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(54) HEAT PUMP LAUNDRY DRYER WITH SYSTEM FOR MONITORING LEVEL OF DRYNESS

WÄSCHETROCKNER MIT EINER WÄRMEPUMPE UND EINEM SYSTEM ZUR ÜBERWACHUNG
EINES TROCKNUNGSGRADES

SÈCHE-LINGE À POMPE À CHALEUR MUNI D'UN SYSTÈME DE SURVEILLANCE DU DEGRÉ DE
SÉCHAGE

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Description

[0001] The present invention relates to a heat pump laundry dryer having an improved dryness monitoring system by which a more timely drying cycle termination decision can be made.

[0002] A heat pump laundry dryer, i.e. a drier having a condensing unit, typically has a closed cycle drying process. The heat pump used for drying the laundry is composed of the compressor that moves the refrigerant fluid and heat sinks named as evaporator and condenser. It comprises flow tubes through which the refrigerant circulates, a compressor that provides the circulation of the refrigerant by pressurizing it.

[0003] The laundry-drying process is performed by passing hot and dry air over the laundry. The condenser disposed in the heat pump functions as a heater and the evaporator functions as a condenser. Humid air leaving the laundry leaves its moisture while passing over the evaporator that works as the condenser and warms while passing over the condenser that works as the heater. Therefore, the process air is heated while passing from the condenser, delivered onto the laundry as being heated and after dehumidifying the laundry, leaves its humidity while passing over the evaporator.

[0004] The evaporator is composed of a refrigerant tube in serpentine form and fins arranged on the refrigerant tube. In the cycle wherein the refrigerant circulates in the flow tubes, the refrigerant that is delivered from the compressor to the condenser with increased pressure and temperature enters the evaporator by passing through the capillary tube, i.e. the expansion valve with decreased pressure.

[0005] It is to be noted that the level of dryness of a cloth item, which was subject to the drying process shortly before, should be within a predefined range of dryness. Otherwise, that is, if the level of dryness is relatively greater, complaints are likely to occur or if the laundry is too dry, the drying cycle will remove more lint and more loose cloth particles.

[0006] Among others, a prior art document in the technical field of the present invention may be referred to as EP 1 600 549, disclosing a control method for drier capable of preventing laundry damage due to over-drying and capable of decreasing power dissipation accordingly. The method comprises the step of detecting a representative value of the dryness degree values and drying the clothes with a preset heating value corresponding to the detected dryness degree representative value.

[0007] German Patent Application DE 10 2007 061 519 A1 discloses a laundry drying device with at least one temperature sensor for determining a moisture content of the process air.

[0008] European Patent Application EP 481 561 A2 relates to a method for controlling the drying stage, comprising measuring the quantity of water released by the clothes during their drying, wherein said measurement may be done by determining the weight variation of the

quantity of condensed water collecting in a vessel.

[0009] British Patent Application GB 1 390 901 A discloses a drier with a condenser connected to a condensate collecting container. The container is mounted on springs and has a switch device which is actuated to detect a predetermined minimal and/or maximal liquid volume state to control the operation of the drier.

[0010] European Patent Application EP 2 666 902 A1 is prior art only under Article 54(3) EPC and discloses a laundry drier comprising a filling level unit adapted to determine a filling level of the condensate tank. The filling level unit comprises at least one strain gauge sensor unit for determining at least a fraction of the condensate tank weight as a parameter for determining the filling level.

The present invention provides an improved method and system for monitoring the level of dryness in a laundry treatment process such that a decision as to the level of dryness as well as termination of the drying process can be made more accurately in a timely manner. The present invention, in a more specific manner, provides that while the high temperature and moisture-laden air is condensed, water vapor is transformed into condensate water; accordingly a condensate water monitoring system dynamically evaluates whether an associated laundry treatment process is to be terminated and whether the dryness of the laundry being treated falls within a predefined range.

[0011] The present invention therefore provides a heat pump laundry dryer with an improved dryness monitoring system, which is defined by the characterizing features as defined in Claim 1.

[0012] Primary object of the present invention is hence to provide an improved dryness monitoring system in a laundry treatment appliance.

[0013] The present invention proposes a laundry treatment appliance having a heat pump with a heat exchanger. The appliance further comprises a water receptacle in which the condensate water condensed in the evaporator of the heat exchanger is collected. A weight measurement device is flexibly connected to the bottom plate of the water receptacle such that weight of the condensate water over the entire surface of the bottom plate is measurable. The condensate water drops into said water receptacle by way of gravitational forces as said water receptacle is at a lower position in respect of the lowermost part of said heat exchanger. The monitoring system of the invention uses preloaded values of the parameters such as total amount of the condensate water, rate of change thereof per unit time and temperature of humid air leaving the drum and compares the same with actual values.

