

MICRO-TEMPERATURE CONTROLLER

FIELD OF INVENTION

5 The application relates to a temperature controller for mounting in a mould injection tool and to a method of use thereof. In particular, the application relates to a temperature controller for obtaining a temperature signal of a mould injection tool in order to control the temperature of the
10 mould injection tool and to a method of use thereof.

BACKGROUND

US 6,312,628 discloses a method and a system for controlling
15 the temperature of a fluid cooled high temperature injection mould that has fluid channels formed therein. The high temperature injection mould has an operating temperature above the boiling point of water. A flow of either elevated pressure or low pressure cooling water is passed through the fluid channels in the high temperature injection mould for a
20 limited duration during the moulding cycle to reduce the temperature of the injection mould to a desired level.

US 5,397,515 discloses a control system for controlling the
25 temperature within process machinery, such as the feed assembly in an injection-moulding machine. The control system provides a six-phase process for starting up a machine from a cold condition and for controlling the machine temperature to attain a command temperature in a rapid and accurate manner
30 while identifying control parameters for use under steady state conditions to maintain the command temperature.

SUMMARY

The application provides a temperature controller module for an injection-moulding machine. The temperature controller module comprises a resistor network and at least one analog
5 controller device.

The resistor network that comprises a power supply terminal, a machine mode selector switch with at least two machine mode selector positions, a material type selector switch with at
10 least two material type selector positions, and an output terminal. The output terminal is connected to the material type resistors.

The power supply terminal is used for receiving a pre-
15 determined DC supply voltage. The machine mode selector switch is used for selectively connecting the power supply terminal to one of two or more variable machine mode resistors. The material type selector switch is used for selectively connecting one of the variable machine mode resistors
20 to one of two or more material type resistors. The output terminal is used for providing a sensor threshold value.

The analog controller device comprises a sensor terminal, a threshold detector, an optical coupling device, an AC power
25 supply terminal, a heater terminal, and an analog semiconductor power switch. The threshold detector comprises a sample and hold input electrical circuit.

The sensor terminal is used for receiving a sensor measurement value. The threshold detector is used for receiving the
30 sensor threshold value and the sensor measurement value. The optical coupling device is configured such that the threshold detector energises the optical coupling device when the sen-

sensor measurement value exceeds the sensor threshold value. The AC power supply terminal is used for receiving an AC power supply. The heater terminal is used for providing electrical power to a heater.

5

The analog semiconductor power switch is used for providing electrical power from the AC power supply terminal to the heater terminal when the optical coupling device activates the analog semiconductor power switch. The analog semiconductor power switch operates in an auto-triggering mode while the AC power supply energizes the analog semiconductor power switch.

10

BRIEF DESCRIPTION OF THE DRAWINGS

15

Fig. 1 illustrates an embodiment of an improved temperature controller,

Fig. 2 illustrates a diagram of a temperature control circuit of the temperature controller of Fig. 1,

20 Fig. 3 illustrates a diagram of a reference-temperature selection circuit of the temperature controller of Fig. 1,

Fig. 4 illustrates a diagram of an embodiment of a temperature-sensing device of the temperature control circuit of Fig. 2,

25

Fig. 5 illustrates a diagram of another embodiment of the temperature-sensing device of Fig. 2,

Fig. 6 illustrates a diagram of a further embodiment of the temperature-sensing device of Fig. 2,

30 Fig. 7 illustrates a diagram of an embodiment of an opto-coupler of the temperature control circuit of Fig. 2,

- Fig. 8 illustrates another diagram of another embodiment of the optocoupler of Fig. 2,
- Fig. 9 illustrates electrical waveform diagrams for a TRIAC (Triode for Alternating Current) of the temperature control circuit of Fig. 2,
- Fig. 10 illustrates a front view and a side view of a casing for the temperature controller of Fig. 1,
- Fig. 11 illustrates different views of an injection-moulding machine with the temperature controller of Fig. 1,
- Fig. 12 illustrates a schematic of a controller system that includes the temperature controller of Fig. 1,
- Fig. 13 illustrates a temperature graph of a mould assembly of an injection-moulding machine that uses the controller system of Fig. 12,
- Fig. 14 illustrates a heater status graph of the mould assembly, the heater status graph is associated with the temperature graph of Fig. 13,
- Fig. 15 illustrates a temperature graph of an injection-moulding apparatus, the temperature graph is associated with the temperature graph of Fig. 13,
- Fig. 16 illustrates a heater status graph of the injection-moulding apparatus, the heater status graph is associated with the temperature graph of Fig. 13,
- Fig. 17 illustrates steps for binning a finished parts produced by the injection-moulding machine of Fig. 11 using information from the controller system of Fig. 12,
- Fig. 18 illustrates a variation of the injection-moulding machine of Fig. 11,
- Fig. 19 illustrates another embodiment that is a variation of the temperature control circuit of Fig. 2,

- Fig. 20 illustrates electrical waveform diagrams for a thyristor of the temperature control circuit of Fig. 19,
- Fig. 21 illustrates a further embodiment that is a variation of the temperature control circuit of Fig. 2,
- Fig. 22 illustrates a variation of a comparator of Fig. 2 that includes a hysteresis module,
- Fig. 23 illustrates a diagram of relationship between input voltages and output voltages of the comparator of Fig. 22,
- Fig. 24 illustrates a variation of the comparator of Fig. 2 that includes a sample and hold module,
- Fig. 25 illustrates a cross-sectional top view of an embodiment of an improved injection-moulding machine in a first position,
- Fig. 26 illustrates a side cross-sectional view of the injection-moulding machine of Fig. 25,
- Fig. 27 illustrates an expanded cross-sectional view of a part of the injection-moulding machine of Fig. 26,
- Fig. 28 illustrates a cross-sectional top view of the injection-moulding machine of Fig. 25 in a second position,
- Fig. 29 illustrates a side cross-sectional view of the injection-moulding machine of the Fig. 28,
- Fig. 30 illustrates an expanded cross-sectional view of a part of the injection-moulding machine of Fig. 29,
- Fig. 31 illustrates an embodiment of a pressure controller, which shows another way of using the controller of Fig. 1,
- Fig. 32 illustrates an embodiment of a pressure sensor module of a pressure sensor device for the pressure controller of Fig. 31,

Fig. 33 illustrates a cross-sectional top view of a further embodiment of an injection-moulding machine,
Fig. 34 illustrates a side view of the injection-moulding machine of Fig. 33,
5 Fig. 35 illustrates a pressure controller for the injection-moulding machine of Fig. 33,
Fig. 36 illustrates a pressure sensor for the pressure controller of Fig. 35, and
Fig. 37 illustrates a management system for an injection-
10 moulding machine.

DETAILED DESCRIPTION

In the following description, details are provided to describe embodiments of the application. It shall be apparent
15 to one skilled in the art, however, that the embodiments may be practiced without such details.

Some parts of the embodiments, which are shown in the Figures
20 below, have similar parts. The similar parts have the same names or similar part numbers. The description of one similar part also applies by reference to another similar part, where appropriate, thereby reducing repetition of text without limiting the disclosure.

25

Fig. 1 shows a temperature controller 300 for adjusting various temperatures of multiple zones of an injection-moulding machine or a heating system of a tool. The temperature controller 300 includes a control circuit 100 and a control circuit 100', wherein both control circuits 100 and 100' are
30 connected in parallel to a reference voltage supply 200. Parts of the control circuits 100 are similar to parts of the

control circuit 100'. The similar parts are denoted with a prime.

5 In use, the injection-moulding machine is used for shaping molten resin material to form finished moulded parts. The control circuits 100 and 100' are used for controlling different zones or areas of the injection-moulding machine.

10 The temperature controller 300 is provided in a housing having thermal-insulating properties such that the parts of the temperature controller 300 are shielded from environmental conditions of the injection-moulding tool.

15 In a generic sense, the temperature controller 300 can include more control circuits if additional zones for temperature control are desired. The single reference voltage supply 200 can provide a reference voltage for one or more control circuits.

20 The parts of the temperature controller 300 are described below in more detail.

Fig. 2 shows the temperature control circuit 100 of the temperature controller of Fig. 1. The control circuit 100 comprises a control circuit connected to power circuit.

25 The control circuit includes a voltage comparator 12 that is coupled to an optocoupler 28 while the power circuit includes a TRIAC (Triode for Alternating Current) 34 that is coupled to the optocoupler 28. The optocoupler 28 is also known as an optical coupler while the TRIAC 34 is also known as a bidirectional triode thyristor or a bilateral triode thyristor.

The voltage comparator 12 has an inverting input pin 14 and a non-inverting input pin 16 as well as an output pin 18. The output pin 18 is connected to a DC (Direct Current) power source 36 through a resistive-capacitive (RC) circuit 23,
5 which comprises a capacitor 20 and a resistor 22 connected together in parallel. Moreover, the comparator output pin 18 is also connected to an anode pin 25 of a LED (Light Emitting Diode) 24.

10 The optocoupler 28 includes an input pin 26 and an electrical ground pin 27 as well an emitter output pin 30 and a collector output pin 31. The optocoupler input pin 26 is connected to a cathode pin 29 of the LED 24.

15 The TRIAC 34 has a gate pin 32, a Main Terminal One (MT1) pin 44, and a Main Terminal Two (MT2) pin 46, wherein the gate pin 32 is connected to the optocoupler emitter output pin 30. The MT1 pin 44 is connected to the optocoupler collector output pin 31.

20

In practice, the inverting input pin 14 of the voltage comparator 12 is connected to a temperature-sensing device 40 that is attached to a part of an injection-moulding tool or machine, which is not shown in Fig. 2. The temperature-
25 sensing device 40 has a positive temperature coefficient, wherein it produces an electrical voltage that increases when temperature of the temperature-sensing device 40 increases.

The injection-moulding tool is also known as a mould injection tool or a moulding injection tool. The tool is also
30 known as tool or machine. The non-inverting input pin 16 of the voltage comparator 12 is connected to a reference voltage supply 200. The MT1 pin 44 of the TRIAC 34 is connected to an

AC (Alternating Current) power supply 48. The MT2 pin 46 of the TRIAC 34 is connected to a heater 50 of the injection-moulding tool.

5 In one example, the capacitor 20 has a capacitance of about 0.1 microfarad and the resistor 22 has a resistance of about 4.2 kilo-ohms. The collector output pin 31 and the emitter output pin 30 of the optocoupler 28 has a potential difference of about 0.9 volts AC when the optocoupler 28 it is in
10 the ON state and a potential difference of about 230 volts AC when the optocoupler 28 it is in the OFF state. The TRIAC 34 has a gate turn on current of about 2.2 milliamperes.

Operationally, the temperature control circuit 100 is used
15 for adjusting the temperature of the injection-moulding tool. In other words, the control circuit 100 serves a temperature controller of the injection-moulding tool. Specifically, the circuit 100 is used to adjust the temperature of a plastic moulding material that is provided within the injection-
20 moulding machine as well as adjusting the temperature of certain machine components of the injection-moulding machine, such as its mould injection nozzle. The moulding material is also known as a moulding resin material. The temperature adjustment is often done such that the moulding material is in
25 a molten state. The mould injection nozzle feeds the molten moulding material to runners of a moulding assembly, wherein these runners channel the received molten moulding material to a mould cavity of the moulding assembly for shaping the moulding material to produce a desired part.

30

The moulding material includes thermoplastic material or thermosetting material. The thermoplastic material, also known as thermo-softening plastic, refers to a polymer that

turns to a liquid when heated and turns to a glassy state when cooled sufficiently. The thermoplastic polymers can be melted and be moulded repeatedly. In contrast, the thermosetting material, also known as a thermo-set plastic, refers to
5 a polymer material that irreversibly cures. The cure is often done through heat that is generally above 200 degree Celsius, through a chemical reaction such as a two-part epoxy, or through irradiation such as electron beam processing.

10 An accurate temperature control of the moulding material often serves to reduce aesthetic defects of parts produced using the moulding material. These aesthetic defects include weld lines, incorrect dimensions, warping, or poor surface finishing. Certain plastics moulding material, such as Polya-
15 cetal, may even decompose such that it explodes when its temperature falls outside of its operating range.

Referring to the voltage comparator 12, it provides analog to digital simple conversion. The inverting input pin 14 re-
20 ceives a temperature reading or a temperature signal from the temperature-sensing device 40. The non-inverting input pin 16 is used for receiving a reference voltage signal from the reference voltage supply 200. The reference voltage supply 200 often includes a reference-temperature selection circuit
25 that provides different reference voltages according to a user temperature selection.

The voltage comparator 12 compares the voltage of the input pin 14 against the voltage of the input pin 16 to produce a
30 voltage on the output pin 18 in accordance to the comparison. The voltage comparator 12 has an open collector output transistor that is connected to the output pin 18. The collector of the transistor is connected to the RC circuit 23 while the

emitter of the transistor is connected to an electrical ground. In this arrangement, the resistor 22 acts as a pull-up resistor.

5 When the moulding material in the injection-moulding tool is not heated up sufficiently, the temperature-sensing device 40 provides a temperature reading value that is lower than the voltage signal value of the reference voltage supply 200. This causes the output transistor of the comparator 12 to be
10 in an off state, thereby allowing the output pin 18 to provide a high-level voltage. The high-level voltage is generated by a flow of electrical current from the 8 volts DC source 36 through the resistor 22. The electrical current also flows through the LED 24, through the input pin 26, through and to
15 the ground pin 27 of the optocoupler 28 and to an electrical ground. This current flow through the LED 24 also energizes the LED 24, which provides a visibly indication that the TRIAC 34 is activated.

20 In contrast, when the moulding material in the injection-moulding tool has reached the desired temperature or has exceeded the desired temperature, the temperature-sensing device 40 provides a temperature reading value that is equal to or that is higher than the reference-voltage signal value.
25 This causes the output transistor of the comparator 12 to be in on state, which causes the output pin 18 to provide a low-level voltage. The electrical current from the DC source 36 flows through the resistor 22, through the collector of the output transistor, through the emitter of the transistor and
30 to the electrical ground, wherein the electrical current does not energize the LED 24 and the optocoupler 28.

In one example, when the output transistor of the comparator 12 is in the off state, the output pin 18 has a potential of 1.5 volts and electrical current of 8.6 milliamperes flows from the DC source 36 to the LED 24. When the output transis-
5 tor of the comparator 12 is in the on state, the output pin 18 has a potential of 0 volts and electrical current of 0 milliamperes flows from the DC source 36 to the LED 24.

The optocoupler 28 is used to couple electrical signals from
10 the voltage comparator 12 to the TRIAC 34 using an optical means while providing electrical isolation between them. In particular, the optocoupler 28 is energized when the electrical current from the LED 24 flows to the optocoupler input pin 26 and to the optocoupler ground pin 27. The flow also
15 allows electrical current from the AC power supply 48 to flow from the optocoupler-collector output pin 31 to the optocoupler emitter output pin 30 to energise the TRIAC 34. The optocoupler 28 is selected such that the breakdown voltage between the collector output pin 31 and the emitter output
20 pin 30 is able to withstand the voltage of the AC power supply 48.

The AC power supply 48 provides alternating electrical currents of 240 volts. In other words, the movement of electric
25 current periodically reverses direction.

The TRIAC 34 acts as a pair of thyristors connected in anti-parallel with a single gate terminal. An anode of the first thyristor is connected to a cathode of the second thyristor
30 while a cathode of the first thyristor is connected to an anode of the second thyristor. The thyristor here refers to a reverse blocking triode thyristor and is also known as a silicon controlled rectifier. The thyristor acts a switch that

allows conduction of electrical current from its anode terminal to its cathode terminal when its gate terminal receives a triggering signal. In short, the TRIAC 34 acts as a solid-state switching-device.

5

The TRIAC 34 operates between an off state and an on state. In the off state, essentially no electrical current flows between the MT1 pin 44 and the MT2 pin 46. In the on state, electrical current can flow between the MT1 pin 44 and the
10 MT2 pin 46 in either direction while an external circuit that is connected to the TRIAC 46 limits the flow of this electrical current.

A flow of electrical current to or flow the gate pin 32 initiates a latching mechanism within the TRIAC 34 such that the
15 TRIAC 34 is in the on state. This latching mechanism is also known as triggering. This on state of the TRIAC 34 continues even when the flow of electrical current to the gate pin 32 is removed. This continues until the voltage across the MT1
20 pin 44 and the MT2 pin 46 falls below a pre-determined threshold value.

The electrical current is permitted to flow between the AC power supply 48 and the gate pin 32 when the comparator 12
25 energizes the optocoupler 28. In contrast, the electrical current flowing between the MT1 pin 44 and the MT2 pin 46 carries electrical energy from the AC power supply 48 to the heater 50 via the triggered TRIAC 34. The heater 50, in turn, then provides thermal energy to the injection-moulding tool
30 and to the moulding material causing the temperature of the moulding material to increase for achieving its desired temperature.

In one example of the temperature control circuit 100, the TRIAC 34 controls the AC power supply 48 that is capable of providing about 1000 watts and more of electrical power.

5 Fig. 3 shows the reference voltage supply 200 of Fig. 1. The reference voltage supply 200 has a resistor network with switches for a user to select reference voltages.

The reference voltage supply 200 includes a DC power source
10 62 that is connected to a pair of parallel resistive trimmers 64 and 66. The resistive trimmer 64 and 66 are also known as variable resistors. The pair of trimmers 64 and 66 is connected to a first switch 68, which is connected in turn to a second switch 70, wherein the second switch 70 is connected
15 to a plurality 82 of resistors. An output pin 84 is connected to the plurality 82 of resistors.

One end 86 of the first trimmer 64 is connected to the DC power source 62 whilst another end 87 of the first trimmer 64
20 is connected to an input node 89 of the first switch 68. Similarly, one end 90 of the second trimmer 66 is connected to the DC power source 62 whilst another end 91 of the trimmer 66 is connected to another input node 92 of the first switch 68.

25

An output node 93 of the first switch 68 is connected to an input node 95 of the second switch 70. The second switch 70 has further output nodes 97, 98, 99, 102, 103, and 104. Each of the output nodes 97, 98, 99, 102, 103, and 104 is connect-
30 ed to the plurality 82 of resistors, which includes a resistor 72, a resistor 74, a resistor 76, a resistor 78, and a resistor 80. These resistors 72, 74, 76, 78, and 80 have dif-

ferent resistive values for providing different reference voltages.

One end of the resistor 72 is connected to the node 98 whilst
5 another end of the resistor 72 is connected to the output pin
84. In a similar manner, one end of the resistor 74 is con-
nected to the node 99 whilst another end of the resistor 74
is connected to the output pin 84. One end of the resistor 76
is connected to the node 102 whilst another end of the resis-
10 tor 76 is connected to the output pin 84. One end of the re-
sistor 78 is connected to the node 103 whilst another end of
the resistor 78 is connected to the output pin 84. One end of
the resistor 80 is connected to the node 104 whilst another
end of the resistor 80 is connected to the output pin 84.

15

The output pin 84 is also connected to one end of a resistor
106 whilst another end of the resistor 106 is connected to an
electrical ground.

20 Operationally, the reference voltage source 200 provides an
adjustable and switchable voltage divider structure.

The output pin 84 is used for providing a reference voltage
signal. The first and second trimmers 64 and 66 serve as var-
25 iable resistors with a predetermined range of resistance val-
ues, wherein a user may adjust the resistance value for cali-
brating purposes.

The first switch 68 is used for electrically connecting the
30 node 93 to one of the nodes 89 and 92. Similarly, the second
switch 70 is used for connecting the node 95 to one of the
nodes 97, 98, 99, 102, 103, and 104.

One of the first trimmer 64 and the second trimmer 66 with one of the resistors 72, 74, 76, 78, and 80 together with the resistor 106 act as a voltage divider for stepping down the voltage of the DC power source 62 to provide the reference
5 voltage signal of the output pin 84.

In one possible method of using the reference voltage supply 200 is described below. A user adjusts the resistance values of the trimmers 64 and 66 such that these trimmers 64 and 66
10 have the desired resistance values.

The user then rotates the first switch 68 according to different modes of plastic specification. The first switch 68 is rotated such that the node 93 is connected to the node 89
15 that is connected to the trimmer 64 when the injection-moulding tool is in a standby or waiting mode. In the waiting mode, the injection-moulding tool raises the temperature of resin material, which it contains, such that the resin material is ready to be used producing moulded parts. In contrast,
20 the first switch 68 is rotated such that the node 93 is connected to the node 92 that is connected to the trimmer 66 when the injection-moulding tool is in a running or operating mode.

