

(6) By providing rectifier, resistor and condenser between the thermostat 11 and the relay B, and the thermostat 16 and the relay C respectively, the phenomenon of oscillating the defective contact of the relays B and C, caused by the "On" or "Off" action of the thermostats 11 and 16, can be avoided.

(7) By providing another rectifier, resistor and condenser between the relays C and D, such time-delay action can be conducted that the relay D is delayed for a short time after the relay C is energized for the first operation when the printing and developing machine is first started.

(8) An auxiliary switch 15 is provided in parallel with the thermostat 11. However, while the power line extensions are de-energized the light source 30, the ammonia liquid evaporating heater 29, the space heater 22, the motor 8 for ammonia liquid supply pump 8' and the pilot lamp 28 are de-energized and only the drive motor 9 and the motor 10 for the exhausting and cooling fans can be placed in operation by closing the auxiliary switch 15. Accordingly, the cleaning and maintenance of the the endless rubber blanket and the glass cylinder can be conducted easily and simply.

An object of the present invention is to provide an exposing and developing machine which overcomes the objections of the prior art.

Another object of the invention is to provide a control which is free of arcing and provides for time delay operation of an indicator to show the readiness of the equipment for full operation.

Other and further objects will be apparent as the description proceeds and upon reference to the accompanying drawing wherein:

FIGURE 1 is a diagrammatic wiring diagram showing the electrical connections including thermostats, relays, time delay devices for operating the relays and showing the connections for motors, heaters, lamps and indicators.

FIGURE 2 is a diagrammatic side elevation of the printing and developing machine of the present invention showing the conveyor belt drive, the pump for supplying ammonia, the exhaust fans for cooling the exposure lamp and for removing noxious gases and also showing the thermostats for controlling the equipment and showing the motors for operating the various mechanisms.

Upon reference to the drawing, the continuous printing and developing machine of the present invention includes an exposing structure having a source of actinic light shown as a lamp 30 within a glass cylinder 31 around which the sensitive paper and the master are passed by means of a conveyor belt 33 driven by a motor 9. A developing structure is shown to include a casing 32 forming a developing gas receiving chamber therein and the bottom thereof is closed by a conveyor belt 34 also driven by the motor 9 and a plurality of guide rollers cooperate with the belt 34 to maintain the sensitive surface of the exposed light sensitive material to the gas within the chamber 32.

An ammonia gas receiving trough is positioned within the chamber 32 and an ammonia evaporating heater 29 is positioned within the trough to vaporize the ammonia and thereby fill the chamber 32 with the gas required for development. As second motor 8 drives a pump 8' which carries liquid through a suitable tube to the trough 29A within the chamber. A third motor 10 operates one or more exhaust fans 10' and 10'' which serve to remove noxious gases and excess heat from the area around the development structure which includes the casing 32 and for causing cooling air to pass through the glass cylinder 31 to cool such glass cylinder and prevent excessive heating respectively of the development area and of the exposing area.

A space heater is mounted within the chamber 32 to provide sufficient heat to assure development at a satisfactory rate and thermostats 16 and 11 are provided for controlling the temperature of the chamber by turning off the supply of current to the space heater 22 when the temperature reaches the desired value within the chamber.

A pilot light 28 is provided to indicate when proper operating conditions have occurred within the development chamber and such pilot light is turned on by the control system shown in the electrical diagram of FIGURE 1.

The control system receives its power from power lines L1 and L2 and auxiliary power lines L1A and L2A which are connected to lines L1 and L2 by the first and second sets of contacts A₁, A₂ of a relay A and such relay is operated by its coil 3 having one terminal connected through a normally open start switch 4 connected to line L1 and the other terminal of the coil 3 is connected through a normally closed stop switch 5 to the other line L2. The relay A has a third set of contacts A₃ with one contact connected to line L1 and the other contact connected to the one terminal of the coil 3 whereby when the start switch is closed the coil 3 is energized and the relay operates closing all of the contacts A₂, A₂ and A₃ thereby providing power to the auxiliary supply lines L1A and L2A.

The control system also includes three time delay relays. The first time delay relay C includes a normally open set of contacts C₁ which serve to complete a circuit from auxiliary lines L1A and L2A to the space heater 22 within the development chamber. A second set of normally closed contacts C₂ are also provided for a purpose hereinafter described.

