



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.11.2016 Bulletin 2016/45

(51) Int Cl.:
E06B 7/096 (2006.01) **E06B 9/386** (2006.01)
E06B 9/24 (2006.01)

(21) Application number: **15461528.0**

(22) Date of filing: **04.05.2015**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(71) Applicant: **Politechnika Rzeszowska im. Ignacego Lukasiewicza**
35-959 Rzeszów (PL)

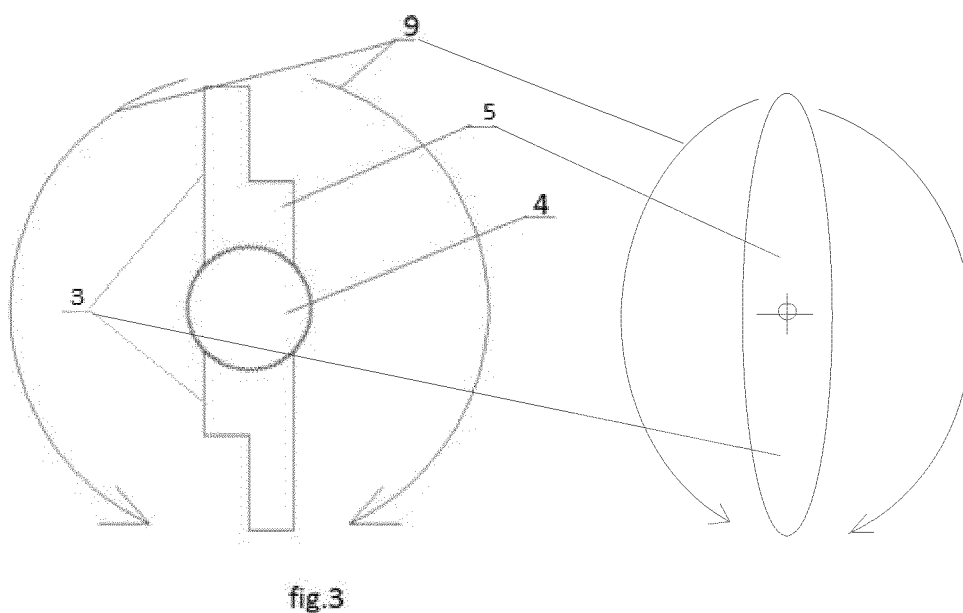
(72) Inventors:
• **Licholai, Lech**
35-077 Rzeszów (PL)
• **Musiał, Micha**
37-700 Przemyśl (PL)
• **Szyszka, Jerzy**
35-210 Rzeszów (PL)

(74) Representative: **Rumpel, Alicja**
Rumpel sp. k.
Al. Smigłego-Rydza 29/11
93-281 Łódź (PL)

(54) **MOBILE WINDOW INSULATION**

(57) Mobile window insulation in the form of blinds, preferably horizontal or vertical, made of strips 3 with rotation ability up to 90° in both directions 9 vs. the longitudinal axis of the strip, where the inside of the strip 3 encloses a filling 5 of phase change material (PCM) of organic origin, with phase change heat value of 90-230 kJ/kg and phase change temperature (solid body - fluid)

in the range of 17-25°C. Change phase materials (PCM) were selected out of: the esters of carboxylic acids, preferably the ester of palmitic acid and propanol and/or mixtures of saturated fatty acids, preferably the mixture of caprylic and lauric acid and/or PEG600 ethylene glycol polymere and/or the mixture of alkanes.



Description

[0001] The subject of the invention is mobile window insulation which plays a storing-reflecting function.

[0002] Over the recent years, new solutions have continuously been implemented, the goal of which is the reduction of energy, necessary to maintain air temperature at building's indoor premises within the (temperature) range of of thermal comfort.

