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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **Drier, in particular a clothes-drying cabinet.**

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Description

The present invention relates to driers specially designed for household use as clothes-drying cabinets but which can be used equally well for drying various types of industrial articles.

Driers for household use of many different types are already known; we will refer here to some of the known machines only, which exemplify the prior art.

The British Patent No. 1133098 discloses a drying apparatus comprising an air heating chamber, an air cooling chamber and a drying chamber. An air duct is situated underneath the chambers and connects the drying chamber to the heating chamber; a compression refrigeration system is mounted within the drier, the compressor being contained within the duct, the condenser in the heating chamber and the evaporator in the cooling chamber; a V-shaped trough positioned directly below the evaporator cooperates with a drain pipe to collect and dispose of water condensed from the air in the cooling chamber; a fan forces air from the duct into the heating chamber. The French Patent No. 1370792 discloses a drier comprising a cabinet with rods to append the clothes to be dried; in the bottom of the cabinet there is a heating apparatus; outside the cabinet there is a compression refrigeration system; the evaporator is located inside a condensation chamber; a fan on the top of the cabinet forces all the air into the condensation chamber; at the bottom of the cabinet there is provided a hole to allow external air to enter the cabinet.

The U.S.A. Patent No. 3064358 describes a clothes drying device in which blowers circulate filtered air past an evaporator, an expansion valve, and a condenser coil trough which a refrigerant is conveyed by means of a compressor unit, and forcing the dry air into a perforated enclosure in which a revolving cylinder supporting the clothes is disposed. The enclosure shows inlet openings which may be closed by dampers controlled by pressure responsive linkages.

All the three cited documents describe driers which all show low efficiency factors; in fact the apparatus according to the cited British Patent takes in the air to be sent to the evaporator at the bottom of the drying chamber, where it has a low humidity percentage; driers described in the cited French Patent and in the cited U.S. Patent both send all the air coming from the drying chamber to the evaporator, so that the evaporator only receives air with a low humidity percentage since it passed only once through the chamber. In addition, the British apparatus needs a powerful (and costly) refrigerating system, because it must counteract a large temperature range on the condenser and the evaporator.

From the EP—A—0060 226, a document according to article 54(3) EPC which is not prepublished, a drier apparatus is known comprising an enclosure which contains a drying chamber for receiving articles to be dried, an air heating passage and an air cooling passage communicating with said chamber wherein the heating passage has inlet means and outlet means communicating therewith, air heating means being provided in the heating passage between the inlet and the outlet means thereof to heat air flowing through said heating passage, and wherein the cooling passage has inlet means through which the top of the drying chamber communicates with the top of the cooling passage and outlet means at the bottom of the cooling passage, air cooling means being provided in the cooling passage between the inlet and outlet means thereof, to condense moisture from air flowing in the cooling passage, and water collecting means being provided underneath the outlet means of the cooling passage to collect the water dripping from the cooling means, the arrangement being such that a major air flow is circulated between the drying chamber and the heating passage and a minor air flow is circulated from the drying chamber to the cooling passage.

This arrangement provides for a relatively low loss in sensible heat in the damp air so that the refrigerating circuit condenser required relatively little energy to compensate for the sensible heat absorbed by the evaporator or a cold wall in the cooling passage. The drawback on this known type of drier, however, is that the efficiency of the cooling circuit gradually falls off as the drying cycle proceeds. The reason for this is that, as the cycle proceeds, the difference in temperature between the evaporator and the condenser gradually becomes smaller on account of a gradual increase in the temperature of the air recirculated along the cooling passage. Under such conditions, besides a gradual increase in the energy consumption of the compressor, the entire refrigerating circuit may even rise to unacceptable temperatures. On the one hand, this could damage the refrigerating system and, on the other, the temperature in the drying chamber could rise high enough to damage delicate fabrics such as synthetic fibres, silk and the like.

The aim of the present invention is to provide a drier of the described type, not showing the drawbacks of the prior art machines.

According to the present invention, this aim is achieved with a drying unit having the characteristics recited in the main claim.

This arrangement provides for drying cycles with lower, more uniform refrigeration circuit pressures and temperatures than would be possible if the unit operated with no communication with the outside air. Supposing for example, as is usually the case, that the temperature in the room where the drier is installed does not vary during the drying cycle. This means there will be no substantial variation in the temperature difference with which heat is exchanged between the air and the refrigerating fluid on the condenser and evaporator. In other words, air pumped in from outside acts as a sort of "brake" on the rise in temperature and the temperature differences in the refrigerating circuit.