A first thermostat 16, normally closed when cold, a first

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capacitor 21, a first resistor 20 and a first rectifier 19 are connected in series and connected between auxiliary supply lines L1A and L2A with the coil 18 of the first relay being connected in parallel to the first capacitor 21 whereby when the lines L1A and L2A are energized the capacitor 21 is charged and after being fully charged the current then flows through the coil 18 thereby actuating the relay and closing contacts C₁ to energize the space heater 22 and simultaneously opening the contacts C₂ and the heater is energized until the temperature within the chamber 32 reaches the desired temperature when the thermostat 16 opens thereby deenergizing the coil 18 with a time delay action and turning off the electric power to the heater 22 also with a time delay action since the capacitor 21 serves to energize the coil 18 for a period of time after the circuit is broken by the raised temperature of the thermostat 16.

A second time delay relay B has two sets of contacts B₁ and B₂ both of which are normally open and one set of the contacts B₁ being connected with the first motor 8 to the one line of the main supply and to the second line of the auxiliary supply to operate the ammonia supply pump 8'.

The second set of contacts B₂ complete a circuit through the main supply lines to the conveyor operating motor 9 and the exhaust fan operating motor 10 whereby all of the motors will be operated when the relay B is energized and the relay A is energized.

To operate the second time delay relay, a thermostat 11 having contacts which are normally open when the thermostat is cold, a rectifier 13, a resistor 13 and a capacitor 14 are arranged in series between the supply lines L1 and L2 whereby when the thermostat 11 is heated to the desired temperature a circuit is completed which begins to charge the capacitor 14 and after the capacitor is charged the coil 7 of the second relay B is energized thereby operating the relay B with a time delay action and the relay remains closed for a period of time after the circuit is broken when the thermostat 11 is cooled and the coil 7 obtains its energy from the discharging condenser 14 which is connected in parallel with the coil 7.

A third time delay relay D is provided with first and second sets of contacts D₁ and D₂ with one contact of the first set of contacts being connected to the first auxiliary supply line and the other contact being connected to the other contact of the second set of contacts C₂ of the relay C, the first contact of the contacts C₂ being connected to the auxiliary supply line L1A and such auxiliary supply line being also connected to the one contact of the set of contacts D₁.

A third rectifier 25, a third resistor 26, and a third capacitor 27 are connected in series and between the auxiliary supply line L2A and the contact of the set of contacts C₂ with the coil 24 of the relay D being connected in parallel with the capacitor 27. The second set of contacts D₂ of the third relay D₁ provides for closing a circuit to the pilot lamp 28 between the auxiliary supply lines L1A and L2A. The time delay of relay D is approximately three minutes and is obtained by selecting the proper value for the resistor 26 and the capacitor 27 with respect to the impedance of the coil 24 and the time delay of relay D is substantially greater than the time delay of the first relay C so that when the auxiliary supply lines L1A and L2A are first energized a flow of current is produced to both coil 18 and coil 24 as well as the cooperating capacitors 21 and 27 but the capacity of the capacitors 21 and 27 is so arranged that the relay C is first energized long before the relay D is energized and therefore the supply of power to the coil 27 is broken upon the opening of contacts C₂ of the relay C upon the actuation of the relay C and therefore the pilot light 28 cannot be illuminated.

After the heater 22 heats the chamber sufficiently high, the thermostat 16 breaks the circuit for holding the relay

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C₁ in energized condition and upon discharge of the capacitor 21 the supply of current is broken to the heater 22 thereby closing contacts C₂ and causing energization of the relay D but the relay D does not operate until the capacitor 27 is charged which takes approximately three minutes and if the thermostat 16 should close during this period and operate the relay C, the relay D would not be actuated and therefore before the pilot light 28 is energized, the temperature within the chamber 32 is necessarily within the operating range.

When the machine is to be turned off, the stop switch 5 is operated to open the circuit to coil 3 of the relay A thereby opening the sets of contacts A₁ and A₂ which deenergize lines L1A and L2A stopping the pump motor 8, breaking the circuit to space heater 22, turning off the pilot light 28, de-energizing the ammonia heater 29 and turning off the exposure lamp 30. The fan motor 10 and the conveyor motor 9 continue to operate since the coil 7 of the relay B is energized and such coil remains energized as long as the thermostat 11 makes contact and this continues until the chamber 32 is cool and the chamber 32 has been completely cleared of ammonia gas and after the thermostat 11 breaks its contact, the coil 7 remains energized for a period of time due to the charge on the capacitor 14 and after the charge on the capacitor 14 is dissipated, the relay B breaks its contacts B₁ and B₂ thereby preparing the equipment for operation at a future time merely by operating the starting switch 4.