25 After this, the user rotates the second switch 95 according to type of moulding material used in the injection-moulding machine. Put differently, the node 95 of the second switch 95 connects to one of the nodes 97, 98, 99, 102, 103, and 104 according to the type of moulding material used.

30

The output pin 84 provides a reference voltage according to the connected or selected trimmers 64 or 64 and according to the connected resistors 97, 98, 99, 102, 103, or 104.

In short, the combination of one of trimmers 64 and 66 as well as one of resistors 72, 74, 76, 78, or 80 is intended to provide a reference voltage for the voltage comparator 12 of Fig. 2. The reference voltage corresponds to a particular mode of an injection-moulding tool and to a type of moulding material used by the injection-moulding tool.

Any resistance deviation or variation of the resistors 72, 74, 76, 78, or 80 can be eliminated by adjusting the values of the trimmers 64 or 66. A user may measure the values of the trimmers 64 and 66 together with the resistors 72, 74, 76, 78, and 80 using a multi-meter.

In one example of the reference voltage supply 200,
-the DC power source 62 provides about a voltage of 5 volts with an accuracy of 1%,
-the resistive trimmer 64 has a variable resistance ranging from 0 ohms to 100k ohms,
-the resistive trimmer 66 has a variable resistance ranging from 0 ohms to 100k ohms,
-the resistor 72 has a value of 196 kilo-ohms,
-the resistor 74 has a value of 169 kilo-ohms,
-the resistor 76 has a value of 137 kilo-ohms,
-the resistor 78 has a value of 118 kilo-ohms, and
-the resistor 80 has a value of 102 kilo-ohms while
-the resistor 106 has a value of 390 ohms.

The resistors 72, 74, 76, 78, and 80 as well as the resistor 106 have a resistance tolerance of 1%, although other tolerance values, such as 0.1%, 2%, 5%, or 10%, are also possible.

The above trimmer and resistor values have a feature of allowing the reference voltage supply 200 to provide voltage values that are suitable to process different resin material for injection-moulding tool. This is illustrated below.

5

When the injection-moulding machine is processing -acetal polyoxymethylene (POM) material and the injection-moulding machine is in the wait mode, the output pin 84 provides 6.8 mV (millivolts) that corresponds to a temperature of 160 degrees Celsius while in the run mode, the output pin 84 provides 9.6 mV that corresponds to a resin temperature of 210 degrees Celsius;

10

-polypropylene (PP) material, polyethylene (PS) material, or acrylonitrile-butadiene-styrene (ABS) material and the injection-moulding machine is in the wait mode, the output pin 84 provides 7.5 mV that corresponds to a temperature of 170 degrees Celsius while in the run mode, the output pin 84 provides 11.3 mV that corresponds to a resin temperature of 240 degrees;

20

-polyamide (PA) material, polyethylene terephthalate (PET) material, or Polybutylenterephthalat (PBT) material and the injection-moulding machine is in the wait mode, the output pin 84 provides 8.6 mV that corresponds to a temperature of 190 degrees Celsius while in the run mode, the output pin 84 provides 13.6 mV that corresponds to a resin temperature of 280 degrees;

25

-polycarbonate (PC) material or polyphenylene oxide (PPO) material and the injection-moulding machine is in the wait mode, the output pin 84 provides 9.1 mV that corresponds to a temperature of 200 degrees Celsius while in the run mode, the

30

output pin 84 provides 15.7 mV that corresponds to a resin temperature of 320 degrees ; and

-polyphthalamide (PPA) material or Polyphenylene sulfide (PPS) material and the injection-moulding machine is in the wait mode, the output pin 84 provides 10.2 mV that corresponds to a temperature of 220 degrees Celsius while in the run mode, the output pin 84 provides 17.8 mV that corresponds to a resin temperature of 360 degrees.

Other embodiments of the temperature-sensing device 40 are also possible.

Fig. 4 shows an embodiment of the temperature-sensing device 40 of Fig. 2. Fig. 4 depicts an IC (Integrated Circuit) sensor 54 that includes a centigrade temperature sensor 55 connected to a voltage step-down circuit 56.

The centigrade temperature sensor 55 includes a temperature-sensor output node 57. In contrast, the step-down circuit 56 comprises a first resistor 58 and a second resistor 59. One end of the first resistor 58 is connected to the temperature-sensor output node 57 while another end of the first resistor 58 is connected to a step-down output node 60 and to one end of the second resistor 59. Another end of the second resistor 59 is connected to an electrical ground.

In use, the IC sensor 54 acts as a precision integrated-circuit temperature sensor, wherein the temperature sensor produces an electrical signal that corresponds to a temperature of the IC sensor 54. Put differently, the temperature sensor 55 produces an output voltage that is essentially proportional to the surrounding temperature.

In one example of the temperature sensor 55, it produces an output voltage of 10 mV (millivolt) for every degree Centigrade of surrounding temperature sensed by the temperature sensor 55. The temperature sensor 55 requires a supply voltage of ranging from about 4 volts to about 30 volts and it has an operating range from about -55 degree Centigrade to about +150 degree Centigrade. It has generally rectangular body with a length of about 5.2 mm (millimetre), with a width of about 5.2 mm, and with a depth of about 4.2 mm.

The step-down circuit 56 is used for producing a circuit voltage that is 1000 times smaller than the output voltage of the temperature sensor 55. The first resistor 58 has a resistive value of about 10 kilo-ohms and the second resistor 59 has a resistive value of about 10 mega-ohms. These resistive values enable the voltage of the step-down output node 60 to be essentially 1000 times smaller than the voltage of the sensor output node 57.

20

Fig. 5 depicts another embodiment of the temperature-sensing device 40 of Fig. 2. Fig. 5 shows a thermocouple sensor 61 connected to the comparator 12 of Fig. 2. One end of the thermocouple sensor 61 is connected to an electrical ground while another end of the thermocouple sensor 61 is connected to the input 16 of the comparator 12.

The thermocouple sensor 61 produces a voltage that corresponds to ambient temperature. Specifically, the thermocouple sensor 61 includes two wires with dissimilar metal joined together. In one example of the thermocouple sensor 61, it is of the J type that includes iron and constantan material. This thermocouple sensor has an upper operating range of less

than about 760 degrees Celsius with a temperature measurement error of less than about 1.1 degree Celsius or of less than about 0.4 degree Celsius. It produced a voltage ranging from about 5 mV (millivolt) to about 60 mV.

5 4

The comparator 12 receives this sensor voltage as well as reference or threshold voltage for comparison. Resistors R1 and R2, which are shown in the Fig. 5, produces the reference voltage.

10

Fig. 6 shows a further embodiment of the temperature-sensing device 40 of Fig. 2. Fig. 6 shows a Resistance Temperature Detector (RTD) sensor 65 connected to the input 16 of the comparator 12 and to a voltage supply 36 via a resistor R3.

15

The RTD sensor 65 provides electrical resistance or changes of electrical resistance that corresponds to temperature. In this example, the RTD sensor 65 and the resistor R3 form a voltage divider for producing a sensor voltage to the comparator. The sensor voltage corresponds to the temperature of the RTD sensor 65.

20

In a special example, changes of electrical resistance of the RTD sensor 65 are measured using a resistance bridge. This example can be used for measuring temperature that is less than about 600 degrees Celsius.

25

Beside examples of the temperature-sensing device 40 being provided as a thermocouple sensor, as a RTD sensor, or as an Integrated Circuit (IC) sensor, it can also be provided as a thermistor sensor

30

The thermistor sensor serves as a temperature-sensitive resistor that often comprises semiconductor material although it can also comprise ceramic or polymer material. The relationship of thermistor resistance to temperature is often approximated using the Steinhart-Hart equation. In one example of the thermistor, it has a resistance of about 5000 ohms at 25 degrees Celsius with a temperature coefficient of about 4% per degree Celsius. This thermistor sensor has an operating temperature ranging from about -90 degree Celsius to about +130 degree Celsius.

As can be seen above, the temperature-sensing device 40 can include a suitable corresponding circuit to adapt the electrical output signal of the respective sensor to the voltage comparator 12. The circuit may step down or reduce the voltage of the signal such that it is suitable for the voltage comparator 12.

In a broadening sense, the temperature-sensing device 40 can have a negative temperature coefficient, instead of the positive temperature coefficient. In this case, the temperature control circuit 100 should be adapted such that the temperature-sensing device 40 is connected to the comparator non-inverting input pin 169 instead of the comparator inverting input pin 14. Similarly, the reference voltage supply 200 is connected to the comparator inverting input pin 14 instead of the comparator non-inverting input pin 16.

Different embodiments of the optocoupler 28 of Fig. 2 are possible.

Fig. 7 depicts a first embodiment of the optocoupler 28 of Fig. 1. Fig. 7 shows an optocoupler 37 that includes an LED

51 and a phototransistor 53. The input pin 26 of the optocoupler 37 is connected to an anode of the LED 51 while the ground pin 27 is connected to a cathode of the LED 51. The collector output pin 31 is connected to a collector of the phototransistor 53 and the emitter output pin 30 is connected to an emitter of the phototransistor 53.

In use, the input pin 26 is used for receiving the voltage signal of the output pin 18 of the comparator 12 of Fig. 2. A high-level voltage from the comparator output pin 18 would energise the LED 51 to produce light rays. These light rays activate the phototransistor 53 such that electrical current is allowed to flow from the collector output pin 31 to the emitter output pin 30.

15

Fig. 8 shows a second embodiment of the optocoupler 28 of Fig. 1. Fig. 8 illustrates an optocoupler 38. The optocoupler 38 includes parts of the optocoupler 37 of Fig. 7, wherein the phototransistor 53 of the optocoupler 37 is replaced with a phototriac 39. The phototriac 39 is activated, in the same manner as the phototransistor 53, by the phototransistor 53. This activation allows electrical current is allowed to flow from the output pin 31 of the phototriac 39 to the output pin 30 of the phototriac 39.

25

Fig. 9 shows electrical waveform diagrams 51 for the TRIAC 34 of the control circuit 100 of Fig. 2 when the comparator 12 energises the optocoupler 28. This energised optocoupler 28 places the TRIAC 34 in an on state in a manner that is described below.

30

Fig. 9 depicts an alternating supply voltage 52 that is provided by the AC power supply 48 of Fig. 2. At a beginning

part of a first positive half voltage cycle of the AC power supply 48, the TRIAC 34 is in off state. The beginning part extends from phase angle 0 degrees to phase angle δ (delta) of the AC power voltage cycle. The voltage of the AC power supply 48 is applied across the TRIAC 34. No electrical current is conducted through the TRIAC 44.

After a short time, at phase angle δ (delta), a positive voltage of the supply voltage 52 causes or induces an electrical current to flow from the AC power supply 48 to the optocoupler 28 and to the gate pin 32 of the TRIAC 34. This flow of electrical current to the gate pin 32 triggers or latches the TRIAC 34 such that the TRIAC 34 is in the on state. In this on state, the TRIAC 34 conducts electrical current from the AC power supply 48 via the MT1 pin 44 to the heater 50 via the MT2 pin 46. The voltage across the TRIAC 34 between the MT1 pin 44 and the MT2 pin 46 falls to about zero volts during this current conduction while the voltage of the AC power supply 48 is applied across the heater 50.

20

This on state of the TRIAC 34 continues for the rest of the first positive half cycle until the electrical current to the gate pin 32 falls below a pre-determined holding value and the voltage across the MT1 pin 44 and the MT2 pin 46 falls below a pre-determined threshold value.

At about phase angle 180 degrees, the TRIAC 34 is placed in the off state. Similar to the earlier description, the voltage of the AC power supply 48 is applied across the TRIAC 34 while no electrical current is conducted through the MT1 pin 44 and the MT2 pin 46 of the TRIAC 34.

The TRIAC 34 is triggered again at phase angle $(180 + \delta)$ degrees. At this point, the negative voltage of the AC power supply 48 across the TRIAC 34 causes a flow of electrical current from the gate pin 32 to the AC power supply 48 via
5 the optocoupler 28. This also causes the TRIAC 34 to be triggered or latched and to be placed in the on state. The TRIAC 34 conducts electrical current for the rest of the first negative half-cycle in the reverse direction in a similar manner until the electrical current from the gate pin 32 falls below
10 a pre-determined holding value and the voltage across the MT1 pin 44 and the MT2 pin 46 falls below a pre-determined threshold value.

The above steps repeat for the subsequent power cycles of the
15 AC power supply 48.

In short, the TRIAC 34 is configured in an auto-triggering or self-triggering mode. The TRIAC 34 is enabled by the optocoupler 28 while the optocoupler 28 is responsive to the output
20 voltage of the voltage comparator 12. No auxiliary power is necessary for triggering the TRIAC 34.

If the output voltage of the voltage comparator 12 has a high level, the DC power source 36 would electrically power the
25 optocoupler 28 such that the optocoupler 28 enables the auto-triggering mechanism for the TRIAC 34. The triggered TRIAC 34 is in the on state that allows the energy from the AC power-supply 48 to flow to the heater 50 via the TRIAC 34.

30 In contrast, if the output voltage of the voltage comparator 12 has a low level, the electrical current from the DC power source 36 is shunted to the electrical ground without flowing into the optocoupler 28 and without energising the optocou-

pler 28. This causes the TRIAC 34 to be in the off state. Accordingly, the energy from the AC power-supply 48 would not flow to the heater 50.

5 This configuration of the optocoupler 28 with the TRIAC 34 has a feature of consuming low electrical power.

Fig. 10 shows a casing 590 for the temperature controller 300. The casing 590 has a shape of a rectangular block with a
10 width of about 60 mm (millimetre), with a height of about 98 mm, and with a depth of about 30 mm.

The parts of the temperature controller 300 allow the temperature controller 300 to be housed or contained in this small
15 casing 590. This small size, in turn, enables the temperature controller 300 to be placed near a temperature-sensing device of an injection-moulding apparatus. Only short wires are then needed for connecting the temperature-sensing device to the temperature controller 300. The short wires pick up less
20 electrical noise, thereby improving signal to noise ratio and quality of temperature control. In short, the casing 590 allows the controller 300 to provide an improved temperature control. This is unlike other temperature controllers that use relays and transformer circuits.

25

Fig. 11 shows different views an embodiment a mould assembly of an injection-moulding machine. Fig. 11 depicts a mould assembly 553. The temperature controller 300 of Fig. 1 is mounted in the mould assembly 553.

30

The injection-moulding machine includes a mould injection apparatus that is positioned next to the mould assembly 553. The mould injection apparatus is not shown in Fig. 11.

The mould injection apparatus includes a supply nozzle with a screw mechanism. The supply nozzle has an internal cavity and it is positioned next to the mould assembly 553.

5

Referring to the mould assembly 553, it includes a manifold assembly 559 being placed between a moulding plate 561 and a back plate 562.

10 The back plate 562 has a receiving cavity 570, wherein an outlet of the supply nozzle of the mould injection apparatus is provided in the receiving cavity 570.

The back plate 562 is fastened to the moulding plate 561 by a
15 suitable number of screws while several spacer blocks 568 are positioned between the back plate 562 and the moulding plate 561 to separate them. This separation also provides a space 569, wherein the temperature controller 300 and the manifold assembly 559 are positioned.

20

Several insulator spacers are provided between the back plate 562 and the manifold assembly 559 to keep the back plate 562 from contacting the manifold assembly 559. These insulator spacers are not shown in Fig. 11.

25

The spacer blocks 568 and the moulding plate 561 have openings or cavities. These cavities are provided with multiple cavity nozzles 577, which are connected to the manifold assembly 559.

30

Several stationary moulds or dies 578 are also provided in the cavities of the moulding plate 561. The moulding plate 561 clamps the stationary dies 578 against the spacer blocks

568. Outlets of the cavity nozzles 577 protrude into the stationary dies 578.

5 The manifold assembly 559 includes a network of passages or runners 586. The runners 586 connect the receiving cavity 570 of the back plate 562 to the stationary dies 578 via the cavity nozzles 577.

10 A plurality of heaters with corresponding sensors is attached to the cavity nozzles 577. The heaters and the corresponding sensors 582 are connected to the temperature controller 300 by wires 584. The heaters and sensors are not shown in Fig. 11.

15 In a general sense, the heaters and their sensor can also be connected to the manifold assembly 559.

20 In operation, the screw mechanism is used for receiving a moulding resin material and for introducing the moulding resin material to the internal cavity of the supply nozzle. The supply nozzle is heated such that the moulding resin material melts and changes to a molten state.

25 The screw mechanism is also used for pushing the molten resin material out of the supply nozzle and into the receiving cavity of the back plate 562.

30 The runners 586 of the manifold assembly 559 are used for transferring the resin material from the receiving cavity to the cavity nozzles 577.

The sensors are used for sending temperature of the cavity nozzles 577 to the temperature controller 300. The tempera-

ture controller 300 uses the heaters to control the temperature of the cavity nozzles 577 according to the received temperature readings of the sensors.

5 In a closed state, the stationary dies 578 together movable dies of the mould assembly 553 forms internal moulding cavities. The temperature of the resin material often changes as it passes through the runners 586. The cavity nozzles 577 are near to the internal moulding cavities, which shape the resin
10 material to form a final product. It is important that the temperature of the cavity nozzles 577 be controlled accurately and timely such that the resin material temperature at the internal moulding cavities is at the desired temperature.

15 The temperature controller 300, as it is positioned in the space 569 between the back plate 562 and the moulding plate 561, is close to the heaters and the sensors. The short distance allows no loss or a small loss of signal to enable the required accurate control of the said temperature.

20

Fig. 12 shows a schematic of a controller system 600 that includes the temperature controller of Fig. 1.

The controller system 600 includes a first control module 603
25 for a mould assembly 605 and a second control module 607 for an injection-moulding apparatus 609. The first control module 603 is communicatively connected to the second control module 607 via a wireless means.

30 The first control module 603 includes a reference voltage supply 610, a nozzle control circuit 612, and a transmitter module 614. An output node 616 of the reference voltage supply 610 is connected to a first input node 618 of the nozzle

control circuit 612 and to a first input node 619 of the transmitter module 614. A second input node 621 of the nozzle control circuit 612 is connected to a second input node 623 of the transmitter module 614 and to an output node 625 of a
5 temperature-sensing device 627 of the mould assembly 605. An output node 629 of the nozzle control circuit 612 is connected to a nozzle heater module 631 of the mould assembly 605.

The transmitter module 614 includes a first analog to digital
10 converter (ADC) 632 and a second ADC 634 together with a wireless transmitter device 636. The first input node 619 of the transmitter module 614 is connected to an input port 638 of the first ADC 632 while the second input node 623 of the transmitter module 614 is connected to an input port 640 of
15 the second ADC 634. An output port 642 of the first ADC 632 and an output port 644 of the second ADC 634 are connected to an input port 646 of the transmitter device 636. An output port 648 of the transmitter device 636 is connected to a transmitter antenna 650.

20

Referring to the second control module 607, it includes a receiver module 655 and a barrel heater controller 657. The receiver module 655 includes a wireless receiver device 658 and a receiver antenna 660. The receiver antenna 660 is communi-
25 catively connected to the transmitter antenna 650 of the transmitter device 636. It is also electrically connected to an input port 662 of the receiver module 655. An output port 665 of the receiver module 655 is connected to an input port 667 of the barrel heater controller 657 while an output port
30 669 of the barrel heater controller 657 is connected to a barrel heater module 671 of the injection-moulding apparatus 609.

In a generic sense, the first control module 603 can be communicatively connected to the second control module 607 via a wired means, instead of a wireless means.

5 In use, the second control module 607 is using for adjusting a temperature of a barrel of the injection-moulding apparatus 609. The barrel is not shown in the Fig. 12 for the sake of simplicity. The barrel is used for received a moulding resin material, which is in a solid granular form. The barrel is
10 also intended for melting this resin material such that the resin material can be injected or transferred to the mould assembly 605. The temperature adjustment of the barrel is done in accordance with information received from the first control module 603.

15

The first control module 603 is used for adjusting a temperature of an injection nozzle of the mould assembly 605. The injection nozzle is not shown in the Fig. 12 for the sake of simplicity. The injection nozzle is used for heating the cer-
20 tain resin material received by the mould assembly 605 and for pushing or channelling this resin material into a moulding cavity of the mould assembly 605.