[0014] Accompanying drawings are given solely for the purpose of exemplifying an improved heat pump laundry dryer, whose advantages over prior art were outlined above and will be explained in brief hereinafter.

[0015] The drawings are not meant to delimit the scope of protection as identified in the claims nor should they be referred to alone in an effort to interpret the scope

identified in said claims without recourse to the technical disclosure in the description of the present invention.

Fig. 1 demonstrates a general schematic view of a laundry dryer according to the present invention.

Fig. 2 demonstrates a general schematic view of the components of the dryness level monitoring system according to the present invention.

[0016] The following numerals are used in this detailed description:

1. Laundry dryer
2. Compressor
3. Evaporator
4. Condenser
5. Expansion valve
6. Drum
7. Fan
8. Refrigerant line
9. Air duct
10. Heat exchange unit
11. Water receptacle
12. Weight measurement device
13. Pump

[0017] The present invention relates to a heat pump type laundry dryer (1) comprising a drum (6) wherein the laundry to be dried is placed, a compressor (2) provides the refrigerant cycle in an air duct (9) in a conventional manner meanwhile the processed air is circulated by means of a fan (7) and a heat exchange unit (10) having an evaporator (3) and a condenser (4). The compressor (2) typically moves the refrigerant fluid and heat sinks named as evaporator (3) and condenser (4) disposed in the heat pump system respectively function as a condenser and heater. Further, an expansion valve (5) is conventionally provided between the evaporator (3) and the condenser (4), being disposed in fluid communication with the latter two in the refrigerant line (8).

[0018] According to the present invention, the level of dryness of the laundry is dynamically monitored by means of a system having a water receptacle (11) in which the condensate water is collected. As the hot air is cooled by the relatively cold air supplied by the heat exchange unit (10), moisture contained in the process air is condensed. While this high temperature and moisture-laden air is condensed, water vapor is transformed into condensate water and is collected in said water receptacle (11).

[0019] Said water receptacle (11) according to the invention is in fluid communication with the evaporator (3) of the heat exchange unit (10) such that the condensate water is transferred to said water receptacle (11) by way of gravitational forces. In this regard, the condensate water guided through a discharge pipe drops into said water receptacle (11). The plane on which the bottom plate of said water receptacle (11) extends is lower than the low-

ermost plane of said heat exchange unit (10) on the vertical axis of said laundry drier (1).

[0020] The dryness monitoring system of the present invention dynamically evaluates whether an associated laundry treatment process is to be terminated and whether the dryness of the laundry being treated falls within a desired predefined range. To this end, the level of dryness is not monitored by means of individual electrodes in the form of sensors sensing a voltage change based on a capacitance change, which may distort the quality of the monitoring process.

[0021] It is to be noted that a monitoring system relying on the measurement of the water level by level sensors may prove to be disadvantageous in that inaccurate readings by individual electrodes can occur especially in the case very small amount of condensate water is in question. Considering the fact that an average of 20 g water is condensed per minute, the present invention ensures accurate measurements in a homogenous manner and independent of individual level sensors as explained hereinafter.

[0022] The monitoring system of the invention proposes a weight measurement device (12) to which the bottom plate of the water receptacle (11) is flexibly connected, said weight measurement device (12) having a sensitivity of at least 0,5 g. The weight measurement device (12) of the invention is advantageous in that it provides reliable results by measuring the pressure caused by the condensate water's weight over the entire surface instead of obtaining location-specific data, therefore resulting in that even when very small amount of water is introduced into the water receptacle (11), elimination of inaccurate data collection is ensured.

[0023] The weight measurement device (12) in the form of an electronic weighing scale directly reflects the change in the weight of the water receptacle (11) content. An electronic control unit in electrical communication with said weight measurement device (12) dynamically monitors the actual amount of water in the water receptacle (11) as well as the rate of change of the same in unit time. A pump (13) is accordingly intermittently operated to discharge water from said water receptacle (11) such that water contained therein is kept within a predefined range, i.e. within the capacity of the water receptacle (11).

[0024] The fact that the weight measurement device (12) detects the weight of the condensate water in a more accurate manner in the initial phase of the drying process during which the condensate water is collected drop by drop until an even water surface is obtained, the calculation of the rate of change in the amount of the condensate water will lead to a more accurate estimation of the level of dryness.