Thanks to the principle of the heat pump, a further advantage of the unit according to the present invention is that it also uses the heat content of the outside air.

Supposing the unit, e.g. a clothes-drier, is installed in a room with an air temperature of 20°C, 60% relative humidity and air containing 8.73 gr of water per kilo. The heat content of the air will be 10.10 kcal/kg (42.2 kJ/kg). If the unit is designed so that air is blown off into the atmosphere, through the cooling passage, at 12°C with 100% relative humidity, with the same 8.73 gr of water per kilo, its heat content will be 8.10 kcal/kg (33.8 kJ/kg). At the start of the cycle at least, the air pumped in from the outside will supply 2 kcal/kg with consequent saving in energy.

The invention will now be described with reference to the attached drawing, provided by way of a non-limiting example and showing a schematic vertical cross section of a drier, in particular, a clothes-drying cabinet according to the present invention.

The unit shown in the drawing is in the form of a cabinet with a casing of sheet metal or other suitable material. The casing contains a drying chamber 10 defined by side walls 12, a front door 14, a top 16 and rear dividing wall 18. Walls 12 and 18, top 16 and front door 14 are all lagged.

For the reason given later on, rear dividing wall 18 does not extend as far as top 16. The edge of dividing wall 18, together with top 16, defines a horizontal slot 20.

Drying chamber 10 is fitted inside with hooks and rails on which to hang clothes or other items, an arrangement that turns the unit into a household clothes-drying cabinet. Alternatively, drying chamber 10 may be fitted with grate shelves for drying items other than clothes, e.g. photographs, tobacco leaves, fruit, etc.

Hangers used for another alternative will be described later.

The casing has a rear or outside wall 24 which, together with dividing wall 18, forms a space 26 which, as we shall explain later, acts as a cooling passage. Rear wall 24 is made of sheet metal or other heat-conducting material to act as a cooling means by exchanging heat with the outside air. For even better heat exchange performance, wall 24 may be fitted with fins. The bottom 28 of drying chamber 10 is fitted over another bottom panel 30 so as to form a space 32 which, as we shall see later, acts as a passage for heating and air circulation. The casing or cabinet has yet another horizontal structural panel 33 under bottom panel 30 which, together with the latter, forms a bottom compartment 34. The latter is defined at the front by wall 36 and at the rear by a bottom extension of dividing wall 18. For reasons explained later, compartment 34 communicates with the outside air through opening 38 (e.g. a slit) in wall 36 fitted with a grate 40.

At the inlet end, heating and circulating passage 32 communicates with both the bottom of chamber 10 and compartment 34. The through openings, preferably slits, are marked 42 and 44.

At the outlet end, passage 32 communicates with the bottom of chamber 10 with circulating means in the form of an electric blower in-between.

The casing or cabinet has a built-in refrigerating circuit which acts as a heat pump and comprises a known hermetic electric compressor 48, a condenser 50, a trottling element 52 and an evaporator 54.

The hermetic compressor 48 is a normal household refrigerator type situated in compartment 34 and secured to structural wall 33. The trottling element 52 is preferably a capillary tube.

Condenser 50 is in the form of a box heat exchanger which extends right across the heating and circulating passage 32. Evaporator 54 consists of a box heat exchanger, very similar to heat exchanger 50, situated at the bottom of cooling passage 26 and extending right across it.

Under exchanger-evaporator 54 in rear wall 24 is an opening (preferably a slit) 56 through which cooling passage 26 communicates with the outside air.

A little below the open bottom end of cooling passage 26, there is a receptacle 58 in the form of a gutter which, through drain opening 60, leads to a drip tank or box 62 under structural wall 32. Box 62 slides inside the cabinet for collecting condensed water formed, as we shall see, in cooling passage 26 and exchanger-evaporator 54 during operation of the unit. Condensed water dripping into receptacle 58 is collected in box 62 which can be pulled out of the cabinet. Box 62 is preferably fitted with a transparent (e.g. plastic) front wall so the level of water can be seen for emptying the box periodically. Alternatively, receptacle 58 can be connected directly to a water drain.