The temperature control of the molten resin material within
25 the injection-moulding apparatus 609 is important. Under normal operating conditions, the injection nozzle of the moulding assembly 605 has only a short time to heat the resin material within the moulding apparatus 609 such that it reach its desired temperature without significant temperature over-
30 shoot. Thus, it is important the moulding assembly 605 receives resin material with a desired temperature.

Referring to the first control module 603, the temperature-sensing device 62 is used for providing temperature information of the injection nozzle of the mould assembly 605 to the nozzle control circuit 612.

5

The reference voltage supply 610 is used for providing reference electrical signal information to the nozzle control circuit 612 in accordance to operating condition or mode of the mould assembly 605 and in accordance to the type of resin material within the mould assembly 605.

10

The nozzle control circuit 612 acts in a manner that is similar to the control circuit of Fig. 2. The nozzle control circuit 612 is used for adjusting electrical power or energy from an external source to the nozzle heater module 631 according to the above-mentioned received information. The nozzle heater module 631 is used for receiving the above electrical energy and for using this energy to heat the injection nozzle of the mould assembly 605.

20

The first ADC 632 is used for receiving the reference electrical signal information and for converting this received information into a digital format. Similarly, the second ADC 634 is used for receiving the temperature-sensing device temperature information and for converting the received information into the digital format.

25

The transmitter device 636 is used for receiving the above-mentioned digital information of the first ADC 632 and the above-mentioned digital information of the second ADC 634. The transmitter device 636 is also used for sending the received information to the receiver module 655 via the transmitter antenna 650 and via the receiver antenna 660.

30

Referring to the second control module 607, the receiver module 655 is used transmitting the information that is received from the transmitter device 636 to the barrel heater controller 657.

The barrel heater module 671 is used for receiving the electrical energy and for converting the received electrical energy to heat energy for elevating the temperature of the barrel of the injection-moulding apparatus 609.

The barrel heater controller 657 is used for adjusting electrical energy from an external source to the barrel heater module 671 according to the received reference electrical signal information and according to the received temperature-sensing device temperature information.

When the temperature-sensing device temperature information can be close to or is greater than the reference electrical signal information, this indicates that the temperature of the molten resin material within the injection-moulding apparatus 609 is at a desired value. The barrel heater controller 657 does not need to elevate further the temperature of the barrel of the injection-moulding apparatus 609.

When the temperature-sensing device temperature information is less than the reference electrical signal information, this indicates that the temperature of the molten resin material within the injection-moulding apparatus 609 is less than the desired value. The barrel heater controller 657 then elevates the temperature of the barrel of the injection-moulding apparatus 609.

The use of the received reference electrical signal information and the received temperature-sensing device temperature information for temperature control of the injection-moulding apparatus 609 has a feature of providing a temperature control loop between the moulding assembly 605 and the injection-moulding apparatus 609. Put differently, rather than functioning alone, the second control module 607 uses information from the moulding assembly 605 to provide an improved temperature control of the injection-moulding apparatus 609.

A method of controlling temperature resin material for the moulding assembly 605 is described below.

The method includes a step of the temperature-sensing device 627 sending the temperature information of the injection nozzle of the mould assembly 605 to the nozzle control circuit 612 and to the transmitter device 636 of the first control module 603. The method also includes the step of the reference voltage supply 610 sending the reference electrical signal information to the nozzle control circuit 612 and to the transmitter device 636.

The nozzle control circuit 612 then adjusts electrical power or energy from an external source to the nozzle heater module 631 according to the above-received information. This enables resin material within injection nozzle of the mould assembly 605 to be heated such that the resin material is at an appropriate temperature.

30

In the meantime, the transmitter module 614 also receives the above-mentioned information. The transmitter module 614 later converts the received information to the digital form for

transmitting to the barrel heater controller 657 via the receiver module 655.

5 The barrel heater controller 657 afterward adjusts electrical energy from an external source to the barrel heater module 671 according to this transmitted information.

10 If the transmitted information indicates the resin material within injection nozzle of the mould assembly 605 is not hot enough, the barrel heater controller 657 increases the temperature of the resin material within the barrel of the injection-moulding apparatus 609. The resin material with the barrel is intended for injecting to the mould assembly 605.

15 Figs. 13 to 16 provide an example of the above steps for illustration purposes. In this example, an injection-moulding machine uses the controller system of Fig. 12. The injection-moulding machine includes a mould assembly that receives molten resin material from an injection-moulding apparatus. The
20 said controller system includes a temperature controller that adjusts the temperature of the injection-moulding apparatus in accordance to the temperature of the mould assembly.

Fig. 13 shows a temperature graph 677 of the mould assembly.
25 The temperature graph 677 includes a mould assembly reference temperature line 678 and a mould assembly temperature line 679. Both the temperature lines 678 and 679 extend from time-point t0 to time-point t1, to time-point t2, and to time-point t3.

30

A mould assembly temperature upper control line 680 is provided above the reference temperature line 678 while a mould assembly temperature lower control line 681 is provided below

the reference temperature line 678. The upper control line 680 is separated from the reference temperature line 678 by a fixed distance while the lower control line 681 is separated from the reference temperature line 678 by a fixed distance.

5 The upper control line 680 and the lower control line 681 enclose or border an area, known as a mould assembly temperature control band.

In use, the mould assembly temperature control band denotes
10 an area of temperature adjustment by the mould assembly temperature controller. In other words, the mould assembly temperature controller is designed for adjusting a temperature of the mould assembly that is within the mould assembly temperature control band.

15

Fig. 14 shows a heater status graph 682 of the above-mentioned mould assembly. The mould assembly heater status graph 682 includes a mould assembly heater status line 683 that fluctuates between an on state and an off state. In the
20 on state, the heater of the mould assembly is energised while in the off state, the heater of is disabled.

In use, a mould assembly temperature controller changes the state of the heater of the mould assembly such that the temperature of the mould assembly remains at or near to the reference temperature of the mould assembly. The heater of the
25 mould assembly is used for injecting heat energy into the mould assembly for elevating the temperature of the mould assembly. The mould assembly also acts to dissipate heat by
30 conduction and by dissipation.

Referring to Figs. 13 and 14, between the time-points t_0 and t_1 , the mould assembly temperature line 679 is above the

mould assembly temperature upper control line 680, which indicates that the mould assembly temperature is too high. The mould assembly heater is in the off state such that the mould assembly heater does not release heat energy into the mould assembly.

Between the time-points t_1 and t_2 , and after the time-point 3, the mould assembly temperature line 678 falls within the mould assembly temperature control band. The mould assembly temperature controller adjusts the mould assembly heater such that the mould assembly heater injects an amount of heat into the mould assembly that is about the same as the amount of heat dissipated. This allows the temperature of the mould assembly to remain about the mould assembly reference temperature.

Between the time-points t_2 and t_3 , the mould assembly temperature line 679 is below the mould assembly temperature lower control line 681. This indicates that the temperature of the mould assembly is too low. Thus, the mould assembly heater is set constantly in the on state, as shown by the mould assembly heater status line 683. This allows the mould assembly heater to inject maximum possible amount of heat energy into the mould assembly.

25

Fig. 15 shows a temperature graph 684 of the injection-moulding apparatus. The injection-moulding apparatus temperature graph 684 includes an adjustable reference temperature line 685 and an injection-moulding apparatus temperature line 686. The temperature line 685 is adjusted in accordance to values of the mould assembly temperature line 678.

30

An injection-moulding apparatus temperature upper control line 687 is provided above the reference temperature line 685 and it is separated from the reference temperature line 685 by a fixed distance. Similarly, an injection-moulding apparatus temperature lower control line 688 is provided below the reference temperature line 685 and it is separated from the reference temperature line 685 by a fixed distance. The upper control line 687 and the lower control line 688 enclose or border an area called an injection-moulding apparatus temperature control band.

The injection-moulding apparatus temperature control band denotes a temperature area of the injection-moulding apparatus, wherein the injection-moulding apparatus temperature controller is designed for adjusting.

In practice, the reference temperature is provided by a reference voltage supply with a resistance selector switch. The reference temperature is adjusted by changing positions of the resistance selector switch.

Fig. 16 shows a heater status graph 689 of the above-mentioned injection-moulding apparatus. The injection-moulding apparatus heater status graph 689 includes an injection-moulding apparatus heater status line 690. This status line 690 fluctuates between an on state and an off state. In the on state, the injection-moulding apparatus heater is energised while in the off state, the said heater is disabled.

In use, the injection-moulding apparatus temperature controller changes the state of the heater of the injection-moulding apparatus such that the temperature of the injection-moulding

apparatus remains at or near to the reference temperature of the injection-moulding apparatus.

Furthermore, the injection-moulding apparatus temperature
5 controller adjusts the reference temperature of the injection-moulding apparatus according to information shown by the mould assembly temperature graph 677.

This temperature adjustment by the injection-moulding apparatus temperature controller complements, assists, and improves the temperature control of the mould assembly by the
10 mould assembly temperature controller.

Referring to Figs. 15 and 16 and referring to a period between the time-points t_0 and t_1 , the injection-moulding apparatus temperature line 686 falls within the temperature control band of the injection-moulding apparatus.
15

The injection-moulding heater status line 690 fluctuates between the on state and the off state for injecting a certain amount of heat into the injection-moulding apparatus. The amount of injected heat is related to a period or a duration of the on state. The injected heat is dissipated from the injection-moulding apparatus by conduction and by radiation. In
20 this case, the amount of injected heat is about the same as the amount of dissipated heat such that the temperature of the injection-moulding apparatus remains within the injection-moulding apparatus temperature control band.
25

Between the time-points t_1 to t_2 , the injection-moulding temperature controller receives temperature information of the mould assembly, which indicates that the mould assembly temperature is too high. In accordance to this information, the
30

injection-moulding apparatus temperature controller changes the reference temperature of the injection-moulding apparatus. This is shown by a transition of the reference temperature line 685 to a lower level.

5

Following the lowering of the reference temperature line 685, the injection-moulding apparatus temperature controller adjusts the heater of the injection-moulding apparatus such that the amount of injected heat is less in order that the temperature of the injection-moulding apparatus is also lowered. This also leads to a resin material within the injection-moulding apparatus being cooler. This cooler resin material is later injected into the mould assembly, wherein the resin material serves to cool the mould assembly.

15

Between the time-points t_2 and t_3 , the reference temperature line 685 remains constant at the lower level. The injection-moulding apparatus temperature controller also adjusts its heater such that the heat injected by the heater allows the temperature of the injection-moulding apparatus to remain also at or near the lowered reference temperature.

Following this, after the time-point t_3 , the injection-moulding temperature controller receives temperature information of the mould assembly, which indicates that the mould assembly temperature is too low. The injection-moulding temperature controller then adjusts the reference temperature line 685 upwards according to the received temperature information.

30

The temperature controller of the injection-moulding apparatus temperature controller then adjusted its heater for raising the temperature of the injection-moulding apparatus

to the higher reference temperature. This also causes the temperature of the resin material within the injection-moulding apparatus to increase. The hotter resin material is later injected to the moulding assembly in which the hotter
5 resin material acts to increase the temperature of the moulding assembly.

In this manner, the injection-moulding apparatus temperature controller adjusts its temperature according to the mould as-
10 sembly temperature and thus provides a closed temperature control loop between the mould assembly and the injection-moulding apparatus for improving temperature control of the injection-moulding machine.

15 In a special embodiment of Fig. 12, the controller system 600 further includes a robotic arm controller 674. The output port 665 of the receiver module 655 is connected to an input port 673 of the robotic arm controller 674. An output port 676 of the robotic arm controller 674 is connected to a ro-
20 botic arm unit 691.

In use, the robotic arm controller 674 is used to move the robotic arm unit 691 for removing finished moulded parts from the moulding assembly 605 and for placing the finished mould-
25 ed parts into different bins or buckets. The robotic arm controller 674 selects the respective bin in accordance to the temperature information of the temperature-sensing device 627 and in accordance to the reference electrical signal information of the reference voltage supply 610.

30

The finished moulded parts are placed into a special bin for later consideration when the temperature information and the reference electrical signal information are different from a

desired set of information. In other words, the finished moulded are not considered produced under desired or normal conditions and further study may be needed for disposing these parts.

5

Fig. 17 shows a flow chart 692 with steps of one possible method for binning finished moulded parts using information from the controller system of Fig. 12.

10 The method includes a step 693 of receiving temperature information of the temperature-sensing device 627 and a step 697 of receiving reference electrical signal information of the reference voltage supply 610. The received temperature information and the received reference electrical signal in-
15 formation are then compared against expected or against desired information in a step 695.

If the received information does not meet the desired information, the robotic arm unit 691 transfers or moves the finished parts to a special bin for later inspection. This is
20 shown in step 696. Afterwards, an operator inspects parts in this bin for disposing them.

In contrast, if the received information meets expectation as
25 described in the desired information, the robotic arm unit 691 channels the finished parts to a good part bin, which is shown in step 697.

Fig. 18 shows a variation of the injection-moulding machine
30 of Fig. 11. Fig. 18 shows an injection-moulding machine 400 with the temperature controller 300 of Fig. 1. The injection-moulding machine 400 has a mould injection apparatus 410 positioned next to a mould assembly 413.

The mould assembly 413 includes a stationary mould 417 positioned next to a moveable mould 419, which is attached to a moving apparatus 422. In comparison, the mould injection apparatus 410 includes a nozzle 425 with a screw mechanism 430. The nozzle 425 is positioned next to the stationary mould 417. The nozzle 425 has an internal cavity 428 and two heater elements 433 and 435 with two corresponding temperature sensors 437 and 439. The heater elements 433 and 435 and the temperature sensors 437 and 439 are mounted on an external surface of the nozzle 425.

The temperature controller 300 includes the control circuit 100 and 100' in which both control circuit 100 and 100' are connected to the reference voltage supply 200.

Referring to the control circuit 100', the MT2 pin 46' is connected to the heater element 433 via a wire 442 whilst the sensor voltage input pin 14' is connected to the temperature sensor 437 via a wire 444. The reference voltage input pin 16' is connected to the output pin 84 of reference voltage supply 200.

Similarly, with reference to the control circuit 100, the MT2 pin 46 is connected to the heater element 435 via wire 446 whilst the sensor voltage input pin 14 is connected to the temperature sensor 439 via a wire 448. The reference voltage input pin 16 is connected to the output pin 84 of reference voltage supply 200.

30

In one embodiment, the wires 442, 444, 446, and 448 have a length of less than 0.3 meter. The sensor voltage input 14

and 14' receive voltages ranging from about 8 mV (millivolts) to about 50 mV or from about 8 mV to about 28 mV.

5 In use, the injection-moulding machine 400 is used for producing plastic moulded parts while the temperature controller 300 is used for controlling the temperature of the injection-moulding machine 400.

10 The mould injection apparatus 410 is used for receiving a moulding resin material and for melting the resin material. The screw mechanism 430 is used for pushing the resin material towards the internal cavity 428 of the nozzle 425.

15 The temperature sensors 437 and 439 are used for sending sensor voltages of the nozzle 425 to the control circuits 100 and 100'. The sensor voltages carry temperature information.

20 The reference voltage supply 200 is used for receiving a reference voltage selection or input from a user and for providing a reference voltage signal according to the selection for the control circuits 100 and 100'. The user selects the reference voltage input according to the mode of the injection-moulding machine 400 and to the type of moulding resin material used by the injection-moulding machine 400.

25

The control circuits 100 and 100' are also used for receiving the reference voltage from the reference voltage supply 200 and the temperature sensor voltages from the temperature sensors 437 and 439. The control circuits 100 and 100' then adjust provision of energy or of electrical power to the heater elements 433 and 435 according to differences between the received reference voltage and the received temperature sensor voltages.

30

The heater elements 433 and 435 are used for receiving the above-mentioned energy or electrical power. The energy is intended to raise the temperature of the resin material within the nozzle 425 to a desired pre-determined temperature, wherein the resin material is in a molten state.

The screw mechanism 430 is also used for pushing the molten resin material out of the nozzle 425 and into the mould assembly 413.

The moving apparatus 422 is used for positioning the moveable mould 419 with the stationary mould 417 such that the moveable mould 419 and the stationary mould 417 forms a cavity for receiving the molten resin material from the nozzle 425. The cavity also shapes the molten resin material to form a desired part.

Fig. 19 shows another embodiment, which is a further variation of the temperature control circuit 100 of Fig. 2. Fig. 19 depicts a temperature control circuit 520. The control circuits 520 and 100 include similar parts that have the same part numbers.

The control circuit 520 comprises a thyristor 525 that replaces the TRIAC 34 of the control circuit 100. The thyristor 525 has an anode terminal 527 and a cathode terminal 528 with a gate terminal 530.

In use, this thyristor 525 serves as reverse blocking triode thyristor. The thyristor 525 operates between an on state and an off state. In the off state, the thyristor 525 essentially does not conduct electrical current between the anode termi-

nal 527 and the cathode terminal 528. In contrast, in the on state, an electrical current flows from the anode terminal 527 to the cathode terminal 528.

5 The thyristor 525 can be placed in the on state by a signal at the gate terminal 530 and it will be automatically turned off by the reversal of flow of electrical current in each voltage cycle of the AC power supply 48. While the temperature control circuit 100 with a TRIAC provides a full wave
10 control of the power supply 48, the control circuit 520 provides a half wave control only.

Fig. 20 shows electrical waveform diagrams 535 for the thyristor 525 of the temperature control circuit 520 of Fig. 19
15 when the optocoupler 28 is energised.

Referring to Figs. 11 and 12, an alternating supply voltage 537 of the AC power supply 48 is applied to the anode terminal 527 of the thyristor 525.

20

At a beginning part of the first positive half cycle of an alternating supply voltage 52 when the phase angle of the supply voltage 52 is less than angle δ (delta) degrees, the thyristor 525 is the off state is and it is not triggered.
25 Put differently, no triggering signal is applied to the gate terminal 530 of the thyristor 525. Under these conditions, the thyristor 525 does not conduct electrical current and the voltage of the AC power supply 48 is applied across the thyristor 525.

30

At the phase angle δ (delta) degrees, the positive voltage of the power supply 48 causes an electrical current to flow from the power supply 48 to the collector output pin 31, to the

emitter pin 30 and to the gate terminal 530. This flow of electrical current triggers or latches the thyristor 525 such that the thyristor 525 is in the on state. This allows the thyristor 525 to conduct electrical current from the AC power supply 48 to the heater 50. The voltage across the thyristor 525 falls to about zero volts while the supply voltage of the power supply 48 is applied across the heater 50. This conduction of electrical current continues for the rest of the first positive half cycle until the anode current of the thyristor 525 falls below a particular holding current at about the phase angle of about 180 degrees.

This non-conduction of electrical current by the thyristor 525 continues until the thyristor 525 is triggered again at angle $(360 + \delta)$ degrees.

The configuration of the optocoupler 28 as a switch between the anode terminal 527 and the gate terminal 530 of the thyristor 525 provides a very small angle δ (delta), which is essentially constant over time. Almost immediately after rising from zero, the supply-voltage would auto-trigger the thyristor 525 if only the LED 51 turns on the optocoupler 28.

Fig. 21 shows a further embodiment, which is a variation of the temperature control circuit 100 of Fig. 2. Fig. 21 depicts a temperature control circuit 500. The control circuits 100 and 500 have similar parts. The similar parts have the same part numbers.

The control circuit 500 has an electrical current comparator 502 that replaces the voltage comparator 12 of Fig. 2. The current comparator 502 has an inverting input pin 505 and a non-inverting input pin 506 with an output pin 507.

The current comparator 502 includes a voltage comparator 592 with a first resistor 594 and a second resistor 596. One end of the first resistor 594 is connected to the inverting input 505 and to an inverting input pin of the voltage comparator 592. Another end of the first resistor is connected to an electrical ground. Similarly, one end of the second resistor 596 is connected to the non-inverting input 506 and to a non-inverting input pin of the voltage comparator 592. Another end of the second resistor 596 is connected to an electrical ground.

In application, the non-inverting input pin 506 is connected to an electrical current reference supply 509 while the non-inverting input pin 506 is connected to an electrical current temperature-sensing device 511.

In one implementation of the temperature control circuit 500, the electrical current temperature-sensing device 511 produces an output electrical current proportional to absolute temperature while exhibiting an output impedance of greater than 10 mega-ohms. It operates with a supply voltage ranging from 4 volts to 30 volts. After calibration, it produces 298.2 microamperes at a temperature of 298.2 Kelvin, which is 25 degrees Celsius, and it can be used to measure a temperature of not more than 150 degrees Celsius.

