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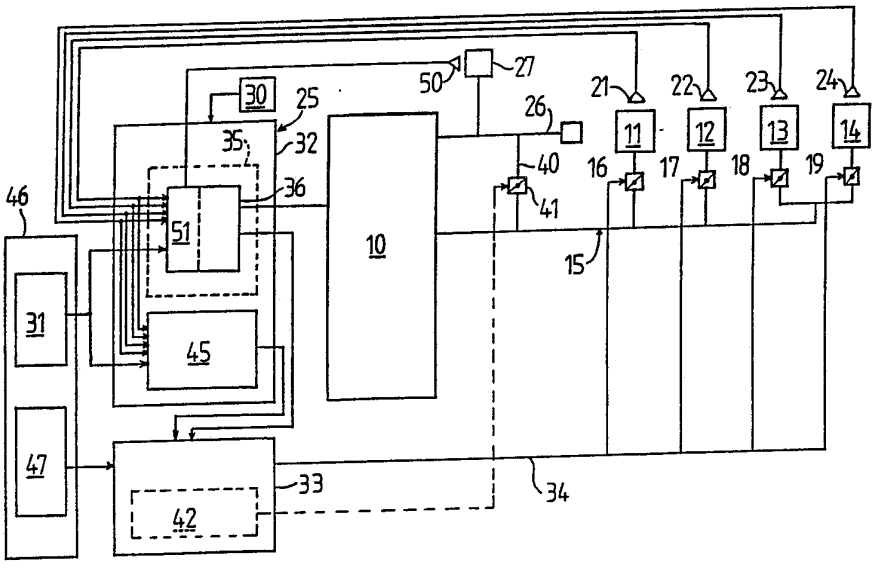
(54) Title: AIR CONDITIONING SYSTEM CONTROL

(57) Abstract



A control system for an air conditioning system including a single or multiple air conditioning units (10, 91-94) for a plurality of zones (11-14). A temperature sensor (21-24) is located at each zone (11-14). A target temperature setting means (31) enables the user to set a respective target temperature for each zone. A central controller (25) includes a logic circuit (32) receiving a respective target temperature signal for each zone from the target temperature setting means (31) and is responsive to the temperature sensors (21-24) to determine the zones requiring heated air or cooled air. The central controller (25) includes command means (33, 95-98) responsive to the logic circuit (32) to control the supply of conditioned air to the zones. Where there is a central air conditioning unit (10), a ducting system (15) conveys the conditioned air from the central air conditioning unit (10) to the plurality of zones (11-14) and the command means (33) comprises a flow command means coupled to flow controllers (16-19) such as dampers in the ducting system controlling flow to each zone. When a particular zone temperature is substantially at its target temperature the logic circuit (32) causes the respective damper to close the ducting system (15) supplying conditioned air to that zone. The logic means (32) includes all zone satisfaction test means (45) to determine whether all zones are at their target temperatures and, if so, to open all of the dampers to the zones. When there are several air conditioning units (91-94), the command means comprises air conditioning unit switching means (95-98) operative to control the various air conditioning units (91-94).

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AIR CONDITIONING SYSTEM CONTROL

This invention relates to air conditioning systems and particularly to control systems therefor.

Air conditioning systems which are used for supplying conditioned air to several zones generally rely on a thermostat being provided in each zone. One known system relies on varying the volume of air supplied to each zone in response to thermostats provided in the zones. Such a system generally relies on variable control of dampers provided in the ducting system. A central control may be provided responsive to the thermostats and operative to average the input from the thermostats to determine whether the central air conditioning system is to operate in a heating or cooling mode. A disadvantage of this system is the need for relatively expensive thermostats in each zone. Another disadvantage is the ability of heating or cooling requirements at one zone having an undue influence on the control and operation of the central air conditioning system resulting in a majority of zones being overridden by a minority, or at least the possibility of user manipulation of the thermostats at different zones having undesirable effects at other zones.

It is an object of the present invention to provide an air conditioning system control and an air conditioning system incorporating a control which is relatively simple and effective in operation.

It is a further and preferred object of the present invention to provide an air conditioning system control for a plurality of zones and which is relatively simple to install and which enables centralised control of the operation of the air conditioning system, particularly the temperatures in each of the zones.

According to the present invention there is provided a control system for an air conditioning system, the air conditioning system including air conditioning means for supplying conditioned air for a plurality of zones; the control system being characterised by a plurality of temperature sensors, each one of the temperature sensors being located in use at a respective one of the zones and being operative to sense and indicate the temperature in the respective

zone; a central controller coupled in use to the air conditioning means and being operative to control operation thereof, a target temperature setting means for enabling a user to set a respective target temperature for each zone, the central controller including a logic circuit receiving a respective target temperature signal for each zone from the target temperature setting means and coupled in use to the temperature sensors and responsive to the temperature sensors to determine the zones requiring heated air or cooled air to reach their respective target temperatures, the central controller including command means responsive to the operation of the logic circuit to control the supply of conditioned air to the zones and thereby control the temperature in the zones.

In one possible embodiment in which the air conditioning means comprises a central air conditioning unit for supplying conditioned air for the plurality of zones, and the air conditioning system further includes a ducting system for conveying the conditioned air from the central air conditioning unit to the plurality of zones, the ducting system including the plurality of flow controllers for controlling the flow of conditioned air through the ducting system to the zones, each one of the zones having a respective one of the flow controllers associated therewith, the control system is characterised in that the command means comprises a flow command means coupled in use to the flow controllers of the air conditioning system and operative to control the flow controllers in response to the operation of the logic circuit so as to control the flow of conditioned air to the zones and thereby control the temperature in the zones.

Preferaby each of the temperature sensors comprises a passive element responsive to the temperature in the associated zone, such as a thermistor, the electrical properties of the passive element varying in a predetermined manner in response to temperature changes.

A timer system may be connected to the central controller, the timer system being selectively adjustable so as to enable user determination of the times at which the central air conditioning unit is operable.