The drier described and shown in the drawing operates as follows:

When the clothes or other items for drying have been loaded into drying chamber 10, door 14 is closed and compressor 48 and blower 46 are started up. The refreigerating fluid starts circulating in the refrigerating circuit so as to heat exchanger-condenser 50 and cool exchanger-evaporator 54.

Electric blower 46 circulates the air in a closed circuit, sucking it up from chamber 10 through opening 42, sending it through condenser 50 and blowing it out into the bottom of chamber 10. At the same time, electric blower 46 sucks up air from the outside through opening 38, compartment 34 and opening 44. When it passes into compartment 34, the air sucked up from the outside flows over the casing of compressor 48, cooling the latter and being heated by it. The air sucked up from the outside also flows through exchanger-condenser 50 and is blown into the bottom of chamber 10 by blower 46. The air circulating in chamber 10 and heated gradually in exchanger-condenser 50 becomes saturated with humidity. The hottest air containing most humidity forms a layer or "dome" at the top of

chamber 10 which traps in the heat to improve the efficiency of the unit.

Part of the saturated air flows through slit 20 into cooling passage 26 where it flows down to the bottom and is cooled first upon contact with cold wall 24 and then by heat exchange in evaporator 54.

The air current flowing down into passage 26 is caused by the difference in pressure between the inside of chamber 10 and the outside air as well as by the "reverse drawing" effect created in space 26 by the increasing density of the air as it is cooled.

As the damp air flows down into cooling passage 26, part of the damp condenses on cold wall 24 so that evaporator 54, situated near the bottom end of passage 26, receives air with part of the damp already taken out of it. The remaining damp is then condensed by evaporator 54. The water condensed by cold wall 24 and in evaporator 54 then drips into receptacle 58 and is collected in box 62.

The cooled air is then exhausted to the outside through opening 56. The size of air inlets 38 and 56 and circulation passages 26 and 32 and the power of air circulating means 46 and heat exchangers 50 and 54 are designed so that the air circulating inside the casing is such that the air flowing over evaporator 54 and condenser 50 is automatically less at the end of the drying cycle than at the beginning.

Operation of the unit is regulated automatically: as the drying cycle proceeds, the temperature of the air in chamber 10 rises while its relative humidity falls. Consequently there is also a fall in the specific weight of the air, in the socalled "reverse drawing" effect and the amount of air exhausted to the outside. The latter case is an advantage as far as the evaporator is concerned in that it receives less and less heat from the air thus preventing any unwanted rise in temperature. What is more, the smaller the amount of air being supplied to the evaporator, the easier it is to cool down to the dew point which provides for better dehumidification.

Sucking up outside air and exhausting it by means of blower 46 provides yet another advantage: the load loss in cooling passage 26 creates a certain pressure in chamber 10 which makes the air in the chamber less flexible, so to speak, thus preventing it from finding its own way out through slit 20. This ensures all parts of chamber 10 are swept more or less evenly so as to dry the clothes or other items in the chamber more uniformly.

The scope of the present invention is not limited to the specific arrangement described here. For example, condenser 50 in circulation passage 32 could be replaced entirely or in part by a coil pipe in drying chamber 10 in the form of horizontal bars on which to hang clothes or other items.

A further variation of the specific arrangement described could be to fit the outside air inlet 38 and outlet 56 with temporary shutters, e.g. controlled by a timer on the unit, which provide for operating the cabinet under airtight conditions during the intermediate drying stage.

The advantages of this arrangement are that it provides for high-speed operation of the drying chamber at the start of the cycle, prevents overheating of the chamber at the end of the cycle and improves drying efficiency during the intermediate stage by making the unit airtight.

Claims

1. A drier apparatus comprising an enclosure which contains a drying chamber (10) for receiving articles to be dried, an air heating passage (42) and an air cooling passage (26) communicating with said chamber (10), wherein the heating passage (42) has inlet means and outlet means (28) communicating therewith, air heating means (50) being provided in the heating passage (42) between the inlet and the outlet means (28) thereof to heat air flowing through said heating passage, and wherein the cooling passage (26) has inlet means (20) through which the top of the drying chamber (10) communicates with the top of the cooling passage (26) and outlet means (56) at the bottom of the cooling passage, air cooling means (54) being provided in the cooling passage (26) between the inlet (20) and outlet means (56) thereof, to condense moisture from air flowing in the cooling passage (26), and water collecting means (60) being provided underneath the outlet means (56) of the cooling passage (26) to collect the water dripping from the cooling means (54), the arrangement being such that a major air flow is circulated between the drying chamber (10) and the heating passage (42) and a minor air flow is circulated from the drying chamber (10) to the cooling passage (26), and wherein the enclosure comprises an outside air inlet (38) which communicates with the bottom of the drying chamber (10) and that the bottom end of the cooling passage (26) opens into the outside air.

2. Drier according to claim 1, characterised in that the inlet means (20) of said cooling passage (26) are disposed in closely spaced relation to and directly communicate with the top of the drying chamber (10) and are disposed at the top of the cooling passage (26) and in that the inlet means (42) of the heating passage are open to the drying chamber (10) at a level which is lower than the level at which the inlet means (20) of the cooling passage (26) are located.

3. Drier according to claim 1 or 2, characterised in that circulating means (46) are situated in the heating passage (42), under the drying chamber (10) and above the outside air inlet (38).

4. Drier according to any one of the preceding claims, characterised by the fact that the said outside air inlet (38) and an outside air outlet (56) at the bottom of the cooling passage (26) are fitted with shutters for preventing air being exchanged between the cabinet and the outside atmosphere during the central part of the operating cycle of the unit.

Patentansprüche

1. Trockenvorrichtung, mit einem Gehäuse, welches eine Trockenkammer (10 zur Aufnahme von zu trocknenden Artikeln, einen Luft-Heizkanal (42) und einen mit der Kammer (10) strömungsverbundenen Luft-Kühlkanal (26) aufweist, wobei der Heizkanal (42) einen Einsatz und einen damit strömungsverbundenen Auslaß (28) aufweist, eine Luft-Heizvorrichtung (50) in den Heizkanal (42) zwischen seinem Einlaß und seinem Auslaß (28) vorgesehen ist, um durch den Heizkanal strömende Luft aufzuheizen, und wobei der Kühlkanal (26) einen Einlaß (20), über den der Oberbereich der Trockenkammer (10) mit dem oberen Bereich des Kühlkanals (26) in Verbindung steht, und einen Auslaß (26) am Boden des Kühlkanals besitzt, in dem Kühlkanal (26) zwischen seinem Einlaß (20) und seinem Auslaß (56) eine Luft-Kühlvorrichtung (54) vorgesehen ist, um aus der durch den Kühlkanal (26) strömenden Luft Feuchtigkeit zu kondensieren une eine Wassersammeleinrichtung (60) unterhalb des Auslasses (56) des Kühlkanals (26) vorgesehen ist, um das von der Kühlvorrichtung (54) tröpfelnde Wasser zu sammeln, wobei die Anordnung derart ausgebildet ist, daß ein Hauptluftstrom zwischen der Trockenkammer (10) und dem Heizkanal (42) sowie ein Nebenluftstrom aus der Trockenkammer (10) zu dem Kühlkanal (26) zirkuliert wird, und wobei das Gehäuse einen Außenlufteinlaß (38) besitzt, der mit dem Boden der Trockenkammer (10) strömungsverbunden ist, und sich das untere Ende des Kühlkanals (26) zur Außenluft hin öffnet.

2. Trockenvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß der Einlaß (20) des Kühlkanals (26) in geringem Abstand zum oberen Bereich der Trockenkammer (10) angeordnet ist und mit ihr direkt strömungsverbunden ist sowie sich oben an dem Kühlkanal (26) befindet, und daß der Einlaß (42) des Heizkanals zur Trockenkammer (10) hin auf einer solchen Höhe offen ist, die niedriger liegt als die Höhe, bei der der Einlaß (20) des Kühlkanals (26) gelegen ist.

3. Trockenvorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß sich in dem Heizkanal (42) unterhalb der Trockenkammer (10) und oberhalb des Außenlufteinlasses (38) Umwälzmittel (46) angeordnet sind.

4. Trockenvorrichtung nach einem der vorhergehenden Ansprüche, gekennzeichnet durch die Tatsache, daß der Außenlufteinlaß (38) und ein Außenluftauslaß (56) am Boden des Kühlkanals (26) mit Verschlüssen ausgestattet sind, um zu verhindern, daß während des Hauptabschnitts des Betriebszyklus der Einheit Luft zwischen dem Schrank und der Außenatmosphäre ausgetauscht wird.