[0003] One of the solutions, which support the above-mentioned assumptions, are blinds or shades, which reduce heat losses with their transparent barriers in winter months, while preventing indoor premises from excessive heating in summer season. While reviewing scientific literature, it is possible to come across a number of solutions which counteract, by means of transparent barriers, heat flow to and from building structures, however, only few solutions assume making use of accumulated heat energy, absorbed from solar radiation energy during the day (especially in the transient season) in order to reduce the 24-hour gradient of building's indoor air temperature.

[0004] The solution, described in "Review of passive PCM latent heat thermal energy storage systems towards buildings' energy efficiency" Soares N, Costa J.J, Gaspar A. R, Santos P. Energy and Buildings Volume 59, April 2013, Pages 82-103 uses PCM (phase change materials) in mobile internal blinds with 24-h system activity. The system employs cyclic melting and solidification processes of PCM, enclosed in the inside of blind strips, during day and night hours, respectively, in order to reduce the 24-h amplitude of indoor temperatures and to increase thermal inertia of the barrier. The reported studies were carried out in Karlsruhe and Kassel, Germany, during the years 2008-2010 and their results proved the system to be a good solution in case of light structures, especially in winter, when the higher thermal inertia of the barrier increases the thermal comfort. In turn, studies, carried out in summer, demonstrated lower indoor air temperature increase vs. blinds without PCM, what reduced the peak load of air-conditioning systems.

[0005] Additionally, both in this paper, as well as in the paper "Possibilities for characterization of a PCM window system using large scale measurements" w Grynning S, Goia F, Rognvik E, Time B. International Journal of Sustainable Built Environment Volume 2, Issue 1, June 2013, Pages 56-64 and

the paper "Comparison between PCMfilled glass windows and absorbing gas filled windows" Kamal A.R. Ismail, Carlos T. Salinas, Henriquez J.R. Energy and Buildings Volume 40, Issue 5, 2008, Pages 710-719 describes possibilities of PCM applications for direct modification of glazing, where the reported studies were carried out by means of physical and numerical models. On the basis of the survey, it was determined that even during sunny days in winter time in the temperate climate, the latent heat potential of PCM was fully utilised. However, periods of high solar radiation intensity are needed with fairly high

temperatures of outdoor air.

[0006] In the paper "Development of a window shutter with phase change materials: Full scale outdoor experimental approach" Silva T, Vicente R, Rodrigues F, Samagaio A, Cardoso C. Energy and Buildings Volume 88, 1 February 2015, Pages 110-121 studies on blinds are described, with PCM in mobile strips. The studies were performed for two cases: for a chamber with PCM-containing strips and for a chamber with conventional blinds. The studies were performed in winter months, in the Mediterranean climate. Particular strips of the blinds were made in such a way that PCM was enclosed only in a half of the cross-section width of a single strip.

[0007] PCM application in blinds reduces heat flow through transparent barriers and increases thermal inertia, what decreases the 24-hour amplitude of temperatures. The shortcoming of this solution is the selection of wrong PCM with too low melting temperature, as for the Mediterranean climatic data.

[0008] A solution, which employs PCM to increase the thermal inertia of barriers and decrease the 24-h amplitude of indoor temperature, are also the blinds, described in the paper by Esam M. Alawadhi E. M. "Using phase change materials in window shutter to reduce the solar heat gain" Energy and Buildings Volume 47, April 2012, Pages 421-429

[0009] The reported studies were carried out for Kuwait and for other countries with hot climate. The goal of the studies was minimising of the energy, necessary to supply air-conditioning systems. The studies comprised shutters with external blinds, including strips 3 cm thick, with PCM inside and shutters with standard blinds, filled with polyurethane foam. The results of those studies demonstrated that, beside the above-mentioned features, the use of PCM in the inside of external blinds in hot climate brings 20-24-percent reduction in air temperature elevations vs. a room with standard blinds. It should additionally be mentioned that the performance of the entire system will depend on properly selected PCM, the melting temperature of which approximates the maximal temperature of windows during the day (in case of hot climate).