Operationally, the electrical current reference supply 509 provides a reference electrical current as selected by a user according to an operation mode of a moulding-injecting machine and to a type of moulding material processed by the moulding-injecting machine. The electrical current temperature-sensing device 511 provides an electrical current corre-

sponding to a temperature of the mould-injecting machine. The current comparator 502 provides a comparison signal according to a comparison between the reference electrical current and the electrical current of the temperature-sensing device 511.

5 The control circuit 500 changes electrical power to the heater 50 according to the comparison signal.

Referring to the current comparator 502, the first resistor 594 is used for converting the reference electrical current
10 to a reference voltage for the voltage comparator 592. The second resistor 596 is used for converting the electrical current of the temperature-sensing device 511 for the voltage comparator 592. The voltage comparator 592 is used for providing the comparison signal.

15

In this implementation, the comparison signal refers to a voltage signal although it can also refer to an electrical current signal.

20 Fig. 22 shows a variation of the comparator 12 of Fig. 2 that includes a hysteresis module. Fig. 22 depicts a comparator device 700.

The comparator device 700 includes a comparator 702 with a
25 non-inverting input node 704, an inverting node input 706 and an output node 707.

The hysteresis module has a first resistor 709 and a second resistor 713. One end of the first resistor 709 is connected
30 to a first input pin 711 while another end of the first resistor is connected to the non-inverting node 704 and to one end of the second resistor 713. Another end of the second resistor 713 is connected to the output node 707. In contrast,

the inverting node input 706 is connected to a second input pin 715.

In use, the resistors 709 and 713 serve as a positive feed-
5 back circuit. The input pin 713 is used for receiving measurement voltages while the input pin 711 is used for receiving a reference voltage

Fig. 23 shows a diagram of relationship between input voltages
10 and output voltages of the comparator 700 of Fig. 22.

On one hand, when the measurement voltage increases and approaches the reference voltage from the negative direction, the hysteresis module allows the comparator 702 to change
15 state when the measurement voltage exceeds the reference voltage by a pre-determined value. On another hand, when the measurement voltage approaches the reference voltage from the positive direction, the hysteresis module allows the comparator 702 to change state when the measurement voltage falls
20 below the reference voltage by a pre-determined value. In this manner, noise near the reference voltage level would not cause the comparator 702 to change state.

This module is especially important for preventing the comparator 702 from changing state when the measurement voltage
25 is close to the reference voltage.

Fig. 24 shows a variation of the comparator 12 of Fig. 2 that includes a sample and hold module. Fig. 24 depicts a comparator device 720 comprising a comparator 723 with a first sample and hold module 725 and with a second sample and hold
30 module 727 at its input terminal. The sample and hold modules 725 and 727 have similar parts.

The sample and hold module 725 includes a first capacitor 729 connected to a first switch 731 and to a first input pin of the comparator 723.

5

In use, the module 725 operates between a sampling mode and a holding mode. In the sampling mode, the switch 731 connects the 729 capacitor to an input signal, wherein the input signal charges or discharges the capacitor 729 such that the

10 voltage across the capacitor 729 practically is equal to or is proportional to the input signal. In holding mode, the switch 731 disconnects the capacitor 729 from the input signal. The capacitor 729 produces a voltage corresponding to its stored electrical charge. The input pin of the comparator
15 723 experiences this produced voltage.

In short, the sample and hold modules 725 and 727 measure voltages of the input signal by storing electrical charges that correspond to voltages of the input signal for a period.

20 The modules then produce a voltage corresponding to the stored charge for a period.

The sample and hold module has a feature of preventing variations of an input signal that may affect the comparator.

25

In a general sense, a comparator can have both the sample and hold module as well as the hysteresis module.

Fig. 25 shows an injection-moulding machine 800 with an improved pressure controller. The injection-moulding machine
30 800 includes a die assembly 812 that operates with a mould injection apparatus 811, which is fixed to a machine bed 833. The term "die" is also known as "mould" or "mold".

The die assembly 812 includes a stationary die 813 and a movable die 814. The movable die 814 is positioned next to the stationary die 813. In a closed position, the movable die 814
5 and the stationary die 813 define two internal mould cavities 816, as shown in Fig. 25.

As better seen in Figs. 26 and 27, the stationary die 813 and the movable die 814 also comprise grooves that form channels
10 817 when the die assembly 812 is in the closed position. The channels 817 are also known as runners.

Referring to Fig. 25, the stationary die 813 is placed next to a first major surface of a cavity plate 815 and it is removably taken up and received by the stationary die receptacle 815. The cavity plate 815 is also called a stationary die receptacle. Both the cavity plate 815 and the stationary die 813 have central openings for taking up a runner insert 826 that is placed into the central portion of the cavity plate
15 815 and into the central portion of the stationary die 813. The runner insert 826 has a hollow core, which is provided as a channel or a runner 832. The runner 832 is connected to the channels 817. These connections are not shown in the figures.

25 As best seen in Figs. 26 and 27, one end of the channels 817 is adapted to receive molten resin from the mould injection apparatus 811 through the runner 832. Another end of the channels 817 is connected to the respective cavities 816 outlets 821, which terminate at an outlet orifice in the stationary die 813.
30

Referring to Fig. 25, a second major surface of the cavity plate 815, which is opposite to the first major surface of

the cavity plate 815, is placed next to a first major surface of a clamping plate 828, which is fixed to the machine bed 833. The clamping plate 828 is also called a stationary plate. The cavity plate 815 is attached to the clamping plate
5 828.

A second major surface of the clamping plate 828, which is opposite to the first major surface of the clamping plate 828, is placed next to an injection head insert 830. The
10 clamping plate 828 is attached to the injection head insert 830. The injection head insert 830 has a central opening 847, is aligned with a central opening 845 in the clamping plate 828.

15 Referring to the movable die 814, it has multiple hollow cores in which longitudinally moving cores 818 are inserted. The moving cores 818 are attached to a moving apparatus 819. The moving cores 818 are also inserted inside a core plate 820 that is adapted to keep longitudinal axe of the moving
20 cores 818 essentially horizontal and essentially parallel to each other while allowing the moving cores 818 to move back and forth essentially in the horizontal direction. The core plate 820 is also called a guiding core.

25 The movable die 814 is placed next to a first major surface of a movable die receptacle that is provided by the core plate 820. A second major surface of the movable die receptacle 820, which is opposite to the first major surface of the movable die receptacle 820, is attached to the moving appa-
30 ratus 819.

Referring to the moving apparatus 819, it includes wedges 822 and a lifting block 823 together with hydraulic pistons 825.

The wedges 822 are located next to the lifting block 823 while the lifting block 823 is in contact with the moving cores 818.

- 5 The wedges 822 are secured to piston rods 831 of the hydraulic pistons 825, wherein the piston rods 831 are adapted to move the respective wedges 822 towards the lifting block 823 or away from the lifting block 823.
- 10 The wedges 822 have inclined surfaces 827 that correspond to inclined surfaces 829 of the lifting block 823. The inclined surfaces 827 and 829 are inclined in relation to the moving direction of the moving cores 818. Put differently, the inclined surfaces 827 and 829 are not perpendicular to the moving direction of the moving cores 818. These inclined surfaces 827 and 829 are also in contact with each other, wherein the inclined surfaces 827 of the wedges 822 contact the lifting block 823 via its inclined surfaces 829, as illustrated in Fig. 25.

20

- The inclined surfaces 827 and 829 are also adapted such that the lifting block 823 would be positioned farther from the die assembly 812 when the wedges 822 are positioned away or farther from the lifting block 823. Similarly, the lifting block 823 would be positioned near to the die assembly 812 when the wedges 822 are positioned toward or nearer to the lifting block 823.
- 25

- The lifting block 823 is guided by the core plate 820 such that the lifting block 823 is movable essentially in the horizontal direction while it slides on its inclined surfaces 829 against the inclined surfaces 827 of the wedges 822. This can be seen from Fig. 25.
- 30

The hydraulic pistons 825 are attached to an intermediary plate 836 of a die clamping apparatus. The intermediary plate 836 is also called a die clamping movable plate. The die
5 clamping apparatus is not shown in the figures. The intermediary plate 836 is attached to a base clamp plate 838 via a support ring 840 and to the movable die receptacle 820. The base clamp plate 838 is also called a main movable plate.

10 The base clamp plate 838 is also connected to a knee lever mechanism 839 that is actuated by a hydraulic piston 841. The knee lever mechanism 839 is fixed to the machine bed 833.

An ejector pin 824 is attached to a superior ejector plate
15 844. The superior ejector plate 844 is also called an ejector actuation plate. An inferior ejector plate 842, which is secured to the base clamp plate 838, blocks the superior ejector plate 844. The inferior ejector plate 842 is also called a blocking plate. The ejector pin 824 is inserted in a cen-
20 tral hollow core of the intermediary plate 836, in a central hollow core of the lifting block 823, a central hollow core of the movable die receptacle 820, and a central hollow core of the movable die 814.

25 The pressure controller 850 is connected to the mould injection apparatus 811 via a hydraulic line 854, to the hydraulic piston 825 via hydraulic lines 852, and to the hydraulic piston 841 via a hydraulic line 853.

30 The hydraulic lines 852 are provided with pressure sensors 834 and with proportional valves 837. The valves 837 are connected a pressure valve controller 851.

Operationally, the die assembly 812 is movable between an open position and a closed position. In the open position, the movable die 814 is positioned apart or away from the stationary die 813. In contrast, in the closed position, the
5 stationary die 813 is positioned next to the movable die 814 such that the stationary die 813 and the movable die 814 define the internal mould cavities 816, as shown in Fig. 25.

Figs. 26 and 27 illustrate a normal volume position while
10 Figs. 29 and 30 illustrate a reduced volume position. The moving cores 818 are movable between the reduced volume position and the normal volume position.

As better seen in Fig. 27, when the die assembly 812 is in
15 the closed position and when the moving cores 818 are in the normal volume position, the moving cores 818 do not block the outlets 821 of the channels 817.

Fig. 30 shows, when the moving cores 818 shift to the reduced
20 volume position, the moving cores 818 block and cover the outlets 821 of the channels 817 such that any molten resin within the outlet 821 is in contact with the circumferential surface of the moving cores 818. The blocking prevents the molten resin within the channels 817 from flowing out of the
25 runner outlets 821 into the mould cavities 816. In this reduced volume position, the moving cores 818 also reduce the volume of the die cavities 816, thereby compressing the molten resin, which is take up therein.

30 In a general sense, the pressure controller 850 and the pressure valve controller 851 can be integrated into one unit.

In use, the movable die 814 is positioned by the intermediary plate 836, which is moved by the base clamp plate 838. The base clamp plate 838 is in turn moved by the knee lever mechanism 839, which is actuated by the hydraulic piston 841. The pressure controller 850 controls the hydraulic piston 841.

The intermediary plate 836 can be actuated such that it moves away from the stationary die 813 or towards the stationary die 813. When the intermediary plate 836 moves away from the stationary die 813, the movable die 814 also moves away from the stationary die 813 to enter into the open position of the die assembly 812. Similarly, when the intermediary plate 836 is actuated toward the stationary die 813, the movable die 814 also moves toward the stationary die 813 to assume the closed position of the die assembly 812.

The mould injection apparatus 811 is used for receiving resin material in the form of pellets. The received resin pellets are intended for kneading and for plasticizing by a screw mechanism of the mould injection apparatus 811 in a manner that is controlled by the controller 850. The plasticizing process includes a step of including plasticizers into the resin pellets. The plasticizers serve as to impart flexibility, workability, or stretchability to the resin pellets. The mould injection apparatus 811 is also used for heating these resin pellets such that the resin pellets are in a molten state. The molten state allows the resin to be injected into the mould cavities 816 of the die assembly 812.

The injection head insert 830 is intended for engaging the mould injection apparatus 811 that provides the molten resin.

The molten resin is intended for transmitting from the mould injection apparatus 811 through the runner 832 of the runner insert 826, through the runners 817, and through the runner outlets 817 to the mould cavities 816.

5

The mould cavities 816 are used for receiving the molten resin and for forming the received molten resin into a predetermined shape. The formed resin solidifies when sufficiently cooled to form mouldings or products. In the open position, the stationary die 813 is positioned apart from the movable die 814 such that the finished mouldings can be removed. The ejector pins 824 are used for removing the finished mouldings by urging the finished mouldings out of the open die assembly 812.

15

The pressure valve controller 851 actuates the proportional valves 837 to control the hydraulic pistons 825 by varying amount of force applied on the hydraulic pistons 825. The amount of actuation is in accordance to pressure measured by the pressure sensor 834. The hydraulic pistons 825 is controlled by pressure valve controller 851 to position the respective wedges 822 towards the lifting block 823 or away from the lifting block 823.

25 The pressure valve controller 851 receives pressure measurement values from the pressure sensor 834. The pressure measurement values correspond to the position of the wedges 822. The measured pressure provides feedback information to the pressure controller 850.

30

When the wedges 822 are positioned towards the lifting block 823, the wedges 822 exerts a pressure force on the lifting block 823 to move the lifting block 823 together with the

moving cores 818 towards the stationary die 813. The moving cores 818 then assume the reduced volume position. In this position, the hydraulic pistons 825 exert forces that are transmitted via the wedges 822, via the lifting block 823,
5 and via the moving cores 818 to the molten resin in the mould cavities 816 to further compress it.

The machine bed 833 is intended for supporting and for fixing the stationary parts of the injection-moulding machine 800
10 and the stationary parts of the mould injection apparatus 811.

Fig. 31 shows a schematic of a pressure controller for the injection-moulding apparatus 811 of Fig. 25. Fig. 31 depicts
15 the pressure controller 850 that includes the control circuit 100 of Fig. 2.

Referring to the input stage of the control circuit 100, the inverting input pin 14 of the comparator 12 of the control
20 circuit 100 is connected to the pressure sensor 834 of Fig. 25. The pressure sensor 834 is also called a pressure sensor device. Referring to the output stage of the control circuit 100, the MT2 pin 46 of the TRIAC 34 is connected the hydraulic piston 825 of the injection-moulding apparatus 811 of
25 Fig. 25.

The pressure sensor device 834 includes a pressure sensor module 857 and a voltage step-down circuit 859. The pressure sensor module 857 has an output node 861. The step-down circuit 859 includes a first resistor 863 and a second resistor
30 865. One end of the first resistor 863 is connected to the pressure-sensor module output node 861 while another end of the first resistor 863 is connected to a step-down output

node 867 and to one end of the second resistor 865. Another end of the second resistor 865 is connected to an electrical ground.

- 5 In use, the pressure sensor module 857 is used for measuring a pressure of a fluid in the hydraulic lines 852 between the hydraulic piston 825 and the proportional valves 837.

10 The step-down circuit 859 is used for stepping down or for reducing the voltage measurement signal of the pressure sensor module 857 such that the reduced signal is suitable for the comparator 12 of the control circuit 100.

15 The control circuit 100 adjust the valves 837 to vary forces applied on the hydraulic piston 825. The force variation is according to the voltage measurement signal of the pressure sensor module 857 and to a pre-determined voltage signal of the reference voltage supply 200.

20 This embodiment shows that the control circuit 100 can be used as a pressure controller and not only as a temperature controller.

25 Fig. 32 shows an embodiment of the pressure sensor module 857 of the pressure sensor device 834 for the pressure controller 850 of Fig. 31.

30 The pressure sensor module 857 includes a sensor unit 870 and a power unit 872. The power unit 872 is connected to the sensor unit 870 by a connection coaxial cable 875.

Referring to the sensor unit 870, it comprises a piezoelectric element 877 connected to an amplifier device 879.

A first end of the piezoelectric element 877 is connected a gate terminal of a MOSFET transistor 881 of the amplifier device 879 while a second end of the piezoelectric element 877
5 is an electrical ground 893 of the sensor unit 870. One end of a capacitor 895 is also connected to the piezoelectric element first end while another end of the capacitor 895 is connected the electrical ground 893. Similarly, one end of a bias resistor 897 is connected to the piezoelectric element
10 first end while another end of the bias resistor 897 is connected the electrical ground 893.

A source terminal of the MOSFET transistor 881 is connected to a wire of the connection coaxial cable 875. A drain terminal of the MOSFET transistor 881 is connected to the electrical ground 893 of the sensor unit 870 and to a base terminal of a bipolar transistor 899. A collector terminal of the bipolar transistor 899 is connected to the connection coaxial cable wire while an emitter terminal of the bipolar transistor 899 is connected to the electrical ground 893.
20

Referring to the connection coaxial cable 875, it has a shielding conductor that surrounds the connection coaxial cable wire. The shielding conductor is separated from the connection coaxial cable wire by an electrical insulating material. The shielding conductor is connected to the electrical ground 893 of the sensor unit 870.
25

Referring to the power unit 872, it comprises a DC voltage source 900 with a current regulation diode 903.
30

A positive terminal of the voltage source 900 is connected to an anode of the current regulation diode 903 while a negative

terminal of the voltage source 900 is connected an electrical ground 906 of the amplifier device 879. A cathode of the regulation diode 903 is connected to the connection coaxial cable wire and to one terminal of a coupling capacitor 905.

5

Another terminal of the coupling capacitor 905 is connected to a wire of an output coaxial cable 907 and to one end of a pull-down resistor 909. Another end of the pull-down resistor 909 is connected to the electrical ground 906. A positive

10 terminal of a monitoring voltage meter 912 is connected to the connection coaxial cable wire while a negative terminal the monitoring voltage meter 912 is connected the electrical ground 906. The electrical ground 906 is also connected to the shielding conductor of the connection coaxial cable 875
15 and thus to the electrical ground 893 of the sensor unit 870.

In use, the sensor unit 870 receives a fluid pressure of the hydraulic line 852 of the injection-moulding apparatus 811 of Fig. 25. The power unit 872 electrically powers the sensor
20 unit 870 such that the sensor unit 870 produces voltage corresponding to the said fluid pressure.

The connection coaxial cable 875 is used for transferring electrical power from the power unit 872 to the sensor unit
25 870 and for transferring the voltage produced by the sensor unit 870 to an output terminal of the power unit 872.

In particular, the piezoelectric element 877 is used for installing in the hydraulic line 852 and for receiving a pressure of the hydraulic line 852. The piezoelectric element 877
30 also produces an electrical charge or voltage corresponding to the received pressure. The capacitor 895 and the bias re-

sistor 897 together are used for smoothen any spikes in the voltage of piezoelectric element 877.

The DC voltage source 900 is used for providing electrical
5 power to the MOSFET transistor 881 and to the bipolar transistor 899 of the amplifier device 879. The monitoring voltage meter 912 is used for checking the voltages of the DC voltage source 900. The diode 903 is used to regulate flow of electrical current from the DC voltage source 900. This elec-
10 trical current flow is dependence on the voltage difference between the voltage of the DC voltage source 900 and the voltage produced or driven by the amplifier device 879.

The amplifier device 879, being powered by the DC voltage
15 source 900, produces an amplified voltage corresponding to the voltage produced by the piezoelectric element 877. This amplified voltage is transmitted to the output coaxial cable 907 via the connection coaxial cable 875.

20 In example of the pressure sensor module 857, the piezoelectric element 877 can be used for sensing a maximum pressure of 100,000 psi (pound per square inches). The 879 produces 0.07 millivolt for every 1 psi experienced by the piezoelectric element 877.

25

Figs. 33 and 34 show an injection-moulding machine 950. The injection-moulding machine 950 has parts similar to the injection-moulding machine 811 of Fig. 25. Description of the similar parts is incorporated by reference.

30

The injection-moulding machine 950 has a die assembly controlled by an improved pressure controller 953. The pressure controller 953 is connected to a pressure sensor 955 and to a

solenoid valve 957 via hydraulic lines. The solenoid valve 957 is also connected to hydraulic cylinders 825 via hydraulic lines.

- 5 The pressure sensor 955 is mounted next to a moulding cavity ejector pin 835 of the injection-moulding machine 950.

The pressure sensor 955 is attached to a superior ejector plate 844 and the pressure sensor 955 blocks the moulding
10 cavity ejector pin 835. The superior ejector plate 844 is secured to an inferior ejector plate 842, which is also connected to the hydraulic cylinder 825.

The moulding cavity ejector pin 835 extends from a hollow
15 core of the superior ejector plate 844, to a hollow core of an intermediary plate 836, to a hollow core of a lifting block 823. In a closed state of the injection-moulding machine 950, the moulding cavity ejector pin 835 also protrudes into a moulding cavity 816 of the injection-moulding machine
20 950.