In the preferred embodiment the logic means further includes mode control means operable to determine and control whether the central air conditioning unit is to operate in a heating mode or a cooling

mode at any particular time. Preferably the mode control means comprises a dominant need test means responsive to the temperature sensors and operative when there are zones requiring heating and further zones requiring cooling to reach their target temperatures, to determine a need demand constituted by a need of the particular zone which has its temperature indicated by its respective temperature sensor that is furthest from the target temperature for that particular zone, the mode control means being responsive to the dominant need test means to operate the central air conditioning unit in a heating or cooling mode.

The flow command means may be responsive to a determination of the logic circuit that a particular zone temperature is substantially at its target temperature to cause the associated respective flow controller to close the ducting system supplying conditioned air to that zone. When designed for use with an air conditioning control system having a by-pass duct and associated flow controller in the by-pass duct, the by-pass duct being arranged to convey conditioned air from the central air conditioning unit back to the unit without having been introduced to any one of the zones, the flow command means preferably includes by-pass commands means for controlling operation of the flow controller in the by-pass duct, the logic circuit being operative to cause the by-pass command means to open the flow controller in the by-pass duct if a predetermined number of the flow controllers associated with the zones are closed at any particular time so as to maintain a predetermined volume of flow of conditioned air from the central air conditioning unit.

The logic circuit preferably includes all zone satisfaction test means operative to determine whether all zones are at respective temperatures substantially equal to their target temperatures and, if so, to control the flow command means to open all of the flow controllers to the zones so as to supply air to all zones simultaneously for maintaining an air circulation through the zones.

The central controller preferably includes a control setting means including the target temperature setting means which is user operable at the central controller to select the target temperature for each zone. In this embodiment the control setting means preferably includes disablement means which is user operable to disable a selected one or more particular disabled zones, the flow

command means being responsive to the disablement means to close the flow controllers in the ducts leading to the selected disabled zones so that no conditioned air is supplied to those disabled zones.

An ambient temperature sensor may be provided for sensing ambient temperature, the central controller including an ambient compensator responsive to the ambient temperature sensor to automatically shift the selected target temperature for each zone towards the ambient temperature when the ambient temperature is different from the target temperature by a predetermined substantial amount so as to thereby automatically improve the comfort of occupants moving into the zones from ambient conditions or vice versa.

Instead of a system with a single air conditioning unit and ducting, the air conditioning means may comprise a plurality of air conditioning units associated with respective ones of the plurality of zones for supplying conditioned air for the associated zones, the control system being characterised in that the command means comprises air conditioning unit switching means coupled in use to the plurality of air conditioning units and operative to control the air conditioning units in response to the operation of the logic circuit so as to control the supply of conditioned air to the associated zones and thereby control the temperature in the zones.

The present invention also provides an air conditioning system including a central air conditioning unit for supplying conditioned air for a plurality of zones, a ducting system for conveying the conditioned air from the central air conditioning unit to the plurality of zones, the ducting system including a plurality of flow controllers for controlling the flow of conditioned air through the ducting system to the zones, each one of the zones having a respective associated one of the flow controllers; and a control system according to the invention and operative to control operation of the air conditioning unit and the flow controllers.

Preferably each flow controller comprises a damper which is movable between two operable positions comprising a fully open position in which conditioned air flow through ducting system past the damper is allowed and a closed position in which conditioned air flow therethrough is substantially prevented, the flow command means causing the respective dampers to move between their fully open and closed positions without remaining in any intermediate positions.

Possible and preferred features of the present invention will now be described with particular reference to the accompanying drawings. However it is to be understood that the features illustrated in and described with reference to the drawings are not to be construed as limiting on the scope of the invention. In the drawings:

Fig. 1 is a schematic block diagram of an air conditioning system embodying and incorporating a control system according to a preferred embodiment of the present invention,

Fig. 2 is a block diagram of a control system embodying the present invention, and

Fig. 3 is a schematic block diagram of a control system for controlling a number of air conditioning units.

The air conditioning system in Fig. 1 includes a central air conditioning unit 10 for supplying conditioned air for a plurality of zones 11,12,13,14, four being shown but a greater number being possible. The air conditioning system includes a ducting system 15 for conveying conditioned air from the central air conditioning unit 10 to the plurality of zones 11-14, the ducting system 15 including a plurality of flow controllers 16,17,18,19 for controlling conditioned air flow to the zones 11-14, each of the flow controllers 16-19 being associated with a respective one of the plurality of zones 11-14. The control system includes a plurality of temperature sensors 21,22,23,24, each one of the temperature sensors 21-24 being in use located at a respective one of the zones 11-14 and being operative to sense the temperature in its respective zone. A central controller 25 is operative to control operation of the central air conditioning unit 10, the central controller 25 being coupled to each temperature sensor 21-24 so as to be responsive thereto and operative to control operation of the flow controllers 16-19 of the ducting system so as to control the temperature of each of the zones.

The central air conditioning unit 10 may be generally of conventional construction and operation. The ducting system 15 may also be generally conventional in comprising insulated ducting passing from the central air conditioning unit 10 via main and branched ducts extending to the zones 11-14. The zones may comprise individual rooms or groups of rooms. The ducting system as is generally known may include a return air duct 26 for returning air to the central air conditioning unit 10. The central air conditioning

unit may additionally draw a proportion of its air from externally of the building where the system is installed as shown at 27.

The flow controllers 16-19 of the ducting system may comprise dampers which may be generally of the construction and operation known in the art. Preferably the dampers move between two only operative positions, namely a fully open position in which air flow through the damper is allowed, and a closed position in which air flow is prevented. Intermediate flow positions in which flow is permitted but restricted is possible although in the preferred embodiment is not essential.

The temperature sensor 21-24 located at each of the zones 11-14 may comprise a passive element responsive to the zone temperature, e.g. a thermistor.