[0025] As the amount of the condensate water obtained per unit time is known to decrease over time, the electronic control unit compares predetermined values of the rate of change with the actual ones to make a timely estimation that the drying cycle is to be terminated.

[0026] Accurate weight measurement at the initial

phase of the drying process where the water receptacle (11) is empty is important as it might be the case that the water receptacle (11) is already discharged several times and the decision by the electronic control unit as to terminate the drying cycle is made at a subsequent initial phase, i.e. when the water receptacle (11) is being replenished again.

[0027] Further, the electronic control unit according to the present invention also monitors the temperature of the humid air while leaving the drum (6) and this information may optionally be used to verify the decision as to terminate the drying cycle. The correlation between the total amount of the condensate water, rate of change thereof per unit time and the temperature of the humid air is taken into consideration by the electronic control unit. Accordingly the data for these parameters is accessible to the electronic control unit in the form of preloaded tables.

[0028] In a nutshell, the invention proposes a laundry dryer (1) comprising a drum (6) wherein the laundry to be dried is placed, an air duct (9) through which processing air is circulated by means of a fan (7), a compressor (2) effecting cycle of refrigerant, an evaporator (3) providing the processing air in the air duct (9) to be dehumidified, a condenser (4) providing the dehumidified processing air to be heated and a refrigerant line (8) providing the refrigerant pressurized by the compressor (2) to pass through the condenser (4) and the evaporator (3) to be redelivered to the compressor (2). Said laundry treatment appliance (1) further comprises a water receptacle (11) in fluid communication with a heat exchange unit (10) such that condensate water is transferrable to said water receptacle (11) and a weight measurement device (12) to which a bottom plate of the water receptacle (11) is flexibly connected such that weight of the condensate water over the entire surface of the bottom plate is measurable.

Claims

1. A laundry dryer (1) comprising

- a drum (6) wherein the laundry to be dried is placed,
- an air duct (9) through which processing air is circulated by means of a fan (7),
- a compressor (2) effecting cycle of refrigerant,
- a heat exchange unit (10) having an evaporator (3) and a condenser (4), said evaporator (3) providing the processing air in the air duct (9) to be dehumidified, said condenser (4) providing the dehumidified processing air to be heated,
- a refrigerant line (8) providing the refrigerant pressurized by the compressor (2) to pass through the condenser (4) and the evaporator (3) to be redelivered to the compressor (2),
- a water receptacle (11) in fluid communication

with the heat exchange unit (10) such that condensate water is transferrable to said water receptacle (11), **characterized in that** the laundry dryer (1) comprises further

- a weight measurement device (12) to which a bottom plate of the water receptacle (11) is flexibly connected such that the weight of the condensate water over the entire surface of the bottom plate is measurable,
- an electronic control unit in electrical communication with said weight measurement device (12) configured to monitor dynamically the actual amount of water in the water receptacle (11) as well as the rate of change of the same in unit time, the electronic control unit being further configured to process the total amount of the condensate water, the rate of change thereof per unit time and the temperature of humid air leaving the drum (6) such that the obtained data is compared with a preloaded data set to verify level of dryness, wherein the electronic control unit is configured to compare the predetermined values of the rate of change with the actual ones to make a timely estimation that the drying cycle is to be terminated, wherein said temperature is used to verify the decision as to terminate the drying cycle.

2. The laundry dryer (1) as in Claim 1, **characterized in that** the condensate water is guided through a discharge pipe to drop into said water receptacle (11) by way of gravitational forces.

3. The laundry dryer (1) as in Claim 1 or 2, **characterized in that** the plane on which the bottom plate of said water receptacle (11) extends is lower than the lowermost plane of said heat exchange unit (10) on the vertical axis of said laundry treatment appliance (1)

4. The laundry dryer (1) as in Claim 1 or 3, **characterized in that** said weight measurement device (12) has a sensitivity of at most 0,5 g.

5. The laundry dryer (1) as in Claim 1, **characterized in that** the laundry dryer comprises a pump (13), wherein the pump (13) is configured to be intermittently operated to discharge water from said water receptacle (11) such that water contained therein is kept within a predefined range within the capacity of the water receptacle (11).

