

“Temperature Control for a Solar Collector”**Field of the Invention**

The invention relates to a means of controlling the temperature of a solar collector and particularly for preventing stagnation temperatures..

5 Background Art

The following discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

- 10 One application of the invention relates to solar water heaters. In the case of solar water heaters the uncontrolled solar heat absorption by a solar collector generally results in the excessive heating of the systems primary heat transfer fluid being heated by the solar collector. During times of low demand or no usage of the hot water being stored and high solar insolation, the temperature in the
- 15 system will rise to its stagnation point which, in the case of solar tubes, can be in excess of 250 degrees C. This condition will often cause damage to the systems components or create an unsafe set of conditions for the user. In addition the likelihood of the water being over heated has required the application of a number of requirements to ensure that the users of the hot water are not endangered.
- 20 Such requirements can include the control of the water being delivered to a hot water outlet to ensure that it is at a safe temperature. In addition the excessive heating can result in the vaporisation of the heat exchange medium passing through the solar collector and/or chemical reactions within in the heating medium resulting in scaling or the precipitation of solids from the liquid. As a result of
- 25 these problems it is common practice to accommodate for the excessive heating by under-designing a solar water heating system to avoid the excessive heating at

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times when the solar insolation is high, however this means that the system will underperform on days of low solar insolation.

The invention has particular application to solar collectors which utilise a "solar tube". Whilst solar tubes are very effective and efficient in collection of solar energy they do present a problem resulting from stagnation as outlined above. This can particularly be the case in climates which are subject to a high degree of solar insolation.

Disclosure of the Invention

Throughout the specification and claims, unless the context requires otherwise the term "solar tube" shall be taken as comprising a dual walled tube having two ends and a generally circular cross section wherein the dual walls define between themselves a closed space which has been evacuated and the interior of the tube is intended in use to accommodate a medium to be heated which can comprises a fluid and/or a heat exchanger or a like means which is to be heated. In some cases one end of the solar tube is closed.

Throughout the specification and claims, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Accordingly the invention resides in a solar collector temperature control intended for use with a solar collector, said solar collector comprising at least one solar tube, the interior of the solar tube in use accommodating a heat exchanger or a like means and/or heat exchange medium, said temperature control comprising a controller and a shield, the shield associated with the outer wall of the solar tube and extending for at least a portion of the length of the solar tube, said shield having an angular extent sufficient to extend partially around the solar tube, the shield supported to be rotatable about the central axis of the solar tube between a

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first position remote from the source of radiation and a second position most proximate the source of radiation, the control further comprising a sensor adapted to sense the temperature of the a heat exchanger or a like means and/or heat exchange medium accommodated by the solar tube, a drive operatively controlled
5 by the controller to cause rotation of the shield around the central axis of the solar tube between the first and second position depending upon the temperature of the heat exchanger or like means and/or medium accommodated within the interior of the solar tube.

According to a preferred feature of the invention the shield is supported to be
10 rotatable about the central axis of the solar tube to a range of positions including a first position remote from the source of radiation and a second position most proximate the source of radiation.

According to a preferred feature of the invention the angular extent of the shield is approximately 180°.

15 According to a preferred feature of the invention the shield extends for substantially the full length of the solar tube.

According to a preferred feature of the invention wherein the outer face of the shield is reflective of solar radiation.

According to a preferred feature of the invention wherein the inner face of the
20 shield is reflective of solar radiation.

According to a preferred feature of the invention wherein the shield comprises an elongate member which is supported in parallel relationship to the tube to be concentrically rotatable around the central axis. According to a preferred feature of the invention the shield is supported to be angularly displaceable relative to the
25 solar tube. According to an alternative preferred feature of the invention the shield is supported from the solar tube and wherein the solar tube is supported to

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be angularly displaceable about the central axis. According to a preferred feature of the invention the operative connection to the drive comprises a toothed formation provided in association with the shield, said toothed formation being engaged with a threaded pinion which is caused to rotate to cause the rotation of the shield. According to a preferred feature of the invention the operative connection to the drive comprises a toothed formation provided in association with the solar tube, said toothed formation being engaged with a threaded pinion which is caused to rotate to cause the rotation of the solar tube.