The central controller 25 is operative to switch the central air conditioning unit 10 between on and off conditions. Associated with the central controller 25 for this purpose there is a timer 30 which is selectively adjustable so as to determine the time or times at which the central air conditioning unit 10 will be operable. The timer 30 is user adjustable for determining the time or times of day when the air conditioning system will be operable. The timer 30 may include, in addition to time of day control means, time of year control means. This time of year control means may include not only day determining means (e.g. to enable user control of the days of the week on which the air conditioning system will be operable), but also to enable pre-selection and programming of days of the year when the air conditioning system will be operable or inoperable. In the latter case, in use of the air conditioning system in a commercial premises, a system may be rendered inoperable by the central controller at weekends, and public holidays.

The central controller 25 includes a target temperature setting means 31 for enabling a user to set a respective target temperature for each zone 11-14. A logic circuit 32 receives a respective target temperature signal for each zone 11-14 from the target temperature setting means 31 and is coupled to the temperature sensors 21-24. The logic circuit 32 determines the zones 11-14 requiring heated air or cooled air to reach their respective target temperatures. A flow command means 33 coupled by line 34 to the flow controllers 16-19 of the air conditioning system and is operative to control the flow

controllers 16-19 in response to the operation of the logic circuit 32 so as to control the flow of conditioned air to the zones 11-14 and thereby control the temperature in the zones.

In addition to controlling the on and off periods, the logic means 32 of the central controller 25 includes mode control means 35 to control the mode of operation of the central air conditioning unit 10. In particular, the mode control means 35 is operable to determine whether the central unit 10 is to operate in a heating or cooling mode at any particular time. The mode control means 35 includes a dominant need test means 36 operable when there are conflicting demands for heating and cooling from the zones 11-14 to determine whether the central air conditioning unit 10 is to operate in heating or cooling mode. The test means 36 is operable to determine a dominant need as determined by the plurality of temperature sensors 21-24. The dominant need may comprise the need of the particular zone which is furthest or most removed from the target temperature for that zone. With this arrangement, if one or more zones 11-14 require heating while one or more others require cooling, the zone furthest from its target temperature will determine whether the central air conditioning unit 10 operates in a heating or cooling mode. If the dominant need test means 36 determines that the central air conditioning unit 10 will operate in a heating mode, the zone furthest from its target temperature and other zones requiring heating will receive heated air while the zone or zones requiring cooling will be unsatisfied. However when a zone requiring cooling becomes the dominant zone the central air conditioning unit 10 will switch to cooling mode and the zones requiring cooling will commence to be satisfied. Thus different zones can be alternately supplied with heated or cooled air as required.

The flow command means 33 is responsive to the logic circuit 32 to close the flow controller 16-19 associated with the respective zone 11-14 as its temperature requirement is satisfied. If a sufficient number of zones 11-14 are satisfied and the associated flow controllers 16-19 are closed to supply of conditioned air it is possible that the air moving means, particularly the fan or blower associated with the central air conditioning unit 10 may cause excessive noise or a draft in unsatisfied zones. Therefore the air conditioning system may include a by-pass duct 40 and associated flow

controller 41 for enabling conditioned air to be returned to the central air conditioning unit 10 without having been introduced to any zone 11-14. The flow command means 33 includes by-pass command means 42 for controlling operation of the flow controller 41 in the by-pass duct 40, the logic circuit 32 being operative to cause the by-pass command means 42 to open the flow controller 41 in the by-pass duct 40 if a predetermined number of the flow controllers 16-19 associated with the zones 11-14 are closed at any particular time so as to maintain a predetermined volume of flow of conditioned air from the central air conditioning unit 10. This will enable a constant volume of air moving over the coil or through the air conditioning unit 10 for as long as the unit 10 is operating.

The logic means 32 includes all zone satisfaction test means 45 operative to determine whether all zones 11-14 are at respective temperatures substantially equal to their target temperatures and, if so, to control the flow command means 33 to open all of the flow controllers 16-19 to the zones 11-14 so as to supply air (unconditioned if desired) to all zones simultaneously for maintaining an air circulation through the zones 11-14.

The air conditioning control system includes control setting means 46 operatively associated with the central controller 25 and which includes the target temperature setting means 31 to enable a user to select zone target temperatures. Preferably the control setting means 46 enables user selection of each individual zone target temperature. This will enable centralised setting of the target temperatures of the zones 11-14 without individual zone occupants being able to manipulate operation of the system if they were able to readily change the selected temperature for that zone from a location within that zone. Preferably also the control setting means 46 includes disablement means 47 operative to enable disablement of one or more particular zones 11-14. This will enable centralised determination of the operation of the control system in such a way as to enable one or more zones to be "ignored", e.g. if one or more zones 11-14 are unoccupied, the flow command means 33 can be responsive to the disablement means 47 so that the flow controllers 16-19 associated with such zones can be closed regardless of the temperature within that zone.

The air conditioning system control system includes an ambient temperature sensor 50 and compensator 51. The compensator 51 may be operative in response to the ambient sensor 50 to automatically shift the target temperatures for the zones 11-14 as determined by the control setting means 46 towards the ambient temperature. This will enable for example automatic compensation for the purposes of improving occupant comfort levels when external temperatures are substantially shifted from the zone target temperatures. For example, if the zone target temperatures are about 23°C and the external temperature is say 35°C, in order to reduce the feeling that the temperature within the zones is too low, the compensator 51 may be operative to shift the effective target temperatures to a higher level regardless of the user selected temperatures determined by the control setting means 46. The ambient sensor 50 may comprise an air temperature sensor which may be located at an air intake 27 for the central air conditioning unit 10 where ambient air is drawn into the air conditioning system from externally or which may be located externally of the building in a suitable location.

Referring to Fig. 2 there is shown a control system based on a central processor unit 60 which may be a micro-processor or the like. A zone temperature sensor 21 is illustrated which is connected to input terminal connector 61 to which there is a respective thermistor or interface 62 connected. This in turn is connected to the analogue input channel select means 63 which operates as a multiplexer under control of the central processor unit 60. The select means 63 applies signals through the analogue to digital converter 64 to the central processing unit 60. Also the select means 63 is coupled to control setting means 46 where the target temperature and if desired other perameters for the first zone are set.