In a special case, the moulding cavity ejector pin 835 also extends into a hollow core of a moving core 818.

- 25 The hydraulic cylinders 825 are connected to wedges 822. The wedges 822 are positioned next to a lift block 823, which is in contact with the moving core 818 of the injection-moulding machine 950. In the close state, the moving core 818 is positioned next to the moulding cavity 816.

30

Fig. 35 shows the pressure controller 953 in detail. The pressure controller 953 includes parts of the temperature controller circuit 100 of Fig. 2.

The comparator 12 of the controller circuit 100 receives pressure sensor signals from the pressure sensor 955 while the TRIAC 34 of the controller circuit 100 adjusts power to
5 the solenoid valve 957.

The hydraulic cylinder 825 includes a hydraulic pump 965 and an oil reservoir 968. The hydraulic pump 965 is connected to the solenoid valve 957 via a hydraulic line, to the hydraulic
10 cylinder 825 via another hydraulic line, and to the oil reservoir 968 via yet another hydraulic line. The hydraulic cylinder 825 includes a piston 825 and a piston rod 831. One end of the piston rod 831 is connected to the piston 825 while another end of the piston rod 831 is connected to the wedge
15 822.

In use, in a closed state of the injection-moulding machine 950, the moulding cavity 816 is used for receiving molten resin material and for shaping the resin material.
20

In a compression mode of the hydraulic pump 965, the hydraulic pump 965 transfers oil from the oil reservoir 968 to the hydraulic cylinder 825. This transfer causes the oil within the hydraulic cylinder 825 to exert a force onto the piston
25 825, onto the piston rod 831, and onto the wedges 822. The force also shifts the wedges 822 towards the lifting block 823, which in turn shifts the moving core 818 towards the moulding cavity 816. The moving core 818 then compresses the resin material within the moulding cavity 816.

30 The moulding cavity ejector pin 835 is used for receiving the pressure of the moulding cavity 816 and for transmitting this pressure to the pressure sensor 955.

The control circuit 100 is used for obtaining pressure readings from the pressure sensor 955 and a pre-determined threshold value from the reference voltage supply 200. The control circuit 100 also used for adjusting the valve 957 according the obtained data. The solenoid valve 957 is actuated electrically.

The valve 957 is used for adjusting force from the hydraulic pump 965 onto the hydraulic cylinder 825. When the pressure reading of the moulding cavity 816 reaches a pre-determined optimal level, the pressure controller 953 actuates the solenoid valve 957 such that the solenoid valve 957 is closed such that the hydraulic cylinder 825 does not receive any pressure or force from the hydraulic pump 965.

In a release mode of the hydraulic pump 965, the hydraulic pump 965 transfers oil in the reverse direction, wherein the oil is transferred from the hydraulic cylinder 825 to the oil reservoir 968. The oil then pushes the piston 825 in an opposite direction in which the piston 825, the piston rod 831, as well as the moving core 818 are moved away from the moulding cavity 816.

In an open state of the injection-moulding machine 950, the inferior ejector plate 842 is used for actuating the superior ejector plate 844. This actuation moves the moulding cavity ejector pin 835 for removing the finished moulded parts away from the moulding cavity 816.

30

Fig. 36 illustrates a pressure sensor 955 for the pressure controller 953 of Fig. 35. The pressure sensor 955 includes a piezoelectric element 960.

The piezoelectric element 960 is used for receiving a pressure of the moulding cavity 816. It produces an electrical charge or voltage corresponding to the received pressure.

5 This voltage is transmitted to the comparator 12 of the temperature controller circuit 100.

Fig. 37 shows a management system 980 for an injection-moulding machine 982. The injection-moulding machine 982 includes a display terminal 983.

The management system 980 includes a plurality of mobile phones 985 communicatively connected to a server 986. The mobile phones 985 are equipped with build-in cameras.

15

In use, the display terminal 983 is used for displaying sensor temperature readings and desired temperature readings of the injection-moulding machine 982.

20 Operators use the mobile phones 985 to generate status reports. The status reports include the readings displayed by the display terminal 983 as well as comments of the injection-moulding machine 982. The status reports can also include photographs of the display or photographs of the injection-moulding machine 982. These photographs are taken with

25

The mobile phones 985 are also used for sending the status reports to the reporting server 986. The reporting server 986 can forward the status reports to mobile phones 985 of other users, such as supervisors or maintenance crews, for further actions. The reporting server 986 can also use the status reports to generate alerts for the other users.

30

In a generic sense, the mobile phones 985 serve as mobile computing devices.

- 5 This embodiment allows visual feedback to supervisors of the production area for better management of the area and for improved efficiency of the production line.

10 In summary, the embodiments show several aspects of the application.

The application provides an improved temperature controller module for an injection-moulding machine. The injection-moulding machine receives moulding resin material, melts the resin material, and shapes the molten resin material to form finished parts.

20 Specifically, the temperature controller module includes a passive component network and one or more analog controllers unit.

Referring to the passive component network, it comprises a power supply terminal, a machine mode selector switch with at least two machine mode selector positions, a material type selector switch with at least two material type selector positions, and an output terminal.

30 The power supply terminal is used for receiving an external pre-determined DC supply voltage. The machine mode selector switch is used for selectively connecting the power supply terminal to one of two or more variable machine mode resistors.

A user can change positions of the machine mode selector switch according to mode of the injection-moulding machine. The user can also change resistance values of the machine mode resistors for eliminating resistor-manufacturing errors.

5

The material type selector switch is used for selectively connecting one of the variable machine mode resistors to one of two or more material type resistors. The machine mode selector switch, the variable machine mode resistors, the material type selector switch, and the material type resistors are connected in series. Similarly, a user can change positions of the material type selector switch according type of resin material used by the injection-moulding machine.

10

15 The output terminal is used for providing a sensor threshold value. The sensor threshold value serves as a reference value for temperature control of a part of the injection-moulding machine, such as injection nozzle.

20 The output terminal is connected to the material type resistors, wherein the output terminal receives a voltage of the external pre-determined DC supply voltage via the selected variable machine mode resistor and the selected material type resistor.

25

Referring to the analog controller unit, it comprises a sensor terminal, a threshold detector, an optical coupling device, a power supply terminal, a heater terminal, and an analog semiconductor power switch.

30

The sensor terminal is used for receiving a measurement value for an external sensor. The threshold detector is used for receiving the above-mentioned sensor threshold value and the

above-mentioned sensor measurement value. The optical coupling device is configured such that the threshold detector actuates the optical coupling device.

- 5 The power supply terminal is used for receiving an external AC power supply. The heater terminal for providing electrical energy to a external heater for heating a part of the injection-moulding machine.
- 10 The analog semiconductor power switch is used for providing the AC power supply from the AC power supply terminal to the heater terminal when the optical coupling device is actuated. Similarly, the analog semiconductor power switch does not provide the AC power supply from the AC power supply terminal
- 15 to the heater terminal when the optical coupling device is not actuated.

In another embodiment, the analog semiconductor power switch does not provide the AC power supply from the AC power supply

20 terminal to the heater terminal when the optical coupling device is actuated. The analog semiconductor power switch provides the AC power supply from the AC power supply terminal to the heater terminal when the optical coupling device is not actuated.

25

The actuation of the optical coupling device can result in an energising or in a disabling of the optical coupling device. When the sensor measurement is less than the threshold detector, the optical coupling device is energised such that it

30 activates the analog semiconductor power switch to conduct energy from the external AC power supply to the heater terminal. When sensor the sensor measurement is more than the threshold detector, the optical coupling device is disabled

such that it actuate the analog semiconductor power switch to stop conducting energy from the external AC power supply to the heater terminal

5 The threshold detector comprises a sample and hold input electrical circuit. This circuit allows the threshold detector to avoid variations of its input signal, namely the sensor measurement value. The variations can include glitches that can lead instability.

10

This temperature controller uses a simple design using readily components to perform effectively its functions. It is thus inexpensive and easy to implement.

15 The passive component network often comprises a pull-down resistor. One end of the pull-down resistor connects to an electrical ground while another end of the pull-down resistor connects to the output terminal. The pull-down resistance together with the selected variable machine mode resistor and
20 with the selected material type resistor form a voltage divider circuit to provide the sensor threshold value or signal for the output terminal.

The threshold detector can comprise a hysteresis circuit. The
25 hysteresis circuit prevents noise from changing state of the threshold detector when input signals of the threshold detector are close to each other.

The threshold detector often comprises a voltage comparator
30 to provide threshold detection.

The threshold detector can comprise a resistor network for converting an electrical current signal of an electrical cur-

rent sensor to a voltage signal. A voltage comparator can then process the converted voltage signal.

The threshold detector can comprise a pull-up circuit to
5 drive the output of the threshold detector.

The pull-up circuit can comprise a pull-up resistor for connected to voltage source, wherein the voltage source provides a driving current through the pull-up resistor for driving
10 the output of the threshold detector.

The pull-up circuit can comprise a capacitor connected in parallel to the pull-up resistor. The capacitor is used to reduce glitches in signals across the pull-up resistor.
15

The analog semiconductor power switch can comprise a bidirectional triode thyristor or a reverse blocking triode thyristor to provide switching functions. These devices are able to handle high electrical power.
20

For implementation, the optical coupling device can comprise a phototriac or a phototransistor.

The application also provides a mould assembly for an injection-moulding machine. The mould assembly is used for shaping molten resin material to produce a finished moulded part. The mould assembly comprises a moulding cavity, a supply nozzle, and the above-mentioned temperature controller device. The supply nozzle provides resin material to the moulding cavity.
25
30 The temperature controller device is mounted on the mould assembly and it is provided for adjusting a temperature of the supply nozzle.

The application provides an injection-moulding machine. The injection-moulding machine comprises an injection-moulding apparatus and the above mould assembly. The mould assembly is provided for receiving resin material from the injection-
5 moulding apparatus and for shaping the resin material.

The application provides another temperature controller module for an injection-moulding machine. The temperature controller module includes auto-triggering configuration for
10 controlling a temperature of the injection-moulding machine. The auto-triggering configuration is also called a self-triggering configuration.

The temperature controller module comprises a passive component network for providing an electrical sensor threshold
15 signal and one or more analog controller units. The passive component can refer to resistor, capacitors, and inductors.

The analog controller unit comprises a sensor terminal, an
20 analog threshold detector, an optical coupling device, a power supply terminal, a heater terminal, and an analog semiconductor power switch. The analog semiconductor power switch includes a thyristor device.

25 The sensor terminal is used for receiving an electrical measurement signal from a temperature sensor.

The analog threshold detector is used for receiving and for comparing the electrical sensor threshold signal and the
30 electrical sensor measurement signal, wherein an analog circuit does the comparison. The signal here refers to an electrical voltage or electrical current signal. In other words, the comparison does not use digital techniques that involve

conversion of an analog signal to a digital signal. This analog comparison provides for a quick comparison while few components are required to form the analog circuit.

- 5 The threshold detector actuates the optical coupling device. The power supply terminal is used for receiving an external AC power supply. The heater terminal is used for providing electrical energy to a heater.
- 10 The thyristor device is used for providing an auto-trigger function when the optical coupling device is actuated. The actuated optical coupling device allows an electrical current of the AC power supply to flow from the power supply terminal to the thyristor device via the optical coupling device. This
- 15 electrical current triggers the thyristor device such that the thyristor device conducts or connects electrical power from the AC power supply terminal to the heater terminal.

- The thyristor device stops conducting electrical power from
- 20 the AC power supply terminal to the heater terminal when the electrical current input signal to the thyristor device falls below a pre-determined threshold. This occurs in each cycle of the AC power supply. Then, in the next cycle, the actuated optical coupling device again allows the electrical current
- 25 to trigger the thyristor device. In this manner, the thyristor device is triggered again or is triggered automatically.

- Furthermore, the threshold detector comprises at least one active component and a sample and hold input electrical circuit. The active component can refer to an operational amplifier, a transistor, and a voltage comparator, which needs
- 30 electrical energy for functioning.

In this embodiment, the thyristor device connects electrically the power supply terminal to the heater terminal when the optical coupling device is actuated. The thyristor device does not connect electrically the power supply terminal to the heater terminal when the optical coupling device is not actuated.

In a further embodiment, the thyristor device does not connect electrically the power supply terminal to the heater terminal when the optical coupling device is actuated. The thyristor device connects electrically the power supply terminal to the heater terminal when the optical coupling device is not actuated.

This temperature controller module is simple to implement and uses readily available components for lower cost.

The passive component network can comprise a power supply terminal, a machine mode selector switch with at least two machine mode selector positions, a material type selector switch with at least two material type selector positions, and an output terminal. The output terminal is connected to the material type resistors.

The power supply terminal is used for receiving a predetermined DC supply voltage. The machine mode selector switch is used for selectively connecting the power supply terminal to one of at least two variable machine mode resistors. The material type selector switch is used for selectively connecting one of the at least two variable machine mode resistors to one of at least two material type resistors. The output terminal is used for providing a sensor threshold signal.

The passive component network can comprise a pull-down resistor. One end of the pull-down resistor connects to an electrical ground and another end of the pull-down resistor connects to the output terminal.

The threshold detector can also comprise a hysteresis circuit, a voltage comparator, or a resistor network. The resistor network is used for converting an electrical current signal of an electrical current sensor to a voltage signal. The threshold detector can also comprise a pull-up circuit. The pull-up circuit can comprise a pull-up resistor. The pull-up circuit can further comprise a capacitor connected in parallel to the pull-up resistor.

The thyristor device can comprise a bidirectional triode thyristor or a reverse blocking triode thyristor.

The threshold detector often energises the optical coupling device when the sensor measurement signal exceeds the sensor threshold signal. The optical coupling device can comprise a phototriac or a phototransistor.

The application also provides a mould assembly for an injection-moulding machine. The mould assembly is used for shaping molten resin material to produce a finished moulded part. The mould assembly includes a moulding cavity, a supply nozzle, and the above-mentioned temperature controller device that is mounted on the mould assembly. The supply nozzle is used for providing resin material to the moulding cavity. The temperature controller device is used for adjusting a temperature of the supply nozzle.

The application provides an injection-moulding machine. The injection-moulding machine comprises an injection-moulding apparatus and the above mould assembly. The mould assembly is provided for receiving resin material from the injection-
5 moulding apparatus and for shaping the resin material.

The application also provides another temperature controller module for an injection-moulding machine. This temperature controller module has resistors with different ratios, where-
10 in the ratios allow quick adaption of the temperature controller module for different resin material.

The temperature controller module comprises a passive component network and at least one analog controller unit.
15

The passive component network that comprises a power supply terminal, a material type selector switch with at least two material type selector positions, and an output terminal being connected to the material type components, which may be
20 resistors. The power supply terminal is used for receiving a pre-determined DC supply voltage. The material type selector switch is used for selectively connecting the pre-determined DC supply voltage to one of at least two material type components, which may be resistors. The output terminal is used
25 for providing a sensor threshold value, the output terminal being connected to the material type components.

The analog controller unit comprises a sensor terminal, a threshold detector, a power supply terminal, and a switch.
30 The sensor terminal is used for receiving a sensor measurement value. The threshold detector is used for receiving the sensor threshold value and the sensor measurement value. The power supply terminal is used for receiving an AC power sup-

ply. The heater terminal is used for providing electrical energy to a heater.

The switch is used for providing the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector activates the switch. Similarly, the switch does not provide the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector does not activate the switch.

In a special embodiment, the switch is used for not providing the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector activates the switch. The switch provides the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector does not activate the switch.

The activation of the switch can result in an energising of the switch or in a disabling of the switch.

Component values of the at least two material type components follow a pre-determined ratio. The component values can refer to resistance values, to capacitance values, or to inductance values. The ratio is formed by at least two different numbers, wherein each number being taken from one group of a set of groups. The set comprises a first group, a second group, a third group, a fourth group, and a fifth group.

The first group comprises whole numbers ranging from [102 minus 10 % (percent)] to [102 plus 10%]. The second group comprises whole numbers ranging from [118 minus 10%] to [118 plus 10%]. The third group comprises whole numbers ranging from [137 minus 10%] to [137 plus 10%]. The fourth group com-

prises whole numbers ranging from [169 minus 10%] to [169 plus 10%]. The fifth group comprises whole numbers ranging from [196 minus 10%] to [196 plus 10%].

- 5 As an example, the resistance value can be taken from the first group or the second group. The first group comprises a whole number ranging from 91 to 113, say 100. The second group comprises a whole number ranging from 106 to 130, say 125. Thus, a possible pre-determined ratio is 100:125.

10

These pre-determined ratios allow the injection-moulding machine to process many different resin material with little or no change to set-up.

- 15 The material type resistors can comprise a resistance tolerance value taken from a set of percents, the set comprises 1% (percent), 5%, and 10%. Other resistance tolerance values are also possible but often 1% resistance tolerance is selected.

- 20 The passive component network can comprise a machine mode selector switch with at least two machine mode selector positions for selectively connecting the power supply terminal to one of at least two variable machine mode resistors. The material type selector switch selectively connects one of the
- 25 variable machine mode resistors to one of the material type resistors. The variable machine mode resistors are connected in series with the material type resistors provide the above-mentioned ratio.

- 30 The passive component network can comprise a pull-down component, which can be a resistor. One end of the pull-down component connects to an electrical ground and another end of the pull-down component connected to the output terminal.

The threshold detector can comprise a sample and hold input electrical circuit, a hysteresis circuit, or a voltage comparator. The threshold detector can also comprise a resistor
5 network for converting an electrical current signal of an electrical current sensor to a voltage signal. The threshold detector can comprise a pull-up circuit. The pull-up circuit can comprise a pull-up resistor. The pull-up circuit can comprise a capacitor connected in parallel to the pull-up resistor.
10

The switch can comprise a bidirectional triode thyristor or a reverse blocking triode thyristor. The analog controller unit can comprise an optical coupling device being actuated by the
15 threshold detector. The threshold detector activates the switch via the optical coupling device. The actuation energises or disables the optical coupling device. The threshold detector often energises the optical coupling device when the sensor measurement value exceeds the sensor threshold value.
20 The optical coupling device can comprise a phototriac or a phototransistor.

The application also provides a mould assembly for an injection-moulding machine. The mould assembly is used for shaping
25 molten resin material to produce a finished moulded part. The mould assembly have a moulding cavity, a supply nozzle, and the above-mentioned temperature controller device. The temperature controller device is mounted in the mould assembly. The supply nozzle is intended for providing resin material to
30 the moulding cavity. The temperature controller device is intended for adjusting a temperature of the supply nozzle.

The application provides an injection-moulding machine. The injection-moulding machine comprises an injection-moulding apparatus and the above mould assembly. The mould assembly is provided for receiving resin material from the injection-
5 moulding apparatus and for shaping the resin material.

The application provides a method of calibrating a temperature controller device for an injection-moulding machine. The method allows the temperature controller device to use different types of sensors, resin materials, and different modes
10 of the injection-moulding machine.

The method comprises the step of choosing or selecting a moulding resin material type. A material type selector switch
15 of a resistor network is then set according to the chosen resin material type. An operating mode of the injection-moulding machine is afterward chosen. A machine mode selector switch of the resistor network is later also set according to the chosen mode of the injection-moulding machine.

20

A suitable temperature sensor type is then chosen. A value is later determined according to the chosen resin material type, to the chosen sensor type, and to the chosen mode of the injection-moulding machine. After this, a voltage of the resistor network is measured and a variable resistor of the resistor network is adjusted until the measured voltage essentially reaches the predetermined value.
25

The application provides a temperature controller device for provision within a manifold chamber assembly of an injection-moulding machine. This provision allows the temperature controller device to be close to its sensors. The closeness reduces electrical noises picked up signal wires of the sen-
30

sors, thereby improving the signal to noise ratio and the quality of temperature control.

5 The temperature controller device includes a temperature controller module and a housing or casing enclosing the temperature controller module. The casing comprises a first outer largest dimension of less than or equal to 60 mm, a second outer largest dimension of less than 100 mm and a third outer largest dimension of less than or equal to 30 mm. The first
10 outer dimension and the second outer dimension are measured in directions that are perpendicular to each other. The second outer dimension and the third outer dimension are also measured in directions that are perpendicular to each other.

15 It has turned out that such a temperature controller casing can be used in many injection-moulding machines, especially in manifold assembly chambers. When the temperature controller is in this chamber, it is near to runners of the manifold assembly and near to runner nozzles connected to the manifold
20 assembly. The temperature controller is often connected to heaters and sensors, which are placed on the runner nozzles, which are then very close to the temperature controller.