According to a preferred feature of the invention the shield is supported from the solar tube from at least one location along the length of the solar tube and wherein said solar tube is supported to be rotatable about its central axis, said drive being operatively connected to the solar tube to cause said rotation. According to a preferred feature of the invention the shield is supported from one end portion of the tube. According to an alternative preferred feature of the invention the shield is supported from at least each end portion of the tube.

According to a preferred feature of the invention the shield comprises a portion of the outer wall on the solar tube which is treated to be opaque to solar radiation and wherein said solar tube is supported to be rotatable about its central axis said drive being operatively connected to the solar tube to cause said rotation. According to a preferred feature of the invention the shield comprises a coating which is applied to the solar tube. According to an alternative preferred feature of the invention the coating comprises a tape which is adhered to the solar tube. According to an alternative preferred feature of the invention the coating comprises a film applied to the solar tube.

According to a preferred feature of the invention the operative connection to the drive comprises a toothed formation provided in association with the solar tube. According to a preferred feature of the invention the toothed formation is associated with a hub element which is grippingly received over one end of the solar tube. According to a preferred feature of the invention the hub element is

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rotatably received in a housing which accommodates the drive. According to a preferred feature of the invention the one end of the solar tube is the closed end.

According to an alternative preferred feature of the invention the one end of the solar tube is the open end.

- 5 According to a preferred feature of the invention the hub element comprises a moulded element having an internal configuration complementary to the one end and the toothed formation is formed around the outer surface of the hub element.

- According to a preferred feature of the invention the drive comprises a toothed sprocket provided on a drive shaft and said toothed formation is provided by a
10 further toothed sprocket, said drive further comprising an endless chain drivingly which interconnects the sprockets.

- According to a preferred feature of the invention the drive includes an element which is subjected to the temperature conditions which are representative of the temperature conditions of the heat exchanger or like means and/or medium
15 accommodated within the interior of the solar tube and wherein the element will undergo longitudinal expansion and contraction resulting from temperature change.

- According to a preferred feature of the invention the drive includes an electric motor. According to a preferred feature of the invention the electrical power to the
20 electrical motor is derived from a photoelectric device. According to a preferred feature of the invention the photoelectric device is connected to an electrical storage battery which and the motor is driven from the battery and/or the photoelectric device.

- The invention will be more fully understood in light of the following description of
25 several specific embodiments.

Brief Description of the Drawings

The invention will be more fully understood in light of the accompanying drawings of which:

Figure 1 is the general isometric view of a solar collector incorporating a temperature control according to the first embodiment;

Figure 2 is a part isometric view illustrating the driving connection for the shields illustrating the shields in their non-shielding position according to the first embodiment;

Figure 3 is an isometric view corresponding to Figure 2 illustrating the shields according to the first embodiment in their shielding positions;

Figure 4 is an enlarged end elevation of a solar tube illustrating the driving connection for the shield according to the first embodiment;

Figure 5 is an isometric view of the support provided for the shield and drive pinions according to first embodiment

Figure 6 is a partial isometric view of a solar collector incorporating a temperature control according to the second embodiment;

Figure 7 is a sectional partial side elevation of the solar collector incorporating a temperature control according to the second embodiment; and

Figure 8 is an isometric view showing the drive according to the second embodiment.

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Detailed Description of Specific Embodiments

The first embodiment as shown at Figures 1 to 5 relates to a stagnation control which can be utilised with a solar collector where the solar collector comprises a set of solar tubes 11 which are supported from a support base 13 in a substantially in parallel relationship with respect to each other. Each of the solar tubes has a closed end and an open end. The support base 23 provides an upper housing 15 from which the open end of the solar tubes are supported and a set of upstanding supports 17 which receive and support the closed ends of the solar tubes 11 which are lowermost. The support for the solar tubes is such that the solar tubes are able to rotate about the central longitudinal axis of the solar tube within the supports provided by the base. Each solar tube is associated with a heat exchanger or like means and/or a medium accommodated within the interior of the solar tube

Each of the solar tubes is associated with a shield 19 which extends substantially the full length of the solar tube. Both the inner and outer face of the shield 19 are reflective of solar radiation. Each shield extends for the length of the respective solar tube and is curved transversely. In addition each shield is supported to be concentric with the solar tube and has a lateral extent such that is disposed angularly 180 degrees around the tube. The open end of the solar tube 11 is supported from an annular hub which is frictionally or adhesively retained on the solar tube to be fixed relative to the solar tube. The closed end of the solar tube is rotatably received within the respective upstanding support 17 which provides the rotatable support for the solar tube through a suitable bearing. As a result of the support provided by the base, the solar tube is maintained in alignment throughout rotation of the solar tube.