Other inputs to the central processor unit 60 include an output enable line 65 for enabling overall on/off control, optional switches 66 such as for selective disablement of particular zones (equivalent to disablement means 47 in Fig. 1), timer 30 and ambient temperature sensor 50. If desired there may be provided remote controls and/or displays 67, e.g. displays at the zones.

The central processor unit 60 may comprise hard wired logic circuitry or, more preferably, a suitably programmed

micro-processor. The unit 60 operates as the logic circuit 32 including the mode select means 35 and dominant need test means 36, compensator 51, and all zone satisfaction test means 45. In addition the unit 60 can operate as the flow command means 33 and the by-pass command means 42.

The outputs of the unit 60 are applied to output switch drives 70, 71. The drive 71 controls relay coils 72 and associated indicator lamps such as LED's 73 which in turn control operation of the air conditioning unit 10 such as the cooling compressor via switches 74, heating means via switches 75 and fan via switch 76. The drive 70 controls associated switches 77 which operate the flow controllers 16-19. Associated with the relay operated switch 77 is an indicator lamp or LED 78 to show the condition of the assoicated remote flow controller 16.

Power supply 80 is provided for the control system.

The Appendix to this specification consists of a possible system outline and system specification for a controller according to the present invention such as the contoller illustrated in Fig. 2 but the invention is not limited by this system outline and specification.

In Fig. 3 the central controller 25 is connected to control the plurality of air conditioning units 91, 92, 93, 94 associated with respective zones 11, 12, 13, 14. In this configuration the input signals from temperature sensors 21-24 and the input of signals from the target temperature setting means 31 remain the same as in the Fig. 1 embodiment. However the output of the central controller 25 controls separate switching means 95,96,97,98 associated with respective air conditioning units 91-94 to provide for example for two stage heating, two stage cooling and fan operation of each air conditioning unit 91-94. When using in the Fig. 3 embodiment a control system generally as shown in Fig. 2, the functions for selecting cool preference or heat preference, and the functions for selecting purge time can be disabled. In Fig 3. the central controller operates as a central switching and central temperature setting station for the four separate air conditioning units, although it is to be understood that more or less air conditioning units can be controlled. Other components of the Fig 3. system which are the same as the Fig 1. system bear the same reference numerals.

It will be seen that the preferred embodiment of the air conditioning system control according to the preferred embodiments of the present invention herein described and illustrated will enable centralised determination of the target temperatures for each of a plurality of zones. The system control can be relatively inexpensive since a number of thermostats equal to the number of zones need not be provided and installed, nor need proportional control dampers or variable air volume delivery means. The provision of centralised zone temperature setting and simple temperature sensors at each zone enables these advantages to be achieved. There may be other advantages of the system such as the elimination of the need for feedback of signals indicating the damper positions.

It is to be understood that various alterations, modifications and/or additions may be made to the features of the possible and preferred embodiment(s) of the invention as herein described without departing from the scope of the invention as defined in the appended claims.

APPENDIX: SYSTEM OUTLINE AND SPECIFICATION

1. SCOPE

This specification covers the electrical requirements for an air conditioner zone controller.

2. GENERAL

2.1 Background

The Zone Controller is primarily intended for use with a single air conditioner unit that is ducted to several zones. It may, however, be modified to control multiple air conditioner units. Each zone has its own temperature sensor connected to the controller via a low voltage, two wire, link. Dampers for each zone allow the air flow to the zone to be switched on or off. The Zone Controller reads and processes the zone temperature sensor information, and responds by appropriately controlling the air conditioning unit 10 and damper motors.

2.2 Zones

In its basic configuration, the zone controller is capable of controlling up to 8 separate zones. Each zone has its own temperature sensor and damper to control the air flow.

Switches on the controller allow any one or more zone to be disabled. Existing but disabled zones will generally have their dampers closed.

3. Zone Controller Inputs

The zone controller inputs are:

Up to 8 temperature sensors.

240V ac 50 Hz single phase mains supply.

Output enable (Time clock) control.

3.1 Temperature sensors

The temperature sensors are located in the zones to be controlled, generally external to the zone controller.

Temperature set points, for control of the air conditioning unit 10, are set by adjustment means, usually provided inside the zone controller enclosure.

The sensors used with the preferred embodiment of the zone controller, are negative temperature coefficient, R-T curve matched, thermistors.

3.2 Temperature Set Point Adjustments

The controller provides four temperature set point adjustments for each zone. These are:

* Desired temperature. This is the temperature that the air conditioner controller aims to maintain within the zone.
* Temperature dead band. This is the temperature range about the desired temperature where the air conditionerr neither heats nor cools.
* Cooling switching differential. This is a temperature difference between the point where the air conditioner starts to cool and the point where it stops cooling.
* Heating switching differential. This is a temperature difference between the point where the air conditioner starts to heat and the point where it stops heating.

3.3 Temperature Adjustment Range

The adjustment ranges (provided with the preferred embodiment of the zone controller,) over which each temperature set point may be adjusted are as follows:

Desired temperature,	15.0° to 30.0°C.
Temperature dead band,	0.0° to 5.0°C.
Cooling switching differential,	0.0° to 5.0°C.
Heating switching differential.	0.0° to 5.0°C.

3.4 Temperature Adjustment Indication

Each temperature adjustment is made by turning the pointer of a single turn resistor potentiometer with appropriate scales marked around the outside. An optional digital display unit may be connected to the controller to provide an alternative adjustment setting indication.

Changes to one temperature set point or range have no effect on any other setting.

4. Zone Controller Outputs

The outputs of the zone controller control the operation of the damper motors for each zone, and the operation of the air conditioning unit(s). Control is achieved by operation of suitable electric switching means (for example, relays or triacs).

Switching means are provided for each zone damper motor, plus the first stage heating and cooling controls of the air conditioning unit. Switching means are also provided for the fan and stage 2 heat and cool controls.

5. Controller Logic

Where several zones share a single air conditioning unit, there cannot be heating in one zone while simultaneously cooling in another. The first zone requiring heating or cooling is generally serviced but other options are offered, such as heat or cool priority.