Patentansprüche

1. Ein Wäschetrockner (1) bestehend aus

- einer Trommel (6), wobei die Wäsche, die ein-

getrocknet werden soll, hingelegt wird,
- einem Luftkanal (9) wodurch Verarbeitungs-
luft in Umlauf gesetzt wird mit Hilfe von einem Lüfter
(7),

- einem Kompressor (2), der den Kältemittel-
kreislauf bewirkt,

- einer Wärmetauscheinheit (10) mit einem Ver-
dampfer (3) und einem Kühler (4), besagte Ver-
dampfer (3) versorgt, daß Verarbeitungs-
luft im Luftkanal (9) entfeuchtet wird, besagte Kühler
(4) versorgt, daß entfeuchtete Verarbeitungs-
luft erwärmt wird,

- einer Kältemittelleitung (8), die versorgt, daß
der vom Kompressor (2) unter Druck stehende
Kältemittel den Kühler (4) und Verdampfer (3)
durchläuft und zum Kompressor (2) erneut ge-
liefert wird,

- einem Wassergefäß (11) in Fluidübertragung
mit Wärmetauscheinheit (10), sodaß Kondens-
wasser zum besagten Wassergefäß (11) über-
tragbar ist, **dadurch gekennzeichnet, daß**

Wäschetrockner (1) bestehend ferner aus
- einem Gewichtsmessgerät (12), wozu eine Bo-
denplatte des Wassergefäßes (11) elastisch
verbunden ist, sodaß das Gewicht des Kondens-
wassers über der ganzen Fläche der Bo-
denplatte messbar ist,

- einer elektronischen Kontrolleeinheit in elektri-
scher Übertragung mit besagter Gewichtsmess-
gerät (12) konfiguriert ist zur dynamischen Über-
wachung des tatsächlichen Betrags im Wasser-
gefäß (11) sowie die Änderungsrate desselben
in Einheitszeit, die elektronische Kontrolleeinheit
ferner konfiguriert ist zur Verarbeitung

- vom gesamten Betrag des Kondenswassers,
deren Änderungsrate pro Einheitszeit und die
Temperatur der feuchten Luft, die die Trommel
(6) verläßt, sodaß erhaltene Daten mit vorgela-
denen Daten verglichen wird, um das Niveau
der Trockenheit zu überprüfen, wobei

- elektronische Kontrolleeinheit konfiguriert ist
zum Vergleich von vorbestimmten Werten der
Änderungsrate mit realen Werten, um eine frist-
gerechte Abschätzung zu machen, daß der
Trocknungskreislauf abgeschlossen wird, worin
besagte Temperatur verwendet wird, um die
Entscheidung für Beendigung des Trocknungs-
kreislaufes zu überprüfen.

2. Wäschetrockner (1) nach Anspruch 1, **dadurch ge-
kennzeichnet, daß** das Kondenswasser durch eine
Abflussleitung geführt wird, um ins besagte Wasser-
gefäß (11) über Schwerkraft fallenzulassen.

3. Wäschetrockner (1) nach Anspruch 1 oder 2, **da-
durch gekennzeichnet, daß** die Ebene, worauf die
Bodenplatte des besagten Wassergefäßes (11) sich

erweitert, niedriger ist als der niedrigsten Ebene der
besagten Wärmetauscheinheit (10) auf der vertika-
len Achse der besagten Wäschebehandlungsein-
richtung (1).

4. Wäschetrockner (1) nach Anspruch 1 oder 3, **da-
durch gekennzeichnet, daß** das besagte Gewicht-
messgerät (12) eine Empfindlichkeit von höchstens
0,5 g hat.

5. Wäschetrockner (1) nach Anspruch 1, **dadurch ge-
kennzeichnet, daß** der Wäschetrockner eine Pum-
pe (13) beinhaltet, wobei die Pumpe (13) konfiguriert
ist für periodische Operation, um Wasser vom be-
sagten Wassergefäß (11) zu entlassen, sodaß das
dort enthaltene Wasser innerhalb einer vorbestimm-
ten Skala im Kapazität des Wassergefäßes (11) be-
halten wird.