The casing can comprise a generally rectangular shape for
25 easy production of the casing. The temperature controller module can comprise a passive component network and at least one analog controller unit. The passive component network comprises an output terminal for providing a sensor threshold value.

30

The analog controller unit comprises
-a sensor terminal for receiving a sensor measurement value,

-a threshold detector for receiving the sensor threshold value and the sensor measurement value,

-a power supply terminal for receiving an AC power supply,

-a heater terminal for providing electrical power to a heater,

5 and

-an analog semiconductor power switch for providing the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector activates the analog semiconductor power switch. Likewise, the analog semiconductor

10 power switch does not provide the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector does not activate the analog semiconductor power switch.

15 In another embodiment, the analog semiconductor power switch does not provide the AC power supply when the threshold detector activates the analog semiconductor power switch. In a like manner, the analog semiconductor power switch provides the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector does not activate the analog semiconductor power switch.

25 The activation of the semiconductor power switch can result in an energising of the switch or in a disabling of the switch.

The passive component network can include

-a power supply terminal for receiving a pre-determined DC supply voltage,

30 -a machine mode selector switch with at least two machine mode selector positions for selectively connecting the power supply terminal to one of at least two variable machine mode resistors, and

-a material type selector switch with at least two material type selector positions for selectively connecting one of the at least two variable machine mode resistors to one of at least two material type resistors. The output terminal is
5 connected to the material type resistors.

The passive component network can comprise a pull-down resistor. One end of the pull-down resistor connects to an electrical ground and another end of the pull-down resistor connects to the output terminal.
10

The threshold detector can comprise a sample and hold input electrical circuit, a hysteresis circuit, or a voltage comparator. The threshold detector can comprise a resistor network for converting an electrical current signal of an electrical current sensor to a voltage signal. The threshold detector can also comprise a pull-up circuit. The pull-up circuit can comprise a pull-up resistor. The pull-up circuit can comprise a capacitor connected in parallel to the pull-up resistor.
15
20

The analog semiconductor power switch can comprise a bidirectional triode thyristor or a reverse blocking triode thyristor.
25

The analog controller unit can comprise an optical coupling device being actuated by the threshold detector. The actuation energises or disables the optical coupling device.

30 The threshold detector often energises the optical coupling device when the sensor measurement value exceeds the sensor threshold value and the threshold detector activates the

switch via the optical coupling device. The optical coupling device can comprise a phototriac or a phototransistor.

The application also provides a mould assembly for an injection-moulding machine. The mould assembly has an improved temperature control. The temperature controller device is provided within a manifold chamber assembly of the mould assembly.

10 The mould assembly includes a back plate comprising a receiving cavity, a moulding plate comprising at least one moulding cavity, a supply nozzle with a manifold assembly, and a temperature controller device. A stationary die together with a movable die defines the moulding cavity when the stationary
15 die and the movable die are in a closed state.

The receiving cavity is used for receiving resin material from an injection-moulding apparatus. The moulding cavity is used for shaping resin material to form finished moulded
20 parts. The supply nozzle with a manifold assembly is used for providing resin material from the receiving cavity to the moulding cavity. The temperature controller device is used for adjusting a temperature of the supply nozzle.

25 The back plate and the moulding plate are separate by a distance in which the back plate and the moulding plate define a space. The manifold assembly and the temperature controller device are provided in this space between the back plate and the moulding plate.

30

The temperature controller is small enough to be fixed into this space. This size also allows the temperature controller to be close to temperature sensors that are mounted on the

supply nozzle. This closeness reduces signal noise picked up wires of the temperature sensor. In this manner, signal to noise ratio is reduced and quality of temperature control is improved.

5

The temperature controller unit can include the above-mentioned temperature controller device.

The application also provides an injection-moulding machine.

10

The injection-moulding machine comprises an injection-moulding apparatus and the above mould assembly. The mould assembly is provided for receiving resin material from the injection-moulding apparatus and for shaping the resin material.

15

The application provides an improved device. The device can refer to an injection-moulding machine or to parts of the injection-moulding machine. The device includes a mould assembly and an injection-moulding apparatus.

20

The mould assembly receives molten resin material from the injection-moulding apparatus. Within a short time, the mould assembly shapes the resin material to form finished products. To provide for improved temperature control of the molten resin material at the injection-moulding apparatus, the mould assembly provides temperature information of the resin material at the mould assembly to the injection-moulding apparatus.

25

The injection-moulding apparatus comprises a barrel and a barrel temperature controller device. The barrel is used for receiving resin material and for melting the resin material.

30

The barrel temperature controller device is used for adjusting the temperature of the barrel.

The mould assembly comprises a moulding cavity, a supply nozzle, a nozzle temperature controller device mounted on the mould assembly, and a wireless transmitter. A stationary die together with a movable die defines the moulding cavity when the stationary die and the movable die are in a closed state.

The supply nozzle is used for channelling the resin material from the injection-moulding apparatus to the moulding cavity. The moulding cavity is used for shaping the molten resin material to form finished parts. The nozzle temperature controller device is used for adjusting the temperature of the supply nozzle. The wireless transmitter is used for sending information of the nozzle temperature controller device.

The injection-moulding apparatus further comprises a wireless receiver for receiving the information from the nozzle temperature controller device. Moreover, the barrel temperature controller is used for adjusting a temperature of the barrel according to the received information from the nozzle temperature controller device.

This manner of controlling the barrel temperature provides a close loop between the injection-moulding apparatus and the moulding assembly, which provides a better barrel temperature control.

The wireless transmitter often comprise an analog to digital converter (ADC) for converting the nozzle temperature controller device information into a digital format, such that the wireless transmitter can send the digitalised infor-

mation. Most wireless transmitters often transmit only digital information.

The nozzle temperature controller can comprise a passive component network that comprises an output terminal for providing a sensor threshold value, and at least one analog controller unit.

The analog controller unit comprises a sensor terminal, a threshold detector, an AC power supply terminal, a heater terminal, and an analog semiconductor power switch. The sensor terminal is used for receiving a sensor measurement value. The threshold detector is used for receiving the sensor threshold value and the sensor measurement value. The AC power supply terminal is used for receiving an electrical power. The heater terminal is used for providing AC electrical power to a heater. The analog semiconductor power switch is used for providing the AC electrical power from the AC power supply terminal to the heater terminal when the threshold detector activates the switch.

The passive component network can comprise a power supply terminal, a machine mode selector switch with at least two machine mode selector positions, and a material type selector switch with at least two material type selector positions. The output terminal is connected to the material type resistors. The power supply terminal is used for receiving a predetermined DC supply voltage. The machine mode selector switch is used for selectively connecting the power supply terminal to one of at least two variable machine mode resistors. The material type selector switch is used for selectively connecting one of the at least two variable machine

mode resistors to one of at least two material type resistors.

5 The passive component network can comprise a pull-down resistor. One end of the pull-down resistor connects to an electrical ground and another end of the pull-down resistor connects to the output terminal.

10 The threshold detector can comprise a sample and hold input electrical circuit, a hysteresis circuit, or a voltage comparator. The threshold detector can also comprise a resistor network for converting an electrical current signal of an electrical current sensor to a voltage signal. The threshold detector can also comprise a pull-up circuit. The pull-up
15 circuit can comprise a pull-up resistor. The pull-up circuit can comprise a capacitor connected in parallel to the pull-up resistor.

20 The analog semiconductor power switch can comprise a bidirectional triode thyristor or a reverse blocking triode thyristor.

The analog controller unit can also comprise an optical coupling device being actuated by the threshold detector. The
25 actuation energises or disables the optical coupling device. The threshold detector activates the switch via the optical coupling device. The threshold detector often energises the optical coupling device when the sensor measurement value exceeds the sensor threshold value.

30

The optical coupling device can comprise a phototriac or a phototransistor.

The application provides a method of controlling a temperature of an injection-moulding machine. The injection-moulding machine includes an injection-moulding apparatus and a mould assembly. The injection-moulding apparatus is used for receiving resin material, for melting the resin material, and for injecting the molten resin material to the mould assembly. The mould assembly is used for shaping the molten resin to form finished moulded parts.

10 The method includes a step of transferring resin material from the injection-moulding apparatus to the mould assembly.

After this, a temperature controller of the mould assembly actuates a heater of the mould assembly. The actuation can refer to energising the heater or to disabling the heater. The heater actuation adjusts the temperature of the mould assembly by injecting heat energy into the mould assembly while the mould assembly dissipates heat energy into the surrounding. By adjusting amount of heat injected, the temperature of the mould assembly can increase or decrease.

Status information of the mould assembly temperature controller is then transmitted to a temperature controller of the injection-moulding apparatus. The status information can indicate that the mould assembly temperature controller is energising or is disabling the mould assembly heater.

The injection-moulding apparatus temperature controller then actuates a heater of the injection-moulding apparatus according to the said transmitted information. The actuation of the injection-moulding apparatus heater can refer to energising or to disabling of the injection-moulding apparatus heater.

The mould assembly heater elevates a temperature of the resin material within the mould assembly when the mould assembly heater is energised. Similarly, the injection-moulding apparatus heater elevates a temperature of resin material within the injection-moulding apparatus when the injection-moulding apparatus heater is energised.

On one hand, when the transmitted information indicates that the mould assembly temperature is too high, the injection-moulding apparatus temperature controller can reduce its temperature by injecting no heater energy or less heat energy into the injection-moulding apparatus. This then leads to resin material within the injection moulding to being cooler. The cooler resin material is later transferred from the injection-moulding apparatus to the mould assembly, wherein the cooler resin material acts to lower the temperature of the mould assembly.

On another hand, when the transmitted information indicates that the mould assembly temperature is too low, the injection-moulding apparatus temperature controller can increase its temperature by injecting more heat energy into the injection-moulding apparatus. This afterward leads to hotter resin material within the injection-moulding apparatus. The hotter resin is then transferred from the injection-moulding apparatus to the mould assembly. The hotter resin material serves to increase the temperature of the mould assembly.

This method allows the injection-moulding apparatus to sent resin material with a desired temperature to the mould assembly. Although the mould assembly temperature controller acts to adjust the temperature of the resin material within the mould assembly, the mould assembly temperature controller may

not be able to bring this resin material to its desired temperature when the resin material temperature is too far off the desired temperature. This is especially so when the mould assembly is operating a certain speed that requires the mould
5 assembly temperature controller to respond with a certain time.

In practice, the mould assembly temperature controller status information can include a mould assembly temperature sensor
10 measurement value of a nozzle of the mould assembly as well as a mould assembly pre-determined temperature value.

The mould assembly heater is usually energised when the temperature sensor measurement value is less than the pre-
15 determined temperature value since this indicates that the temperature of the mould assembly is too low. The energised mould assembly heater serves to elevate the temperature of the mould assembly. Specifically, it acts to elevate the temperatures of the nozzle or the manifold assembly of the mould
20 assembly.

The transmission of mould assembly temperature controller status information is preferably performed in a wireless manner for easy implementation, although the transmission can
25 also be transmitted in a wired manner.

The application provides a pressure controller valve module for adjusting pressure of a moulding cavity of an injection-moulding machine.

30

The pressure controller valve module can use parts of the above temperature controller. In this manner, the pressure controller valve module can also be integrated with the tem-

perature controller and also have the feature the temperature controller, such as simple design.

The pressure controller valve module comprises a passive component network for providing a sensor threshold value and at least one analog controller unit.

Referring to the analog controller unit, it comprises a sensor terminal, an analog threshold detector, an optical coupling device, a power supply terminal, a valve terminal, and an analog semiconductor power switch. The analog semiconductor power switch comprises a thyristor device.

In use, the sensor terminal is used for receiving a pressure measurement value of a moulding cavity.

The analog threshold detector is used for receiving and for comparing the sensor threshold value and the pressure measurement value, wherein an analog circuit does the comparison. In other words, the comparison does not use digital techniques, such conversion of analog signal to its digital format.

The analog threshold detector actuates the optical coupling device according to the above comparison. The actuation can energise or disable the optical coupling device. In other words, the word actuation includes the meaning of energising and disabling.

The power supply terminal is used for receiving an AC power supply from an external source.

The valve terminal is used for actuating a valve. The valve is provided for controlling an amount of force being applied to a cavity mould of an injection-moulding machine. The force is transmitted from an hydraulic pump to a cylinder-piston
5 arrangement, wherein the cylinder-piston arrangement asserts a force on the cavity mould via a compression or moving core.

The thyristor device is used for providing an auto-trigger function when the optical coupling device is actuated. The
10 actuated optical coupling device allows an electrical current of an electrical power to flow from the power supply terminal to the thyristor device via the optical coupling device. This electrical current serves to trigger the thyristor device, which then act to connect electrical power from the power
15 supply terminal to the valve terminal. The thyristor device stops connecting when the electrical current input signal of the thyristor device falls below a pre-determined threshold, which occurs every cycle of an AC power supply. In the next cycle, the actuated optical coupling device again allows the
20 electrical current to trigger the thyristor device. In other words, the thyristor device is triggered automatically or is self-triggered when the optical coupling device is actuated.

In this embodiment, the analog semiconductor power switch
25 connects electrical power from the power supply terminal to the valve terminal when the analog semiconductor power switch is actuated. The analog semiconductor power switch does not connect electrical power from the power supply terminal to the valve terminal when the analog semiconductor power switch
30 is not actuated.

In a further embodiment, the analog semiconductor power switch does not connect electrical power from the power sup-

ply terminal to the valve terminal when the analog semiconductor power switch is actuated. The analog semiconductor power switch connects electrical power from the power supply terminal to the valve terminal when the analog semiconductor
5 power switch is not actuated.

The actuation of the semiconductor power switch can refer to an energising of the semiconductor power switch or to a disabling of the semiconductor power switch.

10

The analog threshold detector can comprise a sample and hold input electrical circuit, a hysteresis circuit, or a voltage comparator. The threshold detector can also comprise a resistor network for converting an electrical current signal of an
15 electrical current sensor to a voltage signal.

The analog threshold detector can also comprise a pull-up circuit. The pull-up circuit can comprise a pull-up resistor and a capacitor connected in parallel to the pull-up resistor.
20

The analog semiconductor power switch can comprise a bidirectional triode thyristor or a reverse blocking triode thyristor.
25

The controller unit can comprise an optical coupling device being actuated by the threshold detector when the sensor measurement value exceeds or is below the sensor threshold value. The actuation energises or disables the optical coupling device.
30

The analog threshold detector often energises the optical coupling device when the sensor measurement value exceeds the sensor threshold value.

- 5 The optical coupling device can comprise a phototriac or a phototransistor.

The application also provides a mould assembly for an injection-moulding machine. The mould assembly includes an improved pressure controller for adjusting pressure within a moulding cavity.

The mould assembly includes a movable die with a stationary die, a supply nozzle, a moving core, a moulding cavity pin that is provided in the moulding cavity and a pressure controller device. The stationary die and the movable die define a moulding cavity when the stationary die and the movable die are in a closed state. The supply nozzle is used for providing or for injecting resin material to the moulding cavity.

15 The moving core is used for compressing the resin material received within the moulding cavity. The moulding cavity pin is used for receiving a pressure of the resin material within the moulding cavity.

25 Referring to the pressure controller device, it includes a pressure sensor, a hydraulic pump, a cylinder-piston arrangement connecting to the hydraulic pump via a hydraulic line, and a pressure controller unit. The hydraulic line comprises a valve.

30

The pressure sensor is used for receiving the moulding cavity pressure from the moulding cavity pin. The hydraulic pump is used for actuating the cylinder-piston arrangement via in-

jecting a fluid into the hydraulic line. The cylinder-piston arrangement then asserts a force on the moulding cavity via the moving core.

- 5 The cylinder-piston arrangement can be provided such that the cylinder is fixed while the piston is movable or be provided such that the piston is fixed while the cylinder is movable. In a special case, both the cylinder and the piston are provided as movable.

10

The valve is used for adjusting or controlling the cylinder-piston arrangement force on the moving core. The pressure controller unit is used for actuating the valve according to the moulding cavity pressure.

15

The moulding cavity pin can comprise an ejector pin. The ejector pin is provided for removing a finished part of the moulding cavity from the stationary die and from the movable die when the stationary die and the movable die are in an

20

open state.

The moulding cavity pin can extend from the mould cavity to an ejector plate, wherein the ejector plate is provided for activating the moulding cavity pin such that moulding cavity
25 pin removes a finished part of the moulding cavity from the moulding cavity.

The pressure controller unit can comprise the above-mentioned a pressure controller valve module.

30

The application provides an injection-moulding machine. The injection-moulding machine comprises an injection-moulding apparatus and the above-mentioned mould assembly. The mould

assembly is provided for receiving resin material from the injection-moulding apparatus and for shaping the resin material.

- 5 The application also provides an injection-moulding machine. The injection-moulding machine allows for an improved manner of binning finished moulded parts.

10 The injection-moulding machine comprises a mould assembly and a robotic arm unit. The mould assembly comprises a temperature controller device mounted on the mould assembly and a wireless transmitter.

15 The wireless transmitter is used for sending information of the temperature controller device. The robotic arm unit is used for transferring finished moulded parts from the mould assembly to different bins. The robotic arm unit selects the bins for the finished moulded parts according to information received from the temperature controller device.

20

The received information can comprise a pre-determined sensor threshold value and a sensor measurement value. The robotic arm unit may select reject bins for the moulded parts when the sensor measurement value is different from the sensor
25 threshold value. In other words, the moulded parts are produced a temperature different from the threshold or a desired temperature.

The application provides a method for assigning finished
30 parts of an injection-moulding machine to different bins. The method comprises the step of selecting a reject bin type for the finished part when the sensor measurement value of the

injection-moulding machine is substantially different from a pre-determined sensor threshold value.

Put differently, the finished part can be a reject when the
5 sensor measurement value is different from a pre-determined
or a desired sensor threshold value. This is why the finished
part is assigned to a reject bin type for further considera-
tion by perhaps production quality staff.

10 The application provides an injection-moulding management
system. The management system includes an injection-moulding
machine with a display screen, a mobile computing device, and
a reporting server. The mobile computing device can refer to
15 a mobile phone with a certain computing ability or to a per-
sonal digital assistant (PDA).

The display screen is used for showing pre-determined sensor
threshold values and sensor measurement values of a mould as-
sembly of the injection-moulding machine.

20

The mobile computing device is used for receiving a status
report. The status report includes the sensor threshold value
and the sensor measurement value. An operator can provide the
status report to the mobile computing device. The mobile com-
25 puting device is also used for transmitting the status report
to the server, wherein the server is used for generating an
alert for a production line supervisor using the received re-
port. The alert can include just the status report or a sum-
mary of the status report.

30

The mobile computing device often includes a camera. An oper-
ator can produce the reporting status that includes camera
pictures of the injection-moulding machine and/or of parts

produced by the injection-moulding machine. The mobile computing device can be used for transmitted these pictures with comments for storing or for study.

5 The embodiments can also be described with the following lists of features or elements being organized into items. The respective combinations of features, which are disclosed in the item list, are regarded as independent subject matter, respectively, that can also be combined with other features
10 of the application.

1. A temperature controller module for an injection-moulding machine comprising
 - a passive component network that comprises
 - 15 - a power supply terminal for receiving a pre-determined DC supply voltage,
 - a machine mode selector switch with at least two machine mode selector positions for selectively connecting the power supply terminal to
20 one of at least two variable machine mode resistors,
 - a material type selector switch with at least two material type selector positions for selectively connecting one of the at least two
25 variable machine mode resistors to one of at least two material type resistors, and
 - an output terminal for providing a sensor threshold value, the output terminal being connected to the material type resistors,
 - 30 at least one analog controller unit, the analog controller unit comprising
 - a sensor terminal for receiving a sensor measurement value,

- a threshold detector for receiving the sensor threshold value and the sensor measurement value,
- an optical coupling device being actuated by the threshold detector,
- a power supply terminal for receiving an AC power supply,
- a heater terminal for providing electrical energy to a heater, and
- an analog semiconductor power switch for providing the AC power supply from the AC power supply terminal to the heater terminal when the optical coupling device is actuated,

wherein

the threshold detector comprises a sample and hold input electrical circuit.

2. The temperature controller module according to item 1, wherein the passive component network further comprises a pull-down resistor to the output terminal.
3. The temperature controller module according to item 1 or 2, wherein the threshold detector further comprises a hysteresis circuit.
4. The temperature controller module according to one of items 1 to 3, wherein the threshold detector further comprises a voltage comparator.