5.1 Operation of fan only

With no call for heating or cooling all dampers for enabled zones are opened.

5.2 Heating

Any call for heating in a zone operates the heating cycle of the air conditioning unit and closes the dampers in the other zones provided a cooling cycle is not already being performed. Any other call for heating opens the damper or dampers of those zones - all zones can be heating at the same time. If heat priority is selected, any call for cooling has to wait until all the heating calls are satisfied.

Stage 2 heating is initiated if the temperature falls by a set level (eg. 0.5°C) below the start threshold for heating, but not before a set time (eg. 30 seconds) has expired since the start of stage 1 heating. Similarly, stage 2 heating will turn off when the temperature, in all zones, is equal or higher than a set level (eg. 0.5°C) below the heat off threshold.

5.3 Cooling

Any call for cooling in a zone starts the cooling cycle of the air conditioning unit and closeS the dampers in the other zones provided a heating cycle is not already being performed. Any other call for cooling opens the damper or dampers of those zones - all zones can be cooling at the same time. If cool priority is selected, any call for heating has to wait until all the cooling calls are satisfied.

Stage 2 cooling is initiated if the temperature rises by a set level (eg. 0.5°C) above the start threshold for cooling, but not before a set time (eg. 30 seconds) has expired since the start of

stage 1 cooling. Similarly, stage 2 cooling will turn off when the temperature, in all zones, is equal or less than a set level (eg. 0.5°C) above the cool off threshold.

5.4 Compressor Restart Delay

The controller may be programmed to ensure no compressor (heat 1, heat 2, cool 1, or cool 2) is restarted until a set time (eg. 2 minutes) has expired since it was switched off.

5.5 Indication of Control Operation

For each zone, a separate indication means is provided, typically on the zone controller printed circuit board, to show if the zone is enabled, is selected for use as a "bypass zone", if heating or cooling is required, and if heating or cooling is being performed.

The preferred embodiment of the zone controller uses the following:

- "ON" yellow LED - steady on for zone enabled
  - flashing if allocated as a bypass zone
- "HEAT" red LED - steady on if heating required
  - off if allocated as a bypass zone
- "COOL" green LED - steady on if cooling required
  - off if allocated as a bypass zone
- Damper Relay yellow LED - steady on if damper motor control relay is activated (ie. damper open)

Additional indicators are provided (yellow LED's) to indicate operation of the other outputs:

- Air conditioner unit heating cycle stage 1.
- Air conditioner unit heating cycle stage 2.
- Air conditioner unit cooling cycle stage 1.
- Air conditioner unit cooling cycle stage 2.
- Air conditioner unit fan.

5.6 Bypass Dampers

The outputs for zones 5, 6, 7, and 8 may be assigned for use in controlling "bypass" dampers using option switches. Bypass dampers are opened when too few normal zone dampers are opened. The minimum number of dampers to be open at any time (1 to 4) is also selected using option switches. Thus any combination between 8 zones and no bypass to 4 zones and 4 bypasses can be selected.

5.7 Purge time

The zone controller can provide a delay before switching the air

conditioning unit from a cooling operation, during which condensate can build up on the coil, to a heating operation. The delay enables condensate to drain from the coil and the coil to dry. Without such a delay, commencement of heating could cause a sudden introduction of odorous moist air to be introduced into the zones. The controlller is operative to direct the purged air to any or all zones.

CLAIMS

1. A control system for an air conditioning system, the air conditioning system including air conditioning means (10, 91-94) for supplying conditioned air for a plurality of zones (11-14); the control system being characterised by a plurality of temperature sensors (21-24), each one of the temperature sensors being located in use at a respective one of the zones (11-14) and being operative to sense and indicate the temperature in the respective zone (11-14); a central controller (25) coupled in use to the air conditioning means (10, 91-94) and being operative to control operation thereof, a target temperature setting means (31) for enabling a user to set a respective target temperature for each zone (11-14), the central controller (25) including a logic circuit (32) receiving a respective target temperature signal for each zone from said target temperature setting means (31) and coupled in use to the temperature sensors (21-24) and responsive to the temperature sensors to determine the zones (11-14) requiring heated air or cooled air to reach their respective target temperatures, the central controller (25) including command means (33, 95-98) responsive to the operation of the logic circuit (32) to control the supply of conditioned air to the zones (11-14) and thereby control the temperature in the zones.

2. A control system as claimed in Claim 1 and for an air conditioning system in which the air conditioning means comprises a central air conditioning unit (10) for supplying conditioned air for the plurality of zones (11-14), the air conditioning system further including a ducting system (15) for conveying the conditioned air from the central air conditioning unit (10) to the plurality of zones (11-14), the ducting system (15) including a plurality of flow controllers for controlling (16-19) the flow of conditioned air through the ducting system to the zones, each one of the zones (11-14) having a respective one of the flow controllers (16-19) associated therewith, the control system being characterised in that the command means comprises a flow command means (33) coupled in use to the flow controllers (16-19) of the air conditioning system and operative to control the flow controllers in response to the operation of the logic circuit (32) so as to control the flow of conditioned air to the zones (11-14) and thereby control the temperature in the zones.

3. A control system as claimed in Claim 2 characterised in that each of the temperature sensors (21-24) comprises a passive element responsive to the temperature in the associated zone (11-14), the electrical properties of the passive element varying in a predetermined manner in response to temperature changes.

4. A control system as claimed in Claim 3 characterised in that the passive element comprises a thermistor.

5. A control system as claimed in any one of Claims 2 to 4 characterised by a timer system (30) connected to the central controller, the timer system being selectively adjustable so as to enable user determination of the times at which the central air conditioning unit (10) is operable.

6. A control system as claimed in any one of Claims 2 to 5 characterised in that the logic means (32) further includes mode control means (35) operable to determine and control whether the central air conditioning (10) unit is to operate in a heating mode or a cooling mode at any particular time.