Revendications

1. Un sèche-linge (1) comprenant

- un tambour (6) dans lequel le linge à sécher
est placé,

- un conduit d'air (9) à travers lequel l'air de trai-
tement circule au moyen d'un ventilateur (7),

- un compresseur (2) effectuant un cycle de ré-
frigérant,

- une unité d'échange de chaleur (10) compor-
tant un évaporateur (3) et un condenseur (4),
ledit évaporateur (3) fournissant l'air de traite-
ment dans le conduit d'air (9) à déshumidifier,
ledit condenseur (4) fournissant l'air de traite-
ment déshumidifié à chauffer,

- une ligne de réfrigérant (8) fournissant au ré-
frigérant pressurisé par le compresseur (2) de
traverser le condenseur (4) et l'évaporateur (3)
à remettre au compresseur (2),

- un récipient d'eau (11) en communication de
fluide avec l'unité d'échange de chaleur (10) de
telle sorte que l'eau de condensation soit trans-
férable au dit récipient d'eau (11),

caractérisé en ce que

le sèche-linge (1) comprend en outre

- un dispositif de mesure de poids (12) auquel
une plaque inférieure du récipient d'eau (11) est
relié de manière flexible de telle sorte que le
poids de l'eau de condensation sur toute la sur-
face de la plaque inférieure soit mesurable,

- une unité de commande électronique en com-
munication électrique avec ledit dispositif de
mesure de poids (12) configuré pour surveiller
dynamiquement la quantité réelle d'eau dans le
récipient d'eau (11) ainsi que le rapport de chan-
gement de celui-ci en unité de temps, l'unité de
commande électronique étant encore configuré

- pour traiter
- la quantité totale de l'eau de condensation, son rapport de changement par unité de temps et la température de l'air humide quittant le tambour (6) de sorte que les données obtenues sont comparées à un ensemble de données préchargé pour vérifier le niveau de sécheresse, dans lequel 5
 - l'unité de commande électronique est configurée pour comparer les valeurs prédéterminées de la vitesse de changement avec celles réelles afin de déterminer en temps opportun que le cycle de séchage doit être terminé, dans lequel ladite température est utilisée pour vérifier la décision de terminer le cycle de séchage. 10 15
2. Sèche-linge (1) selon la revendication 1, **caractérisé en ce que** l'eau de condensation est guidée à travers un tuyau de décharge pour déposer dans ledit récipient d'eau (11) par des forces de gravité. 20
 3. Sèche-linge (1) selon la revendication 1 ou 2, **caractérisé en ce que** le plan sur lequel la plaque inférieure dudit récipient d'eau (11) s'étend est inférieur au plan le plus bas de ladite unité d'échange de chaleur (10) sur l'axe vertical du dit appareil de traitement de linge (1) 25
 4. Sèche-linge (1) selon la revendication 1 ou 3, **caractérisé en ce que** ledit dispositif de mesure de poids (12) a une sensibilité d'au plus 0,5 g. 30
 5. Sèche-linge (1) selon la revendication 1, **caractérisé en ce que** le sèche-linge comprend une pompe (13), dans lequel la pompe (13) est configurée pour fonctionner de manière intermittente pour évacuer l'eau dudit récipient d'eau (11) de telle sorte que l'eau contenu ici est maintenu dans une plage prédéfinie dans la capacité du récipient d'eau (11). 35 40