It will thus be seen that applicant has provided an automatic control for printing and developing equipment which avoids the objections of the prior art structures.

It will be evident that changes may be made in the precise arrangement within the valid scope of the appended claims.

What is claimed is:

1. A continuous printing and developing machine comprising an exposing structure having a source of actinic light, a developing structure including a casing for retaining a developing media, conveyor means to move light sensitive material through the exposing structure and through the developing structure, a first motor for operating said conveyor means, a developing media receiving trough in said developing structure, conduit means to guide developing liquid to said trough, a pump to positively provide developing liquid to said trough, a second motor for operating said liquid supply pump, exhaust fan means, a third motor for operating said exhaust fan means, duct means extending from said developing structure and from said exposing structure to cool said structures and remove noxious gases therefrom, a space heater in said developing structure for heating the space therein, a first thermostat which is normally closed when cold controlled by the temperature within said developing structure by controlling said space heater, a developing media trough heater within said developing media receiving trough for vaporizing the contents of the trough, a second thermostat which is normally open when cold responsive to the temperature within said developing structure for controlling the motors, control means for said motors for said source of actinic light, and for said heaters whereby upon initiation of operation, said light source and said developing media heater are immediately operated and said space heater is operated promptly thereafter, said motors being operated when the temperature within said chamber is sufficiently high to provide proper conditions for development, a pilot light, means to energize said pilot light only when the desired operating conditions exist, said control means including supply lines of electrical energy, a main relay having three sets of normally open contacts controlling the flow of electricity to auxiliary supply lines, with the first two sets of contacts of said main relay controlling the flow of current to said auxiliary lines, a normally open start switch between one line and one terminal of the coil of the main relay, a normally closed stop switch between the other terminal of the coil and the

other line, the third set of contacts of said main relay being in circuit between the coil side of the starting switch and said one terminal of the coil of said main relay, whereby when said starting switch is operated said third set of contacts serves as a holding circuit for the coil of said main relay, three times delay relays, the first time delay relay having one set of normally open contacts and a second set of normally closed contacts, the space heater being energized from said auxiliary supply lines through said normally open contacts of said first relay when said first relay is energized, a first thermostat normally closed when cold, a first capacitor, a first resistor and a first rectifier between said auxiliary supply lines, the coil of said first relay being in parallel with the first capacitor, the second time delay relay having two sets of normally open contacts, one set of contacts of said second relay being in circuit with the second motor operating said pump for developing media with a connection to said one supply line and to the other auxiliary supply line, the other set of contacts of said second relay being connected between said supply lines and said conveyor and said exhausting fan motor, whereby said motors will be operated when said second relay is energized, a second thermostat with normally open contacts when cold, a second capacitor, a second resistance, a second rectifier connected in series between said supply lines, the coil of said second relay being in parallel with said second capacitor, the third relay having first and second sets of contacts, one contact of the first set of contacts being connected to one auxiliary supply line and the other contact being connected to the other contact of the second set of contacts of said first relay, the first contact of the second set of contacts of said first relay being connected to the said one auxiliary line, the rectifier, resistor, and capacitor of said third relay being connected to the second contact of the second set of contacts of said first relay, the coil of said third relay being in parallel with said capacitor of said third relay, the second set of contacts of said third relay being connected to the pilot light and to the auxiliary lines, the time delay of the third relay being much greater than the time delay of said first relay whereby said third relay will not operate until the developing structure has first reached its operating temperature as determined by the setting of said first thermostat and said second thermostat has reached a temperature to close thereby energizing the second relay starting the motors, and said first relay has been de-energized once thereby closing said second set of contacts of said first relay for a length of time sufficient to cause actuation of said third relay and the energization of the pilot light to show that proper operating conditions exist.