[0010] The mobile window insulation of the invention assumes the form of blinds and is built of strips, rotating 90° in both directions vs. the longitudinal strip axis of the strip by means of a dedicated mechanism. The blinds should be mounted on the internal side, preferably heated glazing side.

[0011] The strip walls are made of sheet, preferably selected out of copper, steel or aluminium sheet 0.5-1.5 mm thick, where the strip thickness does not exceed 5 cm. The strip inside enclosures a filling of phase change material of organic origin, called PCM, with phase change heat value of 90-260 kJ/kg and phase change temperature (solid body-fluid) in 17-25°C range. The PCM volume is within 1-8 kg/m². Change phase materials (PCM) were selected out of: the esters of carboxylic acids, preferably the ester of palmitic acid and propanol and/or mixtures

of saturated fatty acids, preferably the mixture of caprylic and lauric acid and/or PEG600 ethylene glycol polymere and/or the mixture of alkanes. The filling of change phase material is tightly closed in all blind strips. The phase change material (PCM), enclosed in the strip, may assume the form of encapsulated granulate, microgranulate or of pure phase change substance. One of the lateral wall surfaces of every strip is coated with a reflecting layer, preferably a galvanic chromium & nickel layer of reflectiveness above 60%, preferably not lower than 90%.

[0012] The other lateral wall surface of the strip is coated with a highly solar absorbing layer, selected out of black, opaque paint coatings or of highly absorbing coatings, such as black copper, black zinc or black lead.

[0013] The mobile window insulation of the invention solves the problem of meeting the need of differentiated insulation, depending on the actual outdoor conditions, e.g., resulting from the season of the year. The application of both PCM and reflecting and absorbing layers, as well as the possibility of strip rotation to expose appropriate layers to solar radiation, depending on the time of the day and the season of the year, allows for full utilisation of the characteristic features of particular materials.

[0014] Taking the advantage of the above-mentioned blind structure, it is possible to reduce solar radiation energy volume, which enters the internal premises, thereby to reduce their overheating, thanks to the reflecting layer and PCM, enclosed in the strips and characteristic of high phase change heat. The application of reverse strip position, i.e., opposite to that for summer months or a warm day, will result in reducing heat losses, ensured by transparent barrier, thanks to the layer of blinds with PCM, providing an additional heat resistance before the glazing surface from the heated side. The additionally absorbed solar energy, stored in the form of PCM phase change energy, aims to reduce the 24-h amplitude of indoor temperatures.

[0015] The subject of the invention has been presented in the examples of its embodiments below, which do not in any way limit this invention, see the figure, where fig. 1 illustrates the layout of the blinds in relation to the window, fig. 2 Diagram of blind structure, fig. 3 blind strip cross-section.

Example I

[0016] Mobile window insulation, assuming the form of horizontal blinds 2, is built of strips 3, rotating 90° in both directions 9 vs. the longitudinal strip axis by means of a dedicated mechanism 4. The blinds are mounted on the internal side of the insulated surface, e.g., glazing 1.

[0017] The walls 6 of the strip 3 are made of copper sheet 1 mm thick, whereby the maximal thickness of the strip is 3 cm. The inside of the strip 3 encloses a filling of phase change material of organic origin, also called PCM, with phase change heat value of 140 kJ/kg and phase change temperature (solid body-fluid) in 18-23°C

range. The PCM volume is 4 kg / sq m. The applied PCM is the ester stearic acid and butanol with the following semistructural formula $\text{CH}_3(\text{HC}_2)_{16}\text{COO}(\text{CH}_2)_3\text{CH}_3$

[0018] The filling 5 of the change phase material is tightly enclosed in all the blind strips 3. The phase change material (PCM), enclosed in the strip 3, assumes the form of pure phase change substance. One of the lateral surfaces of the walls 6 of each strip is coated with a reflecting layer 7 in the form of galvanic chromium & nickel layer with reflectiveness of 90%.