5. The temperature controller module according to one of items 1 to 4, wherein the threshold detector further comprises a resistor network for converting an electrical current signal of an electrical current sensor to a voltage signal.
6. The temperature controller module according to one of items 1 to 5, wherein the threshold detector comprises a pull-up circuit.
7. The temperature controller module according to item 6, wherein the pull-up circuit comprises a pull-up resistor.
8. The temperature controller module according to item 7, wherein the pull-up circuit further comprises a capacitor connected in parallel to the pull-up resistor.
9. The temperature controller module according to one of items 1 to 8, wherein the analog semiconductor power switch comprises a bidirectional triode thyristor.
10. The temperature controller module according to one of items 1 to 9, wherein the analog semiconductor power switch comprises a reverse blocking triode thyristor.
11. The temperature controller module according to one of items 1 to 10, wherein

the optical coupling device is energised by the threshold detector when the sensor measurement value exceeds the sensor threshold value.

- 5 12. The temperature controller module according to one of items 1 to 11, wherein the optical coupling device comprises a phototriac.
- 10 13. The temperature controller module according to one of items 1 to 11, wherein the optical coupling device comprises a phototransistor.
14. A mould assembly comprising
a moulding cavity,
15 a supply nozzle for providing resin material to the moulding cavity, and
a temperature controller device according to one of items 1 to 13 mounted on the mould assembly, the temperature controller device being provided for adjusting a
20 temperature of the supply nozzle.
15. An injection-moulding machine comprising
an injection-moulding apparatus and
a mould assembly of item 14, the mould assembly being
25 provided for receiving resin material from the injection-moulding apparatus and for shaping the resin material.
16. A temperature controller module for an injection-
30 moulding machine, the temperature controller module comprising
a passive component network for providing a sensor threshold signal and

at least one controller unit, wherein the controller unit comprises

- a sensor terminal for receiving a sensor measurement signal,
 - 5 - an analog threshold detector for receiving and for comparing the sensor threshold signal and the sensor measurement signal, wherein the comparison is done by an analog circuit,
 - 10 - an optical coupling device being actuated by the threshold detector,
 - a power supply terminal for receiving an AC power supply,
 - a heater terminal for providing electrical energy to a heater, and
 - 15 - an analog semiconductor power switch that a thyristor device for providing an auto-trigger function in which
an electrical current flows from the power supply terminal to the thyristor device via the optical
20 coupling device for triggering the thyristor device when the optical coupling device is actuated,
- wherein
the threshold detector comprises a sample and hold input electrical circuit.

25

17. The temperature controller module according to item 16, wherein

the passive component network comprises

- a power supply terminal for receiving a pre-
- 30 determined DC supply voltage,
- a machine mode selector switch with at least two machine mode selector positions for selectively

- connecting the power supply terminal to one of at least two variable machine mode resistors,
- a material type selector switch with at least two material type selector positions for selectively connecting one of the at least two variable machine mode resistors to one of at least two material type resistors, and
 - an output terminal for providing a sensor threshold signal, the output terminal being connected to the material type resistors.
18. The temperature controller module according to item 16 or 17, wherein the passive component network comprises a pull-down resistor connecting to an electrical ground and to the output terminal.
19. The temperature controller module according to one of items 16 to 18, wherein the threshold detector further comprises a hysteresis circuit.
20. The temperature controller module according to one of items 16 to 19, wherein the threshold detector further comprises a voltage comparator.
21. The temperature controller module according to one of items 16 to 20, wherein the threshold detector further comprises a resistor network for converting an electrical current signal of an electrical current sensor to a voltage signal.

22. The temperature controller module according to one of items 16 to 21, wherein the threshold detector comprises a pull-up circuit.
- 5 23. The temperature controller module according to item 22, wherein the pull-up circuit comprises a pull-up resistor.
- 10 24. The temperature controller module according to item 23, wherein the pull-up circuit further comprises a capacitor connected in parallel to the pull-up resistor.
- 15 25. The temperature controller module according to one of items 16 to 24, wherein the thyristor device comprises a bidirectional triode thyristor.
- 20 26. The temperature controller module according to one of items 16 to 25, wherein the thyristor device comprises a reverse blocking triode thyristor.
- 25 27. The temperature controller module according to one of items 16 to 26, wherein the optical coupling device is energised by the threshold detector when the sensor measurement signal exceeds the sensor threshold signal.
- 30 28. The temperature controller module according to one of items 16 to 27, wherein the optical coupling device comprises a phototriac.

29. The temperature controller module according to one of items 16 to 27, wherein the optical coupling device comprises a phototransistor.

5 30. A mould assembly comprising
a moulding cavity,
a supply nozzle for providing resin material to the
moulding cavity, and
a temperature controller device according to one of
10 items 16 to 29 mounted on the mould assembly, the temperature controller device being provided for adjusting a temperature of the supply nozzle.

31. An injection-moulding machine comprising
15 an injection-moulding apparatus and
a mould assembly of item 30, the mould assembly being provided for receiving resin material from the injection-moulding apparatus and for shaping the resin material.

20 32. A temperature controller module for an injection-moulding machine, the temperature controller module comprising

a passive component network that comprises
25 - a power supply terminal for receiving a pre-determined DC supply voltage,
- a material type selector switch with at least two material type selector positions for selectively connecting the pre-determined DC
30 supply voltage to one of at least two material type components, and

- an output terminal for providing a sensor threshold value, the output terminal being connected to the material type components, and at least one analog controller unit, the analog controller unit that comprises
 - a sensor terminal for receiving a sensor measurement value,
 - a threshold detector for receiving the sensor threshold value and the sensor measurement value,
 - a power supply terminal for receiving a power supply,
 - a heater terminal for providing electrical energy to a heater, and
 - a switch for providing the power supply from the power supply terminal to the heater terminal when the threshold detector activates the switch,

wherein

values of the at least two material type components follow a pre-determined ratio, the ratio being formed by at least two numbers, the number being taken from one group of a set of groups, the set comprises a first group, a second group, a third group, a fourth group, and a fifth group,

the first group comprises numbers ranging from [102 minus 10 % (percent)] to [102 plus 10%],

the second group comprises numbers ranging from [118 minus 10%] to [118 plus 10%],

the third group comprises numbers ranging from [137 minus 10%] to [137 plus 10%],

the fourth group comprises numbers ranging from [169 minus 10%] to [169 plus 10%], and

the fifth group comprises numbers ranging from [196 minus 10%] to [196 plus 10%].

33. The temperature controller module according to item 32,
5 wherein
the material type components comprise a resistance tolerance value taken from a set of percents, the set comprises 1% (percent), 5% , and 10%.
- 10 34. The temperature controller module according to item 32 or 33, wherein
the passive component network further comprises
- a machine mode selector switch with at least two machine mode selector positions for selectively
15 connecting the power supply terminal to one of at least two variable machine mode components and
- the material type selector switch selectively connecting one of the at least two variable machine mode components to one of the at least two material
20 type components.
35. The temperature controller module according to one of items 32 to 34, wherein
the passive component network further comprises
25 a pull-down component connecting to an electrical ground and to the output terminal.
36. The temperature controller module according to one of items 32 to 35, wherein
30 the threshold detector comprises a sample and hold input electrical circuit.

37. The temperature controller module according to one of items 32 to 36, wherein the threshold detector further comprises a hysteresis circuit.
- 5
38. The temperature controller module according to one of items 32 to 37, wherein the threshold detector further comprises a voltage comparator.
- 10
39. The temperature controller module according to one of items 32 to 38, wherein the threshold detector further comprises a resistor network for converting an electrical current signal of an electrical current sensor to a voltage signal.
- 15
40. The temperature controller module according to one of items 32 to 39, wherein the threshold detector comprises a pull-up circuit.
- 20
41. The temperature controller module according to item 40, wherein the pull-up circuit comprises a pull-up resistor.
- 25
42. The temperature controller module according to item 41, wherein the pull-up circuit further comprises a capacitor connected in parallel to the pull-up resistor.
- 30
43. The temperature controller module according to one of items 32 to 42, wherein the switch comprises a bidirectional triode thyristor.

44. The temperature controller module according to one of items 32 to 42, wherein the switch comprises a reverse blocking triode thyristor.
- 5
45. The temperature controller module according to one of items 32 to 44, wherein the analog controller unit further comprises an optical coupling device being actuated by the threshold detector, the threshold detector activates the switch via the optical coupling device.
- 10
46. The temperature controller module according to item 45, wherein the optical coupling device is energised by the threshold detector when the sensor measurement value exceeds the sensor threshold value.
- 15
47. The temperature controller module according to item 45 or 46, wherein the optical coupling device comprises a phototriac.
- 20
48. The temperature controller module according to item 45 or 46, wherein the optical coupling device comprises a phototransistor.
- 25
49. A mould assembly comprising
a moulding cavity,
a supply nozzle for providing resin material to the
moulding cavity, and
a temperature controller device according to one of items 32 to 48 mounted on the mould assembly, the tem-
- 30

perature controller device being provided for adjusting a temperature of the supply nozzle.

50. An injection-moulding machine comprising
5 an injection-moulding apparatus and
 a mould assembly of item 49, the mould assembly being provided for receiving resin material from the injection-moulding apparatus and for shaping the resin material.
- 10
51. A method of calibrating a temperature controller device for an injection-moulding machine,
the method comprising
 choosing a resin material type and a sensor type,
15 choosing a mode of the injection-moulding machine,
 setting a material type selector switch of a passive component network according to the resin material type,
 setting a machine mode selector switch of the passive component network according to the mode of the injection-moulding machine,
20 measuring a voltage of the passive component network, and
 adjusting a variable resistor of the passive component network until the measured voltage essentially
25 reaches a value that is determined according to the chosen resin material type, to the chosen sensor type, and to the chosen mode of the mould injecting machine.
- 30 52. A temperature controller device for provision within a manifold chamber assembly of an injection-moulding machine, temperature controller device comprising
 a temperature controller module and

a casing enclosing the temperature controller module, the casing that comprises a first outer dimension of less than or equal to 60 mm, a second outer dimension of less than 100 mm and a third outer dimension of less than or equal to 30 mm.

53. The temperature controller device according to item 52, wherein the casing comprises a rectangular shape.

54. The temperature controller device according to item 52 or 53, wherein

the temperature controller module comprises

- a passive component network that comprises an output terminal, wherein the output terminal provides a sensor threshold value and
- at least one controller unit, the controller unit that comprises
 - a sensor terminal for receiving a sensor measurement value,
 - a threshold detector for receiving the sensor threshold value and the sensor measurement value,
 - a power supply terminal for receiving an AC power supply,
 - a heater terminal for providing electrical power to a heater, and
 - a switch for providing the AC power supply from the AC power supply terminal to the heater terminal when the threshold detector activates the switch.

55. The temperature controller device according to item 54,
wherein
the passive component network further comprises
- a power supply terminal for receiving a pre-
 - 5 determined DC supply voltage,
 - a machine mode selector switch with at least two
machine mode selector positions for selectively
connecting the power supply terminal to one of at
least two variable machine mode resistors, and
 - 10 -
 - a material type selector switch with at least two
material type selector positions for selectively
connecting one of the at least two variable machine
mode resistors to one of at least two material type
resistors,
 - 15 wherein
the output terminal is connected to the material type
resistors.
56. The temperature controller device according to item 54
20 or 55, wherein
the passive component network further comprises a pull-
down resistor connecting to an electrical ground and to
the output terminal.
- 25 57. The temperature controller device according to one of
items 54 to 56, wherein
the threshold detector comprises a sample and hold input
electrical circuit.
- 30 58. The temperature controller device according to one of
items 54 to 57, wherein
the threshold detector further comprises a hysteresis
circuit.

59. The temperature controller device according to one of items 54 to 57, wherein the threshold detector further comprises a voltage com-
5 parator.
60. The temperature controller device according to one of items 54 to 59, wherein the threshold detector further comprises a resistor net-
10 work for converting an electrical current signal of an electrical current sensor to a voltage signal.
61. The temperature controller device according to one of items 54 to 60, wherein
15 the threshold detector comprises a pull-up circuit.
62. The temperature controller device according to item 61, wherein the pull-up circuit comprises a pull-up resistor.
20
63. The temperature controller device according to item 62, wherein the pull-up circuit further comprises a capacitor connected in parallel to the pull-up resistor.
25
64. The temperature controller device according to one of items 54 to 63, wherein the switch comprises a bidirectional triode thyristor.
- 30 65. The temperature controller device according to one of items 54 to 63, wherein the switch comprises a reverse blocking triode thyris-
tor.

66. The temperature controller device according to one of items 54 to 65, wherein the controller unit further comprises
5 an optical coupling device being actuated by the threshold detector when the sensor measurement value exceeds or is below the sensor threshold value, the threshold detector activates the switch via the optical coupling device.
- 10 67. The temperature controller device according to item 66, wherein the optical coupling device is energised by the threshold detector when the sensor measurement value exceeds
15 the sensor threshold value, the threshold detector activates the switch via the optical coupling device.
68. The temperature controller device according to item 66 or 67, wherein
20 the optical coupling device comprises a phototriac.
69. The temperature controller device according to item 66 or 67, wherein the optical coupling device comprises a phototransistor.
25
70. A mould assembly comprising
a back plate that comprises a receiving cavity for receiving resin material,
a moulding plate that comprises at least one mould-
30 ing cavity for shaping the resin material,
a supply nozzle with a manifold assembly for providing the resin material from the receiving cavity to the moulding cavity, and

- a temperature controller unit for adjusting a temperature of the supply nozzle,
wherein the back plate and the moulding plate are separated by a distance,
5 wherein the back plate and the moulding plate define a chamber for enclosing the manifold assembly and the temperature controller device.
71. The mould assembly according to item 70, wherein
10 the temperature controller unit comprises a temperature controller device according to one of items 52 to 69.
72. An injection-moulding machine comprising
an injection-moulding apparatus and
15 a mould assembly according to item 70 or 71, the mould assembly being provided for receiving resin material from the injection-moulding apparatus and for shaping the resin material.
- 20 73. A device comprising
an injection-moulding apparatus that comprises
- a barrel for receiving resin material and for melting the resin material and
- a barrel temperature controller device and
25 a mould assembly that comprises
- a moulding cavity,
- a supply nozzle for channelling the resin material to the moulding cavity,
- a nozzle temperature controller device mounted
30 on the mould assembly, and
- a wireless transmitter for sending information of the nozzle temperature controller device,

wherein the injection-moulding apparatus further comprises a wireless receiver for receiving the nozzle temperature controller device information,
wherein the nozzle temperature controller device is provided for adjusting a temperature of the supply nozzle,
and
wherein the barrel temperature controller is provided for adjusting a temperature of the barrel according to the nozzle temperature controller device information.

10

74. The device according to item 73, wherein
the wireless transmitter comprises an analog to digital converter (ADC) for converting the nozzle temperature controller device information into a digital format,
such that the wireless transmitter can send the digitalised information.

15

75. The device according to item 73 or 74, wherein
the nozzle temperature controller comprises

- a passive component network that comprises an output terminal, wherein the output terminal provides a sensor threshold value, and
- at least one controller unit, the controller unit that comprises

- a sensor terminal for receiving a sensor measurement value,
- a threshold detector for receiving the sensor threshold value and the sensor measurement value,
- a power supply terminal for receiving electrical power,
- a heater terminal for providing electrical power to a heater, and

20

25

30

- a switch for providing the electrical power from the AC power supply terminal to the heater terminal when the threshold detector activates the switch.

5

76. The device according to item 75, wherein

the passive component network further comprises

- a power supply terminal for receiving a predetermined DC supply voltage,

10

- a machine mode selector switch with at least two machine mode selector positions for selectively connecting the power supply terminal to one of at least two variable machine mode resistors, and

- a material type selector switch with at least two material type selector positions for selectively connecting one of the at least two variable machine mode resistors to one of at least two material type resistors, and wherein

15

the output terminal is connected to the material type resistors.

20

77. The device according to item 75 or 76, wherein

the passive component network further comprises a pull-down resistor connecting to an electrical ground and to the output terminal.

25

78. The device according to one of items 75 to 77, wherein the threshold detector comprises a sample and hold input electrical circuit.

30

79. The device according to one of items 75 to 78, wherein the threshold detector further comprises a hysteresis circuit.

80. The device according to one of items 75 to 79, wherein the threshold detector further comprises a voltage comparator.
- 5
81. The device according to one of items 75 to 80, wherein the threshold detector further comprises a resistor network for converting an electrical current signal of an electrical current sensor to a voltage signal.
- 10
82. The device according to one of items 75 to 81, wherein the threshold detector comprises a pull-up circuit.
83. The device according to item 82, wherein
- 15 the pull-up circuit comprises a pull-up resistor.
84. The device according to item 83, wherein the pull-up circuit further comprises a capacitor connected in parallel to the pull-up resistor.
- 20
85. The device according to one of items 75 to 84, wherein the switch comprises a bidirectional triode thyristor.
86. The device according to one of items 75 to 84, wherein
- 25 the switch comprises a reverse blocking triode thyristor.
87. The device according to one of items 75 to 86, wherein the controller unit further comprises
- 30 an optical coupling device being actuated by the threshold detector, the threshold detector activates the switch via the optical coupling device.

88. The device according to item 87, wherein
the optical coupling device is energised by the thresh-
old detector when the sensor measurement value exceeds
the sensor threshold value.
- 5
89. The device according to item 87 or 88, wherein
the optical coupling device comprises a phototriac.
90. The device according to item 87 or 88, wherein
10 the optical coupling device comprises a phototransistor.
91. A method of controlling a temperature of an injection-
moulding machine, the method that comprises
transferring resin material from an injection-
15 moulding apparatus to a mould assembly,
actuating a mould assembly heater by a mould assem-
bly temperature controller,
transmitting mould assembly temperature controller
status information to an injection-moulding apparatus
20 temperature controller, and
actuating an injection-moulding apparatus heater by
the injection-moulding apparatus temperature controller
according to the mould assembly temperature controller
status information.
- 25
92. The method according to item 91, wherein
the mould assembly temperature controller status infor-
mation comprises a mould assembly temperature sensor
measurement value and a mould assembly pre-determined
30 temperature value.
93. The method according to item 92 or 93, wherein

the injection-moulding apparatus heater is energised when the mould assembly temperature sensor measurement value is less than the mould assembly pre-determined temperature value.

5

94. The method according to one of items 91 to 93, wherein the transmission of mould assembly temperature controller status information is performed in a wireless manner.

10

95. A pressure controller valve module comprising
a passive component network for providing a sensor threshold value and

15

at least one controller unit, wherein the controller unit that comprises

- a sensor terminal for receiving a pressure measurement value,
- an analog threshold detector
 - for receiving the sensor threshold value and the pressure measurement value and
 - for comparing the sensor threshold value with the pressure measurement value, wherein the comparison is done by an analog circuit,
- an optical coupling device being actuated by the

25

analog threshold detector,

- a power supply terminal for receiving a power supply,

30

- a valve terminal for actuating the valve, and
- an analog semiconductor power switch that comprises a thyristor device for providing an auto-trigger function in which an electrical current flows from the power supply terminal to the thyristor device via the optical

coupling device for triggering the thyristor device
when the optical coupling device is actuated.

96. The pressure controller valve module according to item
5 95, wherein
the analog threshold detector comprises a sample and
hold input electrical circuit.
97. The pressure controller valve module according to item
10 95 or 96, wherein
the analog threshold detector further comprises a hyste-
resis circuit.
98. The pressure controller valve module according to one of
15 items 95 to 97, wherein
the analog threshold detector further comprises a volt-
age comparator.
99. The pressure controller valve module according to one of
20 items 95 to 98, wherein
the analog threshold detector further comprises a resis-
tor network for converting an electrical current signal
of an electrical current sensor to a voltage signal.
- 25 100. The pressure controller valve module according to one of
items 95 to 99, wherein
the analog threshold detector comprises a pull-up cir-
cuit.
- 30 101. The pressure controller valve module according to item
100, wherein
the pull-up circuit comprises a pull-up resistor.