2. A continuous printing and developing machine comprising an exposing structure having a source of actinic light, a developing structure including a casing for retaining a developing media, conveyor means to move light sensitive material through the exposing structure and through the developing structure, a first motor for operating said conveyor means, a developing media receiving trough in said developing structure, conduit means to guide developing liquid to said trough, a pump to positively provide developing liquid to said trough, a second motor for operating said liquid supply pump, exhaust fan means, a third motor for operating said exhaust fan means, duct means extending from said developing structure and from said exposing structure to cool said structures and remove noxious gases therefrom, a space heater in said developing structure for heating the space therein, a first thermostat which is normally closed when cold controlled by the temperature within said developing structure by controlling said space heater, a developing media trough heater within said developing media receiving trough for vaporizing the contents of the trough, a second thermostat which is normally open when cold responsive to the temperature within said developing structure for controlling the motors, control means for said

motors, for said source of actinic light and for said heaters whereby upon initiation of operation, said light source and said developing media heater are immediately operated and said space heater is operated promptly thereafter, said motors being operated when the temperature within said chamber is sufficiently high to provide proper conditions for development, a pilot light, means to energize said pilot light only when the desired operating conditions exist.

3. A developing machine comprising a chamber for retaining a developing gas, conveyor means to move the light sensitive material through the developing chamber, a first motor for operating said conveyor, an ammonia receiving trough in said developing chamber, conduit means to guide developing media to said trough, a pump for supplying developing media to said trough, a second motor for operating said pump, exhaust fan means, a third motor for operating said exhaust fan means, duct means extending from said developing chamber to said exhaust fan means to cool said chamber and remove noxious gases, a space heater in said developing chamber for heating the space within said chamber, a first thermostat normally closed when cold for controlling said space heater, a developing media trough heater within said trough for vaporizing the contents of the trough, a second thermostat normally open when cold responsive to the temperature within said developing chamber for controlling the motors, control means for said motors, and said heaters whereby upon initiation of operation, said heaters are promptly operated and said motors are operated when the temperature within said chamber is sufficiently high to provide proper conditions for development, a pilot light energized by said control means to indicate when desired operating conditions exist.

4. Control means including supply lines of electrical energy, a main relay having three sets of normally open contacts controlling the flow of electricity to auxiliary supply lines, with the first two sets of contacts of said main relay controlling the flow of current to said auxiliary lines, a normally open start switch between one line and one terminal of the coil of the main relay, a normally closed stop switch between the other terminal of the coil and the other line, the third set of contacts of said main relay being between the coil side of the starting switch and said one terminal of the coil of said main relay, whereby when said starting switch is operated, said third set of contacts serves as a holding circuit for the coil of said main relay, three time delay relays, the first time delay relay having one set of normally open contacts and a second set of normally closed contacts, a space heater in circuit with said normally open contacts of said first relay, a first thermostat normally closed when cold, a first capacitor, a first resistor, and a first rectifier between said auxiliary supply lines, the coil of said first relay being in parallel with the first capacitor, the second time delay relay having two sets of normally open contacts, one set of contacts of said second relay being in circuit with a motor operating said pump and connected to said one supply line and to the other auxiliary supply line, the other set of contacts of said second relay being connected between said supply lines and a motor for operating a conveyor whereby said motor for operating the conveyor will be operated when said second relay is energized, a second thermostat with normally open contacts when cold, a second capacitor, a second resistance, a second rectifier connected in series between said supply lines, the coil of said second relay being in parallel with said second capacitor, the third relay having first and second sets of contacts, one contact of the first set of contacts being connected to one auxiliary line and the other contact being connected to the other contact of the second normally closed set of contacts of said first relay, the first contact of the second set of contacts of said first relay being connected to the other auxiliary line, the rectifier, resistor, and capacitor of said third relay being connected to the

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second contact of the second set of contacts of said first relay, the coil of said third relay being in parallel with said capacitor of said third relay, the second set of contacts of said third relay being connected to a pilot light and to the auxiliary lines, the time delay of the third relay being much greater than the time delay of said first relay whereby said third relay will not operate until the first thermostat has first reached its operating temperature and said second thermostat has reached a temperature to close thereby energizing the third relay starting the motors, said first relay having been de-energized at

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least once thereby closing said second set of contacts of said first relay for a sufficient time to cause actuation of said third relay and the energization of the pilot light to show that satisfactory operating conditions exist.

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EVON C. BLUNK, *Primary Examiner.*