[0019] The other lateral surface of the walls 6 of each strip 3 is covered with a highly solar absorbing layer 8, coated with black copper.

[0020] The mobile window insulation of the invention solves the problem of meeting the need of differentiated insulation, depending on the actual outdoor conditions, e.g., resulting from the season of the year and differs from the solutions described in literature reports. The application of both PCM and reflecting and absorbing layers, as well as the possibility of strip rotation to expose appropriate layers to solar radiation, depending on the time of the day and the season of the year, allows for full utilisation of the characteristic features of particular materials.

Example II

[0021] Mobile window insulation, assuming the form of horizontal blinds 2, is built of strips 3, rotating 90° in both directions 9 vs. the longitudinal strip axis by means of a dedicated mechanism 4. The blinds are mounted on the internal side of the insulated surface, e.g., glazing 1.

[0022] The walls 6 of the strip 3 are made of aluminium sheet 1 mm thick, whereby the maximal thickness of the strip is 3 cm. The inside of the strip 3 encloses a filling of phase change material of organic origin, also called PCM, with phase change heat value of 189 kJ/kg and phase change temperature (solid body-fluid) in 17-23°C range. The PCM volume is 4 kg / sq m. The applied PCM is dodecanol with the following semistructural formula $\text{CH}_3(\text{HC}_2)_{16}\text{COO}(\text{CH}_2)_3\text{CH}_3$

[0023] The filling 5 of the change phase material is tightly enclosed in all the blind strips 3. The phase change material (PCM), enclosed in the strip 3, assumes the form of pure phase change substance. One of the lateral surfaces of the walls 6 of each strip is coated with a reflecting layer 7 in the form of galvanic chromium & nickel layer with reflectiveness of 90%.

[0024] The other lateral surface of the walls 6 of each strip 3 is covered with a highly solar absorbing layer 8, coated with black copper.

[0025] The mobile window insulation of the invention solves the problem of meeting the need of differentiated insulation, depending on the actual outdoor conditions, e.g., resulting from the season of the year and differs from the solutions described in literature reports. The application of both PCM and reflecting and absorbing layers, as well as the possibility of strip rotation to expose

appropriate layers to solar radiation, depending on the time of the day and the season of the year, allows for full utilisation of the characteristic features of particular materials.

Example III

[0026] Mobile window insulation, assuming the form of horizontal blinds 2, is built of strips 3, rotating 90° in both directions 9 vs. the longitudinal strip axis by means of a dedicated mechanism 4. The blinds are mounted on the internal side of the insulated surface, e.g., glazing 1.

[0027] The walls 6 of the strip 3 are made of steel sheet 0.8 mm thick, whereby the maximal thickness of the strip is 3 cm. The inside of the strip 3 encloses a filling of phase change material of organic origin, also called PCM, with phase change heat value of 127 kJ/kg and phase change temperature (solid body-fluid) in 22°C range. The PCM volume is 4 kg / sq m. The applied PCM is PEG600 polymer of ethylene glycol

[0028] The filling 5 of the change phase material is tightly enclosed in all the blind strips 3. The phase change material (PCM), enclosed in the strip 3, assumes the form of pure phase change substance. One of the lateral surfaces of the walls 6 of each strip is coated with a reflecting layer 7 in the form of galvanic chromium & nickel layer with reflectiveness of 90%.

[0029] The other lateral surface of the walls 6 of each strip 3 is covered with a highly solar absorbing layer 8, coated with black copper.

[0030] The mobile window insulation of the invention solves the problem of meeting the need of differentiated insulation, depending on the actual outdoor conditions, e.g., resulting from the season of the year and differs from the solutions described in literature reports. The application of both PCM and reflecting and absorbing layers, as well as the possibility of strip rotation to expose appropriate layers to solar radiation, depending on the time of the day and the season of the year, allows for full utilisation of the characteristic features of particular materials.