The annular hub 21 at the open end of the solar tube is rotatably supported from an upstanding support member 23 within the housing to provide the support for the solar tube from the respective support. The hub 21 is formed with a toothed outer periphery. The housing 15 also supports a threaded pinion 25 which

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extends substantially the full length of the extent of the housing 15 and which is positioned such that the threaded formation on the pinion 25 is threadably engaged with the toothed periphery of the annular hub 21. As shown at Figure 5 the threaded pinion is accommodated within tubular journal 27 provided in the housing wherein the journal is provided with openings at positions corresponding with the position of each annular hub 21 to enable engagement between the toothed periphery of the annular hub 21 and the pinion 25. The pinion is drivingly connected to an electric motor 29 and if desired the electricity provided for driving the motor 29 can be derived from a photoelectric device.

10 The operation of the motor 27 is effected from a controller which is associated with a temperature sensor adapted to sense the temperature of the heat exchanger or like means and/or medium accommodated within the interior of at least one solar tube.

In operation and under a solar collecting mode the shield is located such that is most remote from the source of solar radiation and such that the solar tubes are fully exposed to the solar radiation. In the event of the heat exchanger or like means or the medium in at least one of the solar tubes being heated to an undesirable temperature the control causes activation of the drive motor 29 which will in turn cause rotation of the pinion shaft 25 which in turn will cause rotation of the one hub 21 and thus rotation of the solar tubes and the attached shields 19 to a position at which the shield overlies at least a portion of the solar tube to reduce the amount of solar radiation which is incident upon the inner wall of the solar tube. The degree of rotation of the solar tube will depend upon the degree of overheating of the medium contained within the solar tube. Under the most extreme conditions the shield will occupy a position fully overlying the solar tube as shown at Figure 3 to prevent the incidence of any solar radiation on the solar tube. The reflective nature of the outer face of the shield will ensure that when the shield is overlying the solar tube any solar radiation incident thereon will be reflected and the degree of heating of the solar tube will be minimised.

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Furthermore the inner face of the shield is rendered reflective. This serves to maximise the collection of solar radiation which is incident on the solar tube when the shield is in its remote position as shown at Figure 2. Under normal circumstances the solar radiation which is incident on the space between the dual
5 walls of the solar tube and to each side of the inner wall will not be collected. The presence of the reflective inner face of the shield serves to reflect such solar radiation such that it will be reflected on to the rear portion of inner wall of the solar tube.

According to a further feature of the embodiment, the drive can be activated in the
10 event of hazardous weather conditions such as high winds or hail or heavy rain in order that the solar tubes can be caused to rotate to a position where the shields occupy an overlying position over the solar tube to prevent damage to the solar tubes. In addition the drive can be activated at night in order that the solar tubes can be caused to rotate to a position where the shields occupy an overlying
15 position over the solar tube to prevent radiation loss from the solar tubes.

The second embodiment of the invention is illustrated at Figures 6 to 8. The second embodiment comprises a shield 19 which is reflective on both the inner and outer face and which comprises a coating which in the case of the embodiment takes the form of a tape which is adhered to the outer face of the
20 solar tube to extend for the full length of the tube and 180 degrees around the tube. In addition in the case of the second embodiment, the open ends of the solar tubes are rotatably supported from supports (not shown) which receive and support the open ends of the solar tubes 11 to allow for the free rotation of the solar tubes. The lowermost closed ends are also rotatably supported from a
25 housing 15 which accommodates a drive which is arranged and configured to cause the controlled rotation of the solar tubes. The closed ends of the solar tubes are supported from the housing through hub elements 31. Each hub element comprises a moulding having a cup shaped receptacle 33 at one end which is shaped to snugly receive the closed end of the solar tube 11 and such

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that it is fixed relative to the solar tube . The other end of the hub is formed as a spigot 35 which extends axially from the receptacle and is received through the adjacent wall of 23 of the housing. The spigot has an outer portion 37 which is of a reduced diameter and is snugly retained in an axial socket 39 of a sprocket 41
5 which is rotatably supported by an inner element 43.