102. The pressure controller valve module according to item 101, wherein the pull-up circuit further comprises a capacitor connected in parallel to the pull-up resistor.
- 5
103. The pressure controller valve module according to one of items 95 to 102, wherein the analog semiconductor power switch comprises a bidirectional triode thyristor.
- 10
104. The pressure controller valve module according to one of items 95 to 103, wherein the analog semiconductor power switch comprises a reverse blocking triode thyristor.
- 15
105. The pressure controller valve module according to one of items 95 to 104, wherein the optical coupling device is energised by the analog threshold detector when the sensor measurement value exceeds the sensor threshold value.
- 20
106. The pressure controller valve module according to one of items 95 to 105, wherein the optical coupling device comprises a phototriac.
- 25
107. The pressure controller valve module according to one of items 95 to 105, wherein the optical coupling device comprises a phototransistor.
- 30
108. A mould assembly comprising
a movable die with a stationary die, the stationary die and the movable die defining a moulding cavity when

the stationary die and the movable die are in a closed state,

a supply nozzle for providing resin material to the moulding cavity,

5 a moving core for compressing the resin material within the moulding cavity,

a moulding cavity pin provided in the moulding cavity for receiving a pressure of the moulding cavity and

a pressure controller device that comprises

- 10 - a pressure sensor for receiving the moulding cavity pressure from the moulding cavity pin,
- a hydraulic pump,
- a cylinder-piston arrangement connecting to the hydraulic pump via a hydraulic line,

15 wherein the cylinder-piston arrangement is provided for asserting a force on the moving core when the cylinder-piston arrangement is actuated by the hydraulic pump,

wherein the hydraulic line comprises a valve
20 for adjusting the force on the moving core,
and

- a pressure controller unit for actuating the valve according to the moulding cavity pressure.

25

109. The mould assembly of item 108, wherein the moulding cavity pin comprises an ejector pin.

110. The mould assembly of item 108 or 109, wherein
30 the moulding cavity pin extends from the mould cavity to an ejector plate, the ejector plate being provided for activating the moulding cavity pin such that moulding

cavity pin removes a finished part of the moulding cavity from the moulding cavity.

111. The mould assembly of one of items 108 to 110, wherein
5 the pressure controller unit comprises a pressure controller valve module according to one of items 96 to 108.
112. An injection-moulding machine comprising
10 an injection-moulding apparatus and
a mould assembly according to item 108 to 111, the mould assembly being provided for receiving resin material from the injection-moulding apparatus and for shaping the resin material.
- 15 113. An injection-moulding machine comprising
a mould assembly that comprises
- a temperature controller device and
- a wireless transmitter for sending information
20 of the temperature controller device, and
a robotic arm unit for transferring at least one finished part to at least two bins, wherein the bin is selected according to the temperature controller device information.
- 25 114. The injection-moulding machine according to item 113, wherein
the temperature controller device information comprises a pre-determined sensor threshold value and a sensor
30 measurement value.
115. A method for assigning finished parts of an injection-moulding machine to bins, the method that comprises

selecting a reject bin type when a sensor measurement value of the injection-moulding machine is different from a pre-determined sensor threshold value.

- 5 116. An injection-moulding management system comprising
an injection-moulding machine with a display
screen, the display being provided for showing a sensor
threshold value and a sensor measurement value of the
injection-moulding machine and
10 a mobile computing device
- for receiving a status report, wherein the
status report comprises the sensor threshold
value and the sensor measurement value and
- for transmitting the status report to a serv-
15 er, wherein the server generates an alert us-
ing the status report.
117. The injection-moulding management system according to
item 116, wherein
20 the mobile computing device comprises a camera.

Although the above description contains much specificity,
this should not be construed as limiting the scope of the em-
bodiments but merely providing illustrations of the foreseea-
25 ble embodiments. Equivalent circuits of the electrical cir-
cuits illustrated in the description are possible.

The above stated features of the embodiments should not be
construed especially as limiting the scope of the embodiments
30 but merely to explain possible achievements if the described
embodiments are put into practice. Thus, the scope of the em-
bodiments should be determined by the claims and their equiv-
alents, rather than by the examples given.

REFERENCE NUMBERS

	12	voltage comparator
	14	inverting input pin
5	14'	inverting input pin
	16	non-inverting input pin
	16'	non-inverting input pin
	18	output pin
	20	capacitor
10	22	resistor
	23	RC circuit
	24	Light Emitting Diode (LED)
	25	anode pin
	26	input pin
15	27	ground pin
	28	optocoupler
	29	cathode pin
	30	emitter output pin
	31	collector output pin
20	32	gate pin
	34	Triode for Alternating Current (TRIAC)
	36	DC source
	37	optocoupler
	38	optocoupler
25	39	phototriac
	40	temperature-sensing device
	44	Main Terminal One (MT1) pin
	46	Main Terminal Two (MT2) pin
	46'	Main Terminal Two (MT2) pin
30	48	AC power supply
	50	heater
	51	diagrams
	52	TRIAC supply voltage

	54	IC sensor
	55	centigrade temperature sensor
	56	voltage step-down circuit
	57	temperature-sensor output node
5	58	first resistor
	59	second resistor
	60	step down output node
	61	thermocouple sensor
	62	DC power source
10	64	resistive trimmer
	65	RTD sensor
	66	resistive trimmer
	68	switch
	70	switch
15	72	resistor
	74	resistor
	76	resistor
	78	resistor
	80	resistor
20	82	plurality
	84	reference-voltage output pin
	86	end
	87	end
	89	node
25	90	end
	91	end
	92	node
	93	node
	95	node
30	97	node
	98	node
	99	node
	100	control circuit

	100'	control circuit
	102	node
	103	node
	104	node
5	200	reference voltage supply
	300	temperature controller
	400	injection-moulding machine
	410	mould injection apparatus
	413	mould assembly
10	417	stationary mould
	419	moveable mould
	422	moving apparatus
	425	nozzle
	428	internal cavity
15	430	screw mechanism
	433	heater element
	435	heater element
	437	temperature sensor
	439	temperature sensor
20	442	wire
	444	wire
	446	wire
	448	wire
	500	control circuit
25	502	electrical current comparator
	505	inverting input pin
	506	non-inverting input pin
	507	output pin
	509	electrical current reference supply
30	511	electrical current temperature-sensing device
	520	temperature control circuit
	525	thyristor
	527	anode terminal

	528	cathode terminal
	530	gate terminal
	535	diagram
	537	supply voltage
5	550	injection-moulding machine
	552	mould injection apparatus
	553	mould assembly
	559	manifold assembly
	561	moulding plate
10	562	back plate
	564	insulator spacer
	568	spacer block
	569	space
	577	cavity nozzle
15	578	stationary die
	586	runner
	590	casing
	592	voltage comparator
	594	first resistor
20	596	second resistor
	600	controller system
	603	first control module
	605	mould assembly
	607	second control module
25	609	injection-moulding apparatus
	610	reference voltage supply
	612	nozzle control circuit
	614	transmitter module
	616	output node
30	618	first input node
	619	first input node
	621	second input node
	623	second input node

	625	output node
	627	temperature-sensing device
	629	output node
	631	nozzle heater module
5	632	first ADC
	634	second ADC
	636	wireless transmitter device
	638	input port
	640	input port
10	642	output port
	644	output port
	646	input port
	648	output port
	650	transmitter antenna
15	655	receiver module
	657	barrel heater controller
	658	wireless receiver device
	660	receiver antenna
	662	input port
20	665	output port
	667	input port
	668	line
	669	output port
	670	line
25	671	barrel heater module
	673	input port
	674	robotic arm controller
	676	output port
	677	temperature graph
30	678	mould assembly reference temperature line
	679	mould assembly temperature line
	680	mould assembly temperature upper control line
	681	mould assembly temperature lower control line

	682	heater status graph
	683	mould assembly heater status line
	684	temperature graph
	685	adjustable reference temperature line
5	686	injection-moulding apparatus temperature line
	687	injection-moulding apparatus temperature upper control line
	688	injection-moulding apparatus temperature lower control line
10	689	heater status graph
	690	injection-moulding apparatus heater status line
	691	robotic arm unit
	692	flow chart
	693	step
15	694	step
	695	step
	695	step
	696	step
	697	step
20	700	comparator device
	702	comparator
	704	non-inverting input node
	706	inverting node input
	707	output node
25	709	first resistor
	711	first input pin
	713	second resistor
	715	second input pin
	720	comparator device
30	723	comparator
	725	sample and hold module
	727	sample and hold module
	729	first capacitor

	731	first switch
	800	injection-moulding machine
	811	mould injection apparatus
	812	die assembly
5	813	stationary die
	814	movable die
	815	cavity plate
	816	cavity
	817	channel
10	818	moving core
	819	moving apparatus
	820	core plate
	821	outlet
	822	wedge
15	823	lifting block
	824	ejector pin
	825	hydraulic piston
	826	runner insert
	827	inclined surface
20	828	clamping plate
	829	inclined surface
	830	injection head insert
	831	piston rod
	832	runner
25	833	bed
	834	pressure sensor
	836	intermediary plate
	835	moulding cavity ejector pin
	837	proportional valve
30	838	base clamp plate
	839	knee lever mechanism
	840	support ring
	841	hydraulic piston

	842	inferior ejector plate
	844	superior ejector plate
	845	central opening
	847	central opening
5	850	pressure controller
	851	pressure valve controller
	852	hydraulic line
	853	hydraulic line
	854	hydraulic line
10	857	pressure sensor module
	859	voltage step-down circuit
	861	output node
	863	resistor
	865	second resistor
15	867	step-down output node
	870	sensor unit
	872	power unit
	875	connection coaxial cable
	877	piezoelectric element
20	879	amplifier device
	881	MOSFET transistor
	893	sensor unit electrical ground
	895	capacitor
	897	bias resistor
25	899	bipolar transistor
	900	DC voltage source
	903	current regulation diode
	905	coupling capacitor
	906	amplifier device electrical ground
30	907	output coaxial cable
	909	pull-down resistor
	912	monitoring voltage meter
	950	injection-moulding machine

	955	pressure sensor
	957	solenoid valve
	960	piezoelectric element
	965	hydraulic pump
5	968	oil reservoir
	980	management system
	982	injection-moulding machine
	983	display terminal
	985	mobile phone
10	986	server
	R1	resistor
	R2	resistor
	R3	resistor

CLAIMS

1. A temperature controller module for an injection-
moulding machine, the temperature controller module com-
prising
5 a passive component network for providing a sensor
threshold signal and
at least one controller unit, wherein the control-
ler unit comprises
10 - a sensor terminal for receiving a sensor measure-
ment signal,
- an analog threshold detector for receiving and for
comparing the sensor threshold signal and the sen-
sor measurement signal, wherein the comparison is
15 done by an analog circuit,
- an optical coupling device being actuated by the
threshold detector,
- a power supply terminal for receiving an AC power
supply,
20 - a heater terminal for providing electrical energy
to a heater, and
- an analog semiconductor power switch that a thyris-
tor device for providing an auto-trigger function
in which
25 an electrical current flows from the power supply
terminal to the thyristor device via the optical
coupling device for triggering the thyristor device
when the optical coupling device is actuated,
wherein
30 the threshold detector comprises a sample and hold input
electrical circuit.

2. The temperature controller module according to claim 1,
wherein
the passive component network comprises
- a power supply terminal for receiving a pre-
 - 5 determined DC supply voltage,
 - a machine mode selector switch with at least two
machine mode selector positions for selectively
connecting the power supply terminal to one of at
least two variable machine mode resistors,
 - 10 -
 - a material type selector switch with at least two
material type selector positions for selectively
connecting one of the at least two variable machine
mode resistors to one of at least two material type
resistors, and
 - 15 -
 - an output terminal for providing a sensor threshold
signal, the output terminal being connected to the
material type resistors.
3. The temperature controller module according to claim 1,
20 wherein
the passive component network comprises a pull-down re-
sistor connecting to an electrical ground and to the
output terminal.
- 25 4. The temperature controller module according to claim 1,
wherein
the threshold detector further comprises a hysteresis
circuit.
- 30 5. The temperature controller module according to claim 1,
wherein
the threshold detector further comprises a voltage com-
parator.

6. The temperature controller module according to claim 1,
wherein
the threshold detector further comprises a resistor net-
work for converting an electrical current signal of an
electrical current sensor to a voltage signal.
- 7 The temperature controller module according to claim 1,
wherein
the threshold detector comprises a pull-up circuit.
8. The temperature controller module according to claim 7,
wherein
the pull-up circuit comprises a pull-up resistor.
9. The temperature controller module according to claim 8,
wherein
the pull-up circuit further comprises a capacitor con-
nected in parallel to the pull-up resistor.
10. The temperature controller module according to claim 1,
wherein
the thyristor device comprises a bidirectional triode
thyristor.
11. The temperature controller module according to claim 1,
wherein
the thyristor device comprises a reverse blocking triode
thyristor.
12. The temperature controller module according to claim 1,
wherein

the optical coupling device is energised by the threshold detector when the sensor measurement signal exceeds the sensor threshold signal.

- 5 13. The temperature controller module according to claim 1,
wherein
the optical coupling device comprises a phototriac.
14. The temperature controller module according to claim 1,
10 wherein
the optical coupling device comprises a phototransistor.
15. A mould assembly comprising
a moulding cavity,
15 a supply nozzle for providing resin material to the
moulding cavity, and
a temperature controller device according to claim
1 mounted on the mould assembly, the temperature con-
troller device being provided for adjusting a tempera-
20 ture of the supply nozzle.
16. An injection-moulding machine comprising
an injection-moulding apparatus and
a mould assembly of claim 15, the mould assembly
25 being provided for receiving resin material from the in-
jection-moulding apparatus and for shaping the resin ma-
terial.
17. A temperature controller module for an injection-
30 moulding machine, the temperature controller module com-
prising
a passive component network that comprises

- a power supply terminal for receiving a pre-determined DC supply voltage,
- a material type selector switch with at least two material type selector positions for selectively connecting the pre-determined DC supply voltage to one of at least two material type components, and
- an output terminal for providing a sensor threshold value, the output terminal being connected to the material type components, and at least one analog controller unit, the analog controller unit that comprises
 - a sensor terminal for receiving a sensor measurement value,
 - a threshold detector for receiving the sensor threshold value and the sensor measurement value,
 - a power supply terminal for receiving a power supply,
 - a heater terminal for providing electrical energy to a heater, and
 - a switch for providing the power supply from the power supply terminal to the heater terminal when the threshold detector activates the switch,

wherein

values of the at least two material type components follow a pre-determined ratio, the ratio being formed by at least two numbers, the number being taken from one group of a set of groups, the set comprises a first group, a second group, a third group, a fourth group, and a fifth group,

the first group comprises numbers ranging from [102 minus 10 % (percent)] to [102 plus 10%],
the second group comprises numbers ranging from [118 minus 10%] to [118 plus 10%],
5 the third group comprises numbers ranging from [137 minus 10%] to [137 plus 10%],
the fourth group comprises numbers ranging from [169 minus 10%] to [169 plus 10%], and
the fifth group comprises numbers ranging from [196 minus
10 nus 10%] to [196 plus 10%].

18. A method of calibrating a temperature controller device for an injection-moulding machine,
the method comprising
15 choosing a resin material type and a sensor type,
choosing a mode of the injection-moulding machine,
setting a material type selector switch of a passive component network according to the resin material type,
20 setting a machine mode selector switch of the passive component network according to the mode of the injection-moulding machine,
measuring a voltage of the passive component network, and
25 adjusting a variable resistor of the passive component network until the measured voltage essentially reaches a value that is determined according to the chosen resin material type, to the chosen sensor type, and to the chosen mode of the mould injecting machine.
30
19. A temperature controller device for provision within a manifold chamber assembly of an injection-moulding machine, temperature controller device comprising

a temperature controller module and
a casing enclosing the temperature controller module, the casing that comprises a first outer dimension of less than or equal to 60 mm, a second outer dimension of less than 100 mm and a third outer dimension of less than or equal to 30 mm.

20. A mould assembly comprising

a back plate that comprises a receiving cavity for receiving resin material,

a moulding plate that comprises at least one moulding cavity for shaping the resin material,

a supply nozzle with a manifold assembly for providing the resin material from the receiving cavity to the moulding cavity, and

a temperature controller unit for adjusting a temperature of the supply nozzle,

wherein the back plate and the moulding plate are separated by a distance,

wherein the back plate and the moulding plate define a chamber for enclosing the manifold assembly and the temperature controller device.

21. A device comprising

an injection-moulding apparatus that comprises

- a barrel for receiving resin material and for melting the resin material and

- a barrel temperature controller device and

a mould assembly that comprises

- a moulding cavity,

- a supply nozzle for channelling the resin material to the moulding cavity,

- a nozzle temperature controller device mounted on the mould assembly, and
- a wireless transmitter for sending information of the nozzle temperature controller device,

5 wherein the injection-moulding apparatus further comprises a wireless receiver for receiving the nozzle temperature controller device information,

wherein the nozzle temperature controller device is provided for adjusting a temperature of the supply nozzle,
10 and

wherein the barrel temperature controller is provided for adjusting a temperature of the barrel according to the nozzle temperature controller device information.

- 15 22. A method of controlling a temperature of an injection-moulding machine, the method that comprises
- transferring resin material from an injection-moulding apparatus to a mould assembly,
 - actuating a mould assembly heater by a mould assembly temperature controller,
 - 20 transmitting mould assembly temperature controller status information to an injection-moulding apparatus temperature controller, and
 - actuating an injection-moulding apparatus heater by
 - 25 the injection-moulding apparatus temperature controller according to the mould assembly temperature controller status information.

23. A pressure controller valve module comprising
- 30 a passive component network for providing a sensor threshold value and
- at least one controller unit, wherein the controller unit that comprises

- a sensor terminal for receiving a pressure measurement value,
- an analog threshold detector
 - for receiving the sensor threshold value and the pressure measurement value and
 - for comparing the sensor threshold value with the pressure measurement value, wherein the comparison is done by an analog circuit,
- an optical coupling device being actuated by the analog threshold detector,
- a power supply terminal for receiving a power supply,
- a valve terminal for actuating the valve, and
- an analog semiconductor power switch that comprises a thyristor device for providing an auto-trigger function in which an electrical current flows from the power supply terminal to the thyristor device via the optical coupling device for triggering the thyristor device when the optical coupling device is actuated.

24. A mould assembly comprising

- a movable die with a stationary die, the stationary die and the movable die defining a moulding cavity when the stationary die and the movable die are in a closed state,
- a supply nozzle for providing resin material to the moulding cavity,
- a moving core for compressing the resin material within the moulding cavity,
- a moulding cavity pin provided in the moulding cavity for receiving a pressure of the moulding cavity and
- a pressure controller device that comprises

- a pressure sensor for receiving the moulding cavity pressure from the moulding cavity pin,
- a hydraulic pump,
- a cylinder-piston arrangement connecting to the hydraulic pump via a hydraulic line, wherein the cylinder-piston arrangement is provided for asserting a force on the moving core when the cylinder-piston arrangement is actuated by the hydraulic pump,
- wherein the hydraulic line comprises a valve for adjusting the force on the moving core, and
- a pressure controller unit for actuating the valve according to the moulding cavity pressure.

25. An injection-moulding machine comprising a mould assembly that comprises

- a temperature controller device and
- a wireless transmitter for sending information of the temperature controller device, and

a robotic arm unit for transferring at least one finished part to at least two bins, wherein the bin is selected according to the temperature controller device information.

26. A method for assigning finished parts of an injection-moulding machine to bins, the method that comprises selecting a reject bin type when a sensor measurement value of the injection-moulding machine is different from a pre-determined sensor threshold value.

27. An injection-moulding management system comprising

an injection-moulding machine with a display screen, the display being provided for showing a sensor threshold value and a sensor measurement value of the injection-moulding machine and

5 a mobile computing device

- for receiving a status report, wherein the status report comprises the sensor threshold value and the sensor measurement value and
 - for transmitting the status report to a serv-
- 10 er, wherein the server generates an alert using the status report.

ABSTRACT

MICRO-TEMPERATURE CONTROLLER

5 The application provides a temperature controller module for
an injection-moulding machine. The temperature controller
module comprises a resistor network and at least one analog
controller device. The resistor network comprises a power
supply terminal, a machine mode selector switch with at least
10 two machine mode selector positions, a material type selector
switch with at least two material type selector positions,
and an output terminal. The output terminal is connected to
the material type resistors. The analog controller device
comprises a sensor terminal, a threshold detector, an optical
15 coupling device, an AC power supply terminal, a heater termi-
nal, and an analog semiconductor power switch. The threshold
detector comprises a sample and hold input electrical cir-
cuit.

20 (Fig. 1)