7. A control system as claimed in Claim 6 characterised in that the mode control means (35) comprises a dominant need test means (36) responsive to the temperature sensors and operative when there are zones (11-14) requiring heating and further zones (11-14) requiring cooling to reach their target temperatures, to determine a need demand constituted by a need of the particular zone which has its temperature indicated by its respective temperature sensor (21-24) that is furthest from the target temperature for that particular zone, the mode control means (35) being responsive to the dominant need test means to operate the central air conditioning unit (10) in a heating or cooling mode.

8. A control system as claimed in any one of Claims 2 to 7 characterised in that the flow command means (33) is responsive to a determination of the logic circuit (32) that a particular zone temperature is substantially at its target temperature to cause the associated respective flow controller (16-19) to close the ducting system (15) supplying conditioned air to that zone.

9. A control system as claimed in Claim 8 and for use with an air conditioning control system having a by-pass duct (40) and associated flow controller (41) in the by-pass duct, the by-pass duct (40) being arranged to convey conditioned air from the central air conditioning

unit (10) back to the unit (10) without having been introduced to any one of the zones (11-14), the control system being characterised in that the flow command means (33) includes by-pass commands means (42) for controlling operation of the flow controller (41) in the by-pass duct (40), the logic circuit (32) being operative to cause the by-pass command means (42) to open the flow controller (41) in the by-pass duct (40) if a predetermined number of the flow controllers (16-19) associated with the zones (11-14) are closed at any particular time so as to maintain a predetermined volume of flow of conditioned air from the central air conditioning unit (10).

10. A control system as claimed in Claim 8 or 9 characterised in that the logic circuit (32) includes all zone satisfaction test means (45) operative to determine whether all zones (11-14) are at respective temperatures substantially equal to their target temperatures and, if so, to control the flow command means (33) to open all of the flow controllers (16-19) to the zones (11-14) so as to supply air to all zones simultaneously for maintaining an air circulation through the zones.

11. A control system as claimed in any one of Claims 2 to 10 wherein the central controller (25) includes a control setting means (46) including the target temperature setting means (31) which is user operable at the central controller (25) to select the target temperature for each zone (11-14).

12. A control system as claimed in Claim 11 characterised in that the control setting means (46) includes disablement means (47) which is user perable to disable a selected one or more particular disabled zones (11-14), the flow command means (33) being responsive to the disablement means (47) to close the flow controllers (16-19) in the ducts leading to the selected disabled zones so that no conditioned air is supplied to those disabled zones.

13. A control system as claimed in any one of Claims 2 to 12 characterised by an ambient temperature sensor (50) for sensing ambient temperature, the central controller (25) including an ambient compensator (51) responsive to the ambient temperature sensor (50) to automatically shift the selected target temperature for each zone (11-14) towards the ambient temperature when the ambient temperature is different from the target temperature by a predetermined substantial amount so as to thereby automatically improve the comfort

of occupants moving into the zones (11-14) from ambient conditions or vice versa.

14. A control system as claimed in Claim 1 and for an air conditioning system in which the air conditioning means comprises a plurality of air conditioning units (91-94) associated with respective ones of said plurality of zones (11-14) for supplying conditioned air for the associated zones, the control system being characterised in that the command means comprises air conditioning unit switching means (95-98) coupled in use to the plurality of air conditioning units and operative to control the air conditioning units in response to the operation of the logic circuit (32) so as to control the supply of conditioned air to the associated zones (11-14) and thereby control the temperature in the zones.

15. An air conditioning system including a central air conditioning unit (10) for supplying conditioned air for a plurality of zones (11-14), a ducting system (15) for conveying the conditioned air from the central air conditioning unit (10) to the plurality of zones (11-14), the ducting system (15) including a plurality of flow controllers for controlling (16-19) the flow of conditioned air through the ducting system (15) to the zones (11-14), each one of the zones having a respective associated one of the flow controllers (16-19); and a control system (25) as claimed in any one of Claims 1 to 12 and operative to control operation of the air conditioning unit (10) and the flow controllers (16-19).

16. An air conditioning system as claimed in Claim 15 wherein each flow controller (16-19) comprises a damper which is movable between two operable positions comprising a fully open position in which conditioned air flow through ducting system (15) past the damper is allowed and a closed position in which conditioned air flow therethrough is substantially prevented, the flow command means (33) causing the respective dampers to move between their fully open and closed positions without remaining in any intermediate positions.