Claims

1. Mobile window insulation in the form of blinds, made of strips with rotation ability up to 90° in both directions vs. the longitudinal axis of the strip, wherein the inside of the strip 3 encloses a filling 5 of phase change material (PCM) of organic origin, with phase change heat value of 90-230 kJ/kg and phase change temperature (solid body - fluid) in the range of 17-25°C.
2. The mobile window insulation of claim 1, wherein the blinds 2 should be mounted on the internal side of insulated surface, e.g., the glazing 1.

3. The mobile window insulation of claim 2, wherein the internal side of insulated surface, e.g., the glazing 1, is heated.
4. The mobile window insulation of claim 1 or 2 or 3, wherein the external walls of the strip 6 are made of sheet 0.3-1.5 mm thick, whereby the maximal thickness of the strip does not exceed 5 cm.
5. The mobile window insulation of claim 4, wherein the external walls of the strip 6 are made of sheet, selected out of copper, aluminium or steel sheet.
6. The mobile window insulation of claim 1 or 2 or 3 or 4, wherein the volume of PCM is outside of the 1-8 kg/sq m range.
7. The mobile window insulation of claim 1 or 2 or 3 or 4 or 5, wherein change phase materials (PCM) were selected out of: the esters of carboxylic acids, preferably the ester of palmitic acid and propanol and/or mixtures of saturated fatty acids, preferably the mixture of caprylic and lauric acid and/or PEG600 ethylene glycol polymere and/or the mixture of alkanes.
8. The mobile window insulation of claim 1 or 2 or 3 or 4 or 5 or 6, wherein the filling of PCM 5 is tightly enclosed in all the strips 3 of the blind 2.
9. The mobile window insulation of claim of claim 1 or 2 or 3 or 4 or 5 or 6 or 7, wherein the phase change material (PCM), enclosed in the strip 3, may assume the form of encapsulated granulate, microgranulate or of pure phase change substance.
10. The mobile window insulation of claim 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8, wherein one of the surfaces of the lateral walls 6 of each strip 3 is coated with a reflecting layer 7 with reflectiveness above 60%.
11. The mobile window insulation of claim 9, wherein one of the lateral surfaces of the walls 6 of each strip is coated with a reflecting layer 7 in the form of galvanic chromium & nickel layer with reflectiveness not lower than 90%.
12. The mobile window insulation of claim 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10, wherein the other lateral surface of the walls 6 of each strip 3 is coated with a highly solar absorbing layer 8.
13. The mobile window insulation of claim 11, wherein the highly solar absorbing layer 8 is selected out of black, opaque paint layer, black copper, black zinc, black lead.