The inner element 43 comprises a rectangular hollow section which is received within a section which forms the housing 15. The inner element comprises a pair of channel elements 43a and 43b which are fixed together in opposed relation to each other to define an enclosed longitudinal space. The sprockets associated
10 with each solar tube are supported from the opposed walls of the inner element 43 by bearings 45 and 47 within the space defined by the channel sections 43a and 43b and are drivingly interconnected by an endless chain 49. One end sprocket 41a (see Figures 7 and 8) is associated with an electric drive motor 29 which is associated with a controller to cause joint rotation of the solar tubes in
15 accordance with the temperature of the interior of the solar tubes as described in relation to the first embodiment.

It is a future feature of the second embodiment that the power for the electric motor 29 is to be derived from an electrical storage battery which is charged from a photo electric device positioned to collect incident solar radiation. The power
20 supply can be modified such that in the event of there being no solar incident on the photoelectric device and there being an inadequate charge being present in the battery the motor 29 can be powered from a Mains supply or an alternative electrical source..

According to a further feature of the second embodiment of the invention the drive
25 for the solar tubes may also be controlled in accordance with the position of the sun relative to the collector such that the solar tubes will rotate in order to track the movement of the sun and in order that the shields are at their most remote position from the sun throughout the day thus serving to maximise the collection capacity of the solar tube.

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A further feature of the second embodiment is to have the controller programmed such that on nightfall the shields are caused to rotate to cover the solar tube. This serves to reduce heat loss as a result of radiation from the solar tubes and to provide some insulating capacity for the solar tubes.

- 5 According to an alternative embodiment of the invention the shield takes the form of a treatment and/or a coating and/or a film which is applied to a portion of outer wall of the solar tubes and the solar tubes are rotatably supported in the housing. The treatment can comprise a reflective coating and/or film applied to the inner or outer surface of the outer wall where the coating extends for the full length of the
10 tube but has an angular extent of 180 degrees.

According to an alternative embodiment of the invention the solar tubes are fixed relative to the base and the shields are supported to be rotatable about the central longitudinal axis of the respective tube.

- According to alternative embodiments of the invention the drive for the pinion and
15 actuator need not be through an electrical motor but may be by the means of any other suitable device. In addition the drive for effecting rotation of the solar tubes and/or shields of the previous embodiments need not be restricted to the driving arrangement shown in the drawings and described in relation to the first embodiment. An alternative driving arrangement is one comprising a rack and
20 pinion drive associated with a linear actuator where the linear actuator is controlled by utilisation of the expansion and contraction of an element which is the subject of the temperature conditions representative of the temperature conditions within the solar tubes.

- The present invention is not to be limited in scope by any of the specific
25 embodiments described herein. These embodiments are intended for the purpose of exemplification only. Functionally equivalent products, structures and methods are clearly within the scope of the invention as described herein.

Claims

The Claims Defining the Invention is as Follows:

1. A solar collector temperature control intended for use with a solar collector, said solar collector comprising at least one solar tube, the interior of the solar tube in use accommodating a heat exchanger or a like means and/or heat exchange medium, said temperature control comprising a controller and a shield, the shield associated with the outer wall of the solar tube and extending for at least a portion of the length of the solar tube, said shield having an angular extent sufficient to extend partially around the solar tube, the shield supported to be rotatable about the central axis of the solar tube between a first position remote from the source of radiation and a second position most proximate the source of radiation, the control further comprising a sensor adapted to sense the temperature of the a heat exchanger or a like means and/or heat exchange medium accommodated by the solar tube, a drive operatively controlled by the controller to cause rotation of the shield around the central axis of the solar tube between the first and second position depending upon the temperature of the heat exchanger or like means and/or medium accommodated within the interior of the solar tube.
2. A solar collector temperature control as claimed at claim 1 wherein the shield is supported to be rotatable about the central axis of the solar tube to a range of positions including a first position remote from the source of radiation and a second position most proximate the source of radiation.
3. A solar collector temperature control as claimed at claim 1 or 2 wherein the angular extent of the shield is approximately 180°.
4. A solar collector temperature control as claimed at claim 1 or 2 or 3 wherein the shield extends for substantially the full length of the solar tube.