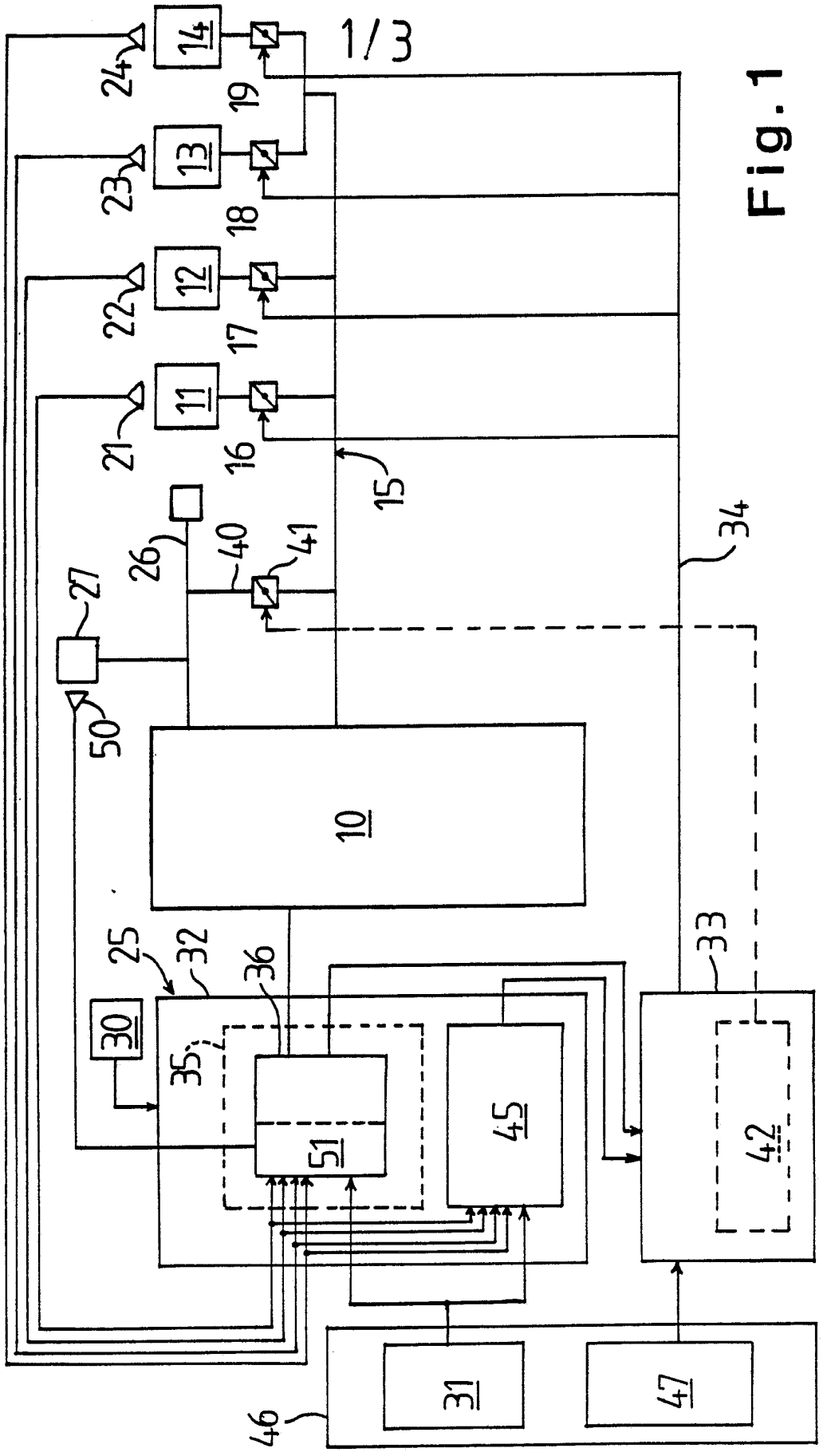
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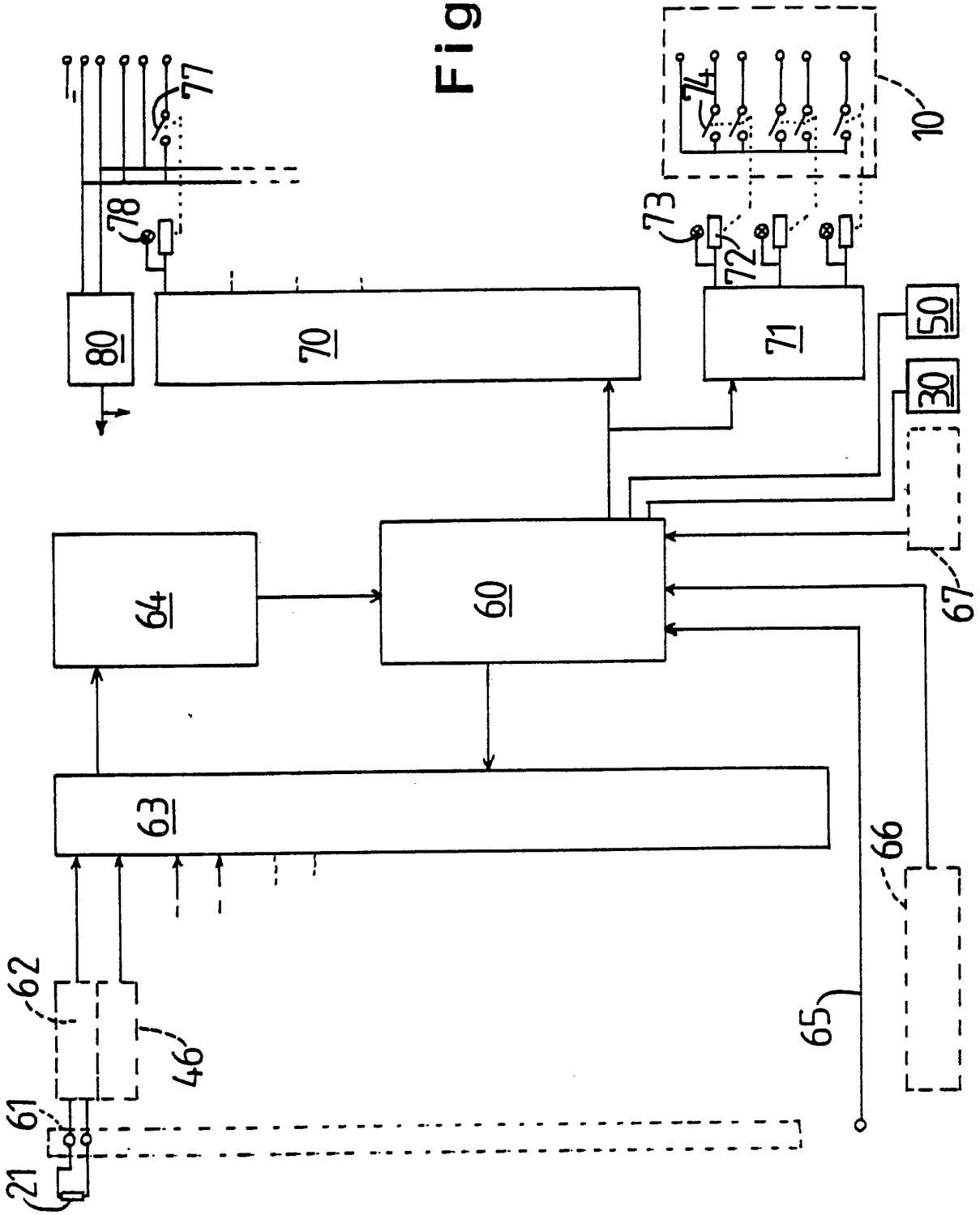
Fig. 1