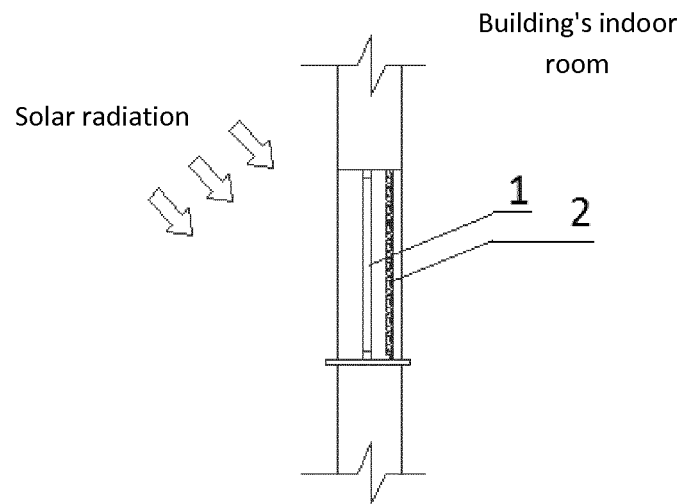


fig. 1

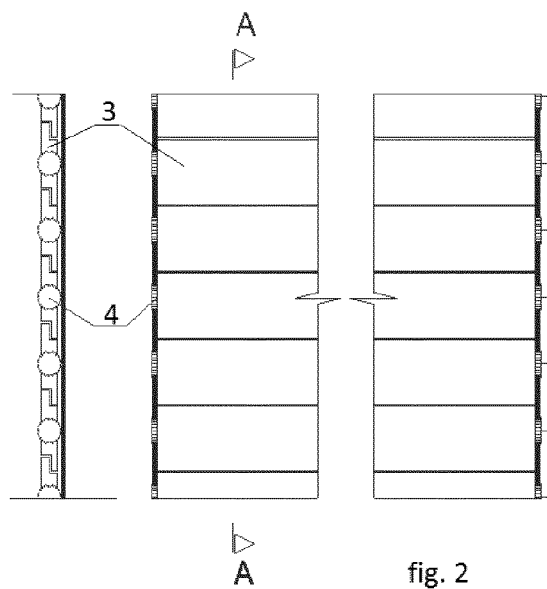


fig. 2

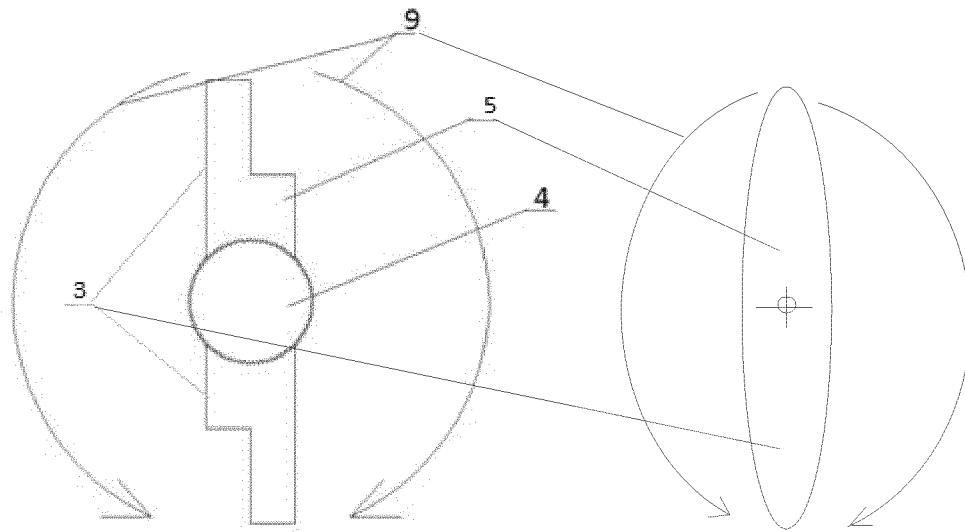


fig.3

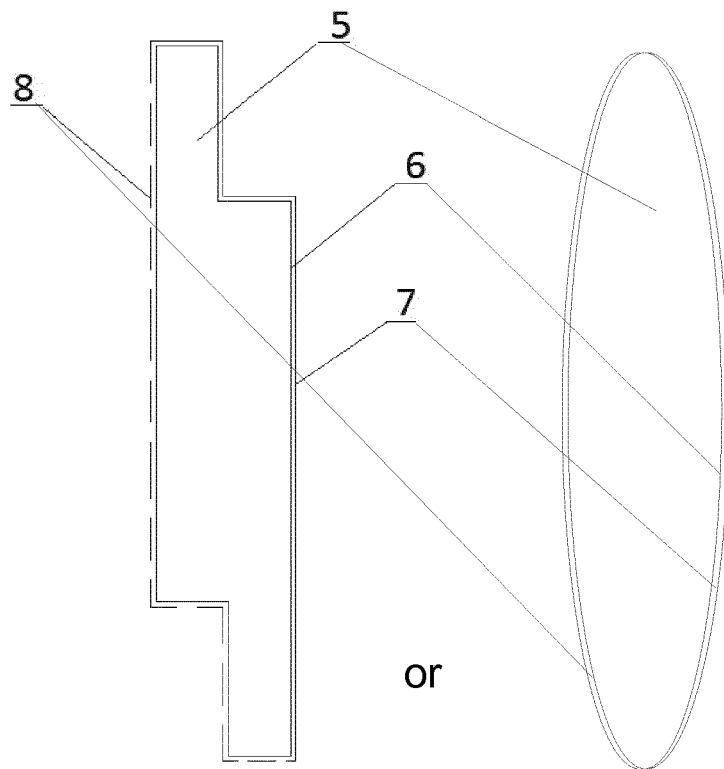


fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 15 46 1528

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 541 797 A1 (ALBISRIEDEN FENSTER [CH]) 15 June 2005 (2005-06-15)	1-6,8,9,12,13	INV. E06B7/096 E06B9/386 E06B9/24
Y	* paragraphs [0007] - [0009], [0011],	7	
A	[0012]; claim 16; figures 1, 2 *	10,11	
Y	WO 2013/191554 A2 (AUTARKIS B V [NL]) 27 December 2013 (2013-12-27)	7	
A	* page 9, lines 6-20 *	1-6,8-13	
A	WO 2006/028366 A1 (BOSELAAR JACOB ADRIAAN [NL]) 16 March 2006 (2006-03-16) * page 3, line 15 - page 4, line 19; claims 3-7; figures 1-3 *	1-13	TECHNICAL FIELDS SEARCHED (IPC) E06B
A	DE 20 2011 002337 U1 (EUROLAM GMBH [DE]) 5 May 2011 (2011-05-05) * claims 1, 8; figures 1-3 *	1-13	
A	US 4 739 748 A (STICE JAMES D [US]) 26 April 1988 (1988-04-26) * column 2, lines 26-39; figures 1-6 *	1-13	
A	WO 2009/011656 A1 (WIDROTH ROLF [SE]) 22 January 2009 (2009-01-22) * abstract; figures 1, 5 *	1-13	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 December 2015	Examiner WeiBbach, Mark
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 46 1528

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-12-2015

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1541797 A1	15-06-2005	NONE	