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Fig. 1

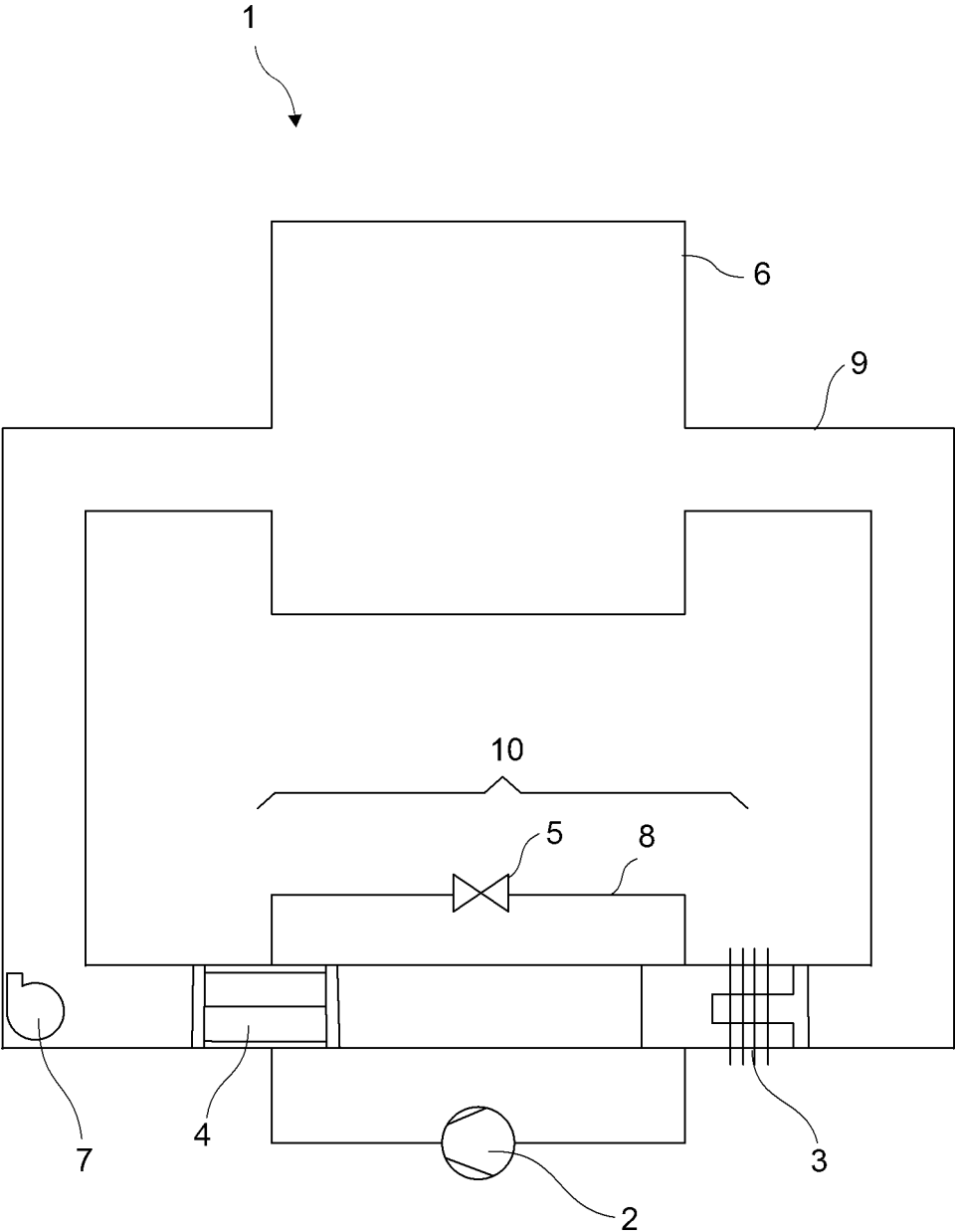
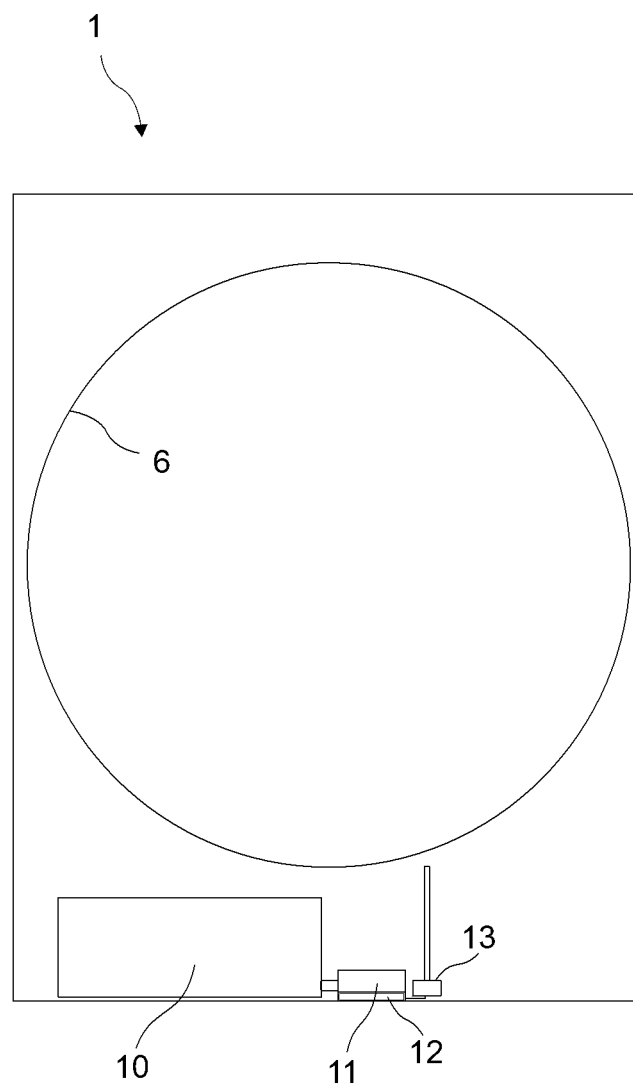


Fig. 2



REFERENCES CITED IN THE DESCRIPTION

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