Fig.2



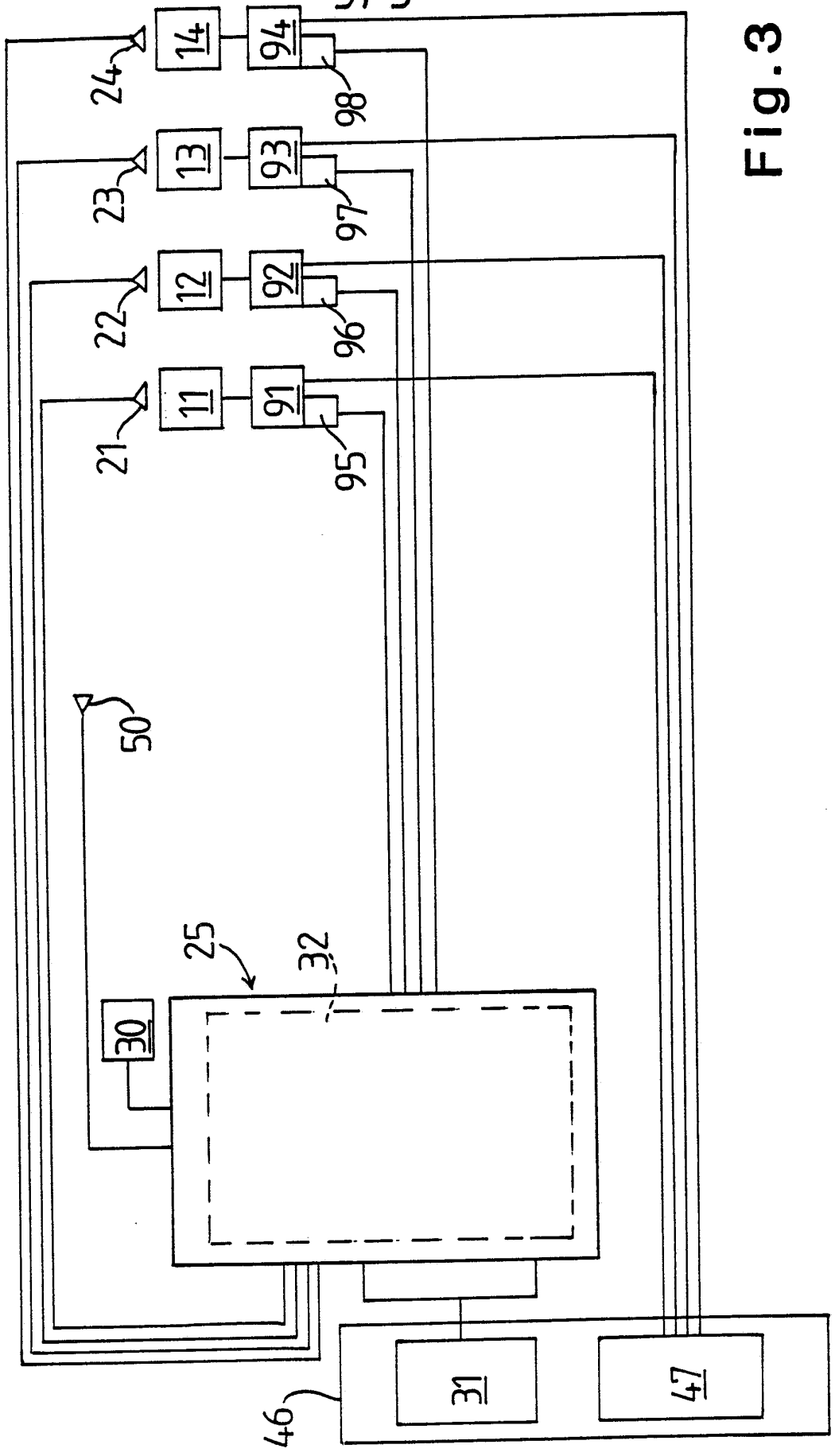


Fig.3

INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 89/00286

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] F24F 11/053, 3/044, 11/00

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC	F24F 11/053, 3/044, 11/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

AU:IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
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X	AU,B, 53351/86 (580931) (MITSUBISHI DENKI KABUSHIKI KAISHA) 28 August 1986 (28.08.86)	1-8, 11-12, 15-16
X	AU,B, 55301/86 (567005) (MITSUBISHI DENKI K.K.) 2 October 1986 (02.10.86)	1-8, 11,15,16
X	AU,B,61149/86 (582664) (MITSUBISHI DENKI K.K.) 26 February 1987 (26.02.87)	1-9, 11-12, 15-16
X	AU,A, 67019/86 (MITSUBISHI DENKI K.K.) 2 July 1987 (02.07.87)	1-2,5-7,10,12, 15-16
P,X	AU,A, 67020/86 (MITSUBISHI DENKI K.K.) 31 March 1988 (31.03.88)	1-13, 15-16

(continued....)

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
31 August 1989 (31.08.89)	(15.09.89) 15 September 1989
International Searching Authority	Signature of Authorized Officer
Australian Patent Office	R HALLETT

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category*	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
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X	US,A, 4013118 (D.E. ZIMMER et al) 22 March 1977 (22.03.77)	1-2, 15-16
X	US,A, 4479604 (R.S. DIDNER) 30 October 1984 (30.10.84)	1-2, 15-16
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X	FR,A, 2471560 (HAGENVK GMBH) 19 June 1981 (19.06.81)	1-2, 15-16

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 89/00286

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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AU 67019/86	JP 62266348		
AU 67020/86	JP 63187044	US 4819714	
AU 17696/88	JP 62285882		
US 4013118	US 3933197		

ANNEX CONTINUED

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 89/00286 (CONTINUED)

Patent Document Cited in Search Report	Patent Family Members		
US 4479604			
US 4308911			
US 4530395	CA 1218438 CA 1211979	US 4646964	US 4487363
US 4549601	AU 15667/83 EP 59013835 US 4549601 EP 146488	CA 1188560 US 4495986 US 4630670	EP 97607 US 4531573 ZA 8304061
FR 2471560			

END OF ANNEX