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5. A solar collector temperature control as claimed at any one of the preceding claims wherein the outer face of the shield is reflective of solar radiation.
6. A solar collector temperature control as claimed at any one of the preceding claims wherein the inner face of the shield is reflective of solar radiation.
- 5 7. A solar collector temperature control as claimed at any one of the preceding claims wherein the shield comprises an elongate member which is supported in parallel relationship to the tube to be concentrically rotatable around the central axis.
- 10 8. A solar collector temperature control as claimed at claim 7 wherein the shield is supported to be angularly displaceable relative to the solar tube.
9. A solar collector temperature control as claimed at claim 7 wherein the shield is supported from the solar tube and wherein the solar tube is supported to be angularly displaceable about the central axis.
- 15 10. A solar collector temperature control as claimed at claim 7 or 8 wherein the operative connection to the drive comprises a toothed formation provided in association with the shield, said toothed formation being engaged with a threaded pinion which is caused to rotate to cause the rotation of the shield.
- 20 11. A solar collector temperature control as claimed at claim 7 or 9 wherein the operative connection to the drive comprises a toothed formation provided in association with the solar tube, said toothed formation being engaged with a threaded pinion which is caused to rotate to cause the rotation of the solar tube.
- 25 12. A solar collector temperature control as claimed at any one of claims 1 to 6 wherein the shield is supported from the solar tube from at least one location along the length of the solar tube and wherein said solar tube is supported to

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be rotatable about its central axis, said drive being operatively connected to the solar tube to cause said rotation.

13. A solar collector temperature control as claimed at claim 12 wherein the shield is supported from one end portion of the tube.
- 5 14. A solar collector temperature control as claimed at claim 12 wherein the shield is supported from at least each end portion of the tube.
- 10 15. A solar collector temperature control as claimed at any one of claims 1 to 6 wherein the shield comprises a portion of the outer wall on the solar tube which is treated to be opaque to solar radiation and wherein said solar tube is supported to be rotatable about its central axis said drive being operatively connected to the solar tube to cause said rotation.
16. A solar collector temperature control as claimed at claim 15 wherein the shield comprises a coating which is applied to the solar tube.
- 15 17. A solar collector temperature control as claimed at claim 16 wherein the coating comprises a tape which is adhered to the solar tube.
18. A solar collector temperature control as claimed at claim 17 wherein the coating comprises a film applied to the solar tube.
- 20 19. A solar collector temperature control as claimed at any one of claims 9 and 12 to 18 wherein the operative connection to the drive comprises a toothed formation provided in association with the solar tube.
20. A solar collector temperature control as claimed at claim 19 wherein the toothed formation is associated with a hub element which is grippingly received over one end of the solar tube.

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21. A solar collector temperature control as claimed at claim 20 wherein the hub element is rotatably received in a housing which accommodates the drive.
22. A solar collector temperature control as claimed at claim 20 or 21 wherein the one end of the solar tube is the closed end.
- 5 23. A solar collector temperature control as claimed at claim 20 or 21 wherein the one end of the solar tube is the open end.
- 10 24. A solar collector temperature control as claimed at claim 20, 21 or 22 or 23 wherein the hub element comprises a moulded element having an internal configuration complementary to the one end and the toothed formation is formed around the outer surface of the hub element.
- 15 25. A solar collector temperature control as claimed at any one of claims 19 to 24 wherein the drive comprises a toothed sprocket provided on a drive shaft and said toothed formation is provided by a further toothed sprocket said drive further comprising an endless chain which drivingly interconnects the sprockets.
- 20 26. A solar collector temperature control as claimed at any one of the preceding claims wherein the drive includes an element which is subjected to the temperature conditions which are representative of the temperature conditions of the heat exchanger or like means and/or medium accommodated within the interior of the solar tube and wherein the element will undergo longitudinal expansion and contraction resulting from temperature change.
27. A solar collector temperature control as claimed at any one of claims 1 to 25 wherein the drive includes an electric motor.

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28. A solar collector temperature control as claimed at claim 27 wherein the electrical power to the electrical motor is derived from a photoelectric device.
29. A solar collector temperature control as claimed at claim 28 wherein the photoelectric device is connected to an electrical storage battery which and the motor is driven from the battery and/or the photoelectric device.
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