WO 2013191554 A2	27-12-2013	EP 2864729 A2 NL 2009052 C WO 2013191554 A2	29-04-2015 24-12-2013 27-12-2013
WO 2006028366 A1	16-03-2006	NL 1026984 C2 WO 2006028366 A1	09-03-2006 16-03-2006
DE 202011002337 U1	05-05-2011	NONE	
US 4739748 A	26-04-1988	NONE	
WO 2009011656 A1	22-01-2009	SE 530485 C2 WO 2009011656 A1	24-06-2008 22-01-2009

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Non-patent literature cited in the description

- **SOARES N ; COSTA J.J ; GASPARA A. R ; SANTOS P.** Review of passive PCM latent heat thermal energy storage systems towards buildings' energy efficiency. *Energy and Buildings*, April 2013, vol. 59, 82-103 [0004]
- **W GRYNNING S ; GOIA F ; ROGNVIK E ; TIME B.** Possibilities for characterization of a PCM window system using large scale measurements. *International Journal of Sustainable Built Environment*, June 2013, vol. 2 (1), 56-64 [0005]
- **KAMAL A.R. ISMAIL ; CARLOS T. SALINAS ; HENRIQUEZ J.R.** Comparison between PCMfilled glass windows and absorbing gas filled windows. *Energy and Buildings*, 2008, vol. 40 (5), 710-719 [0005]
- **SILVA T ; VICENTE R ; RODRIGUES F ; SAMAGAIO A ; CARDOSO C.** Development of a window shutter with phase change materials: Full scale outdoor experimental approach. *Energy and Buildings*, 01 February 2015, vol. 88, 110-121 [0006]
- **ESAM M. ; ALAWADHI E. M.** Using phase change materials in window shutter to reduce the solar heat gain. *Energy and Buildings*, April 2012, vol. 47, 421-429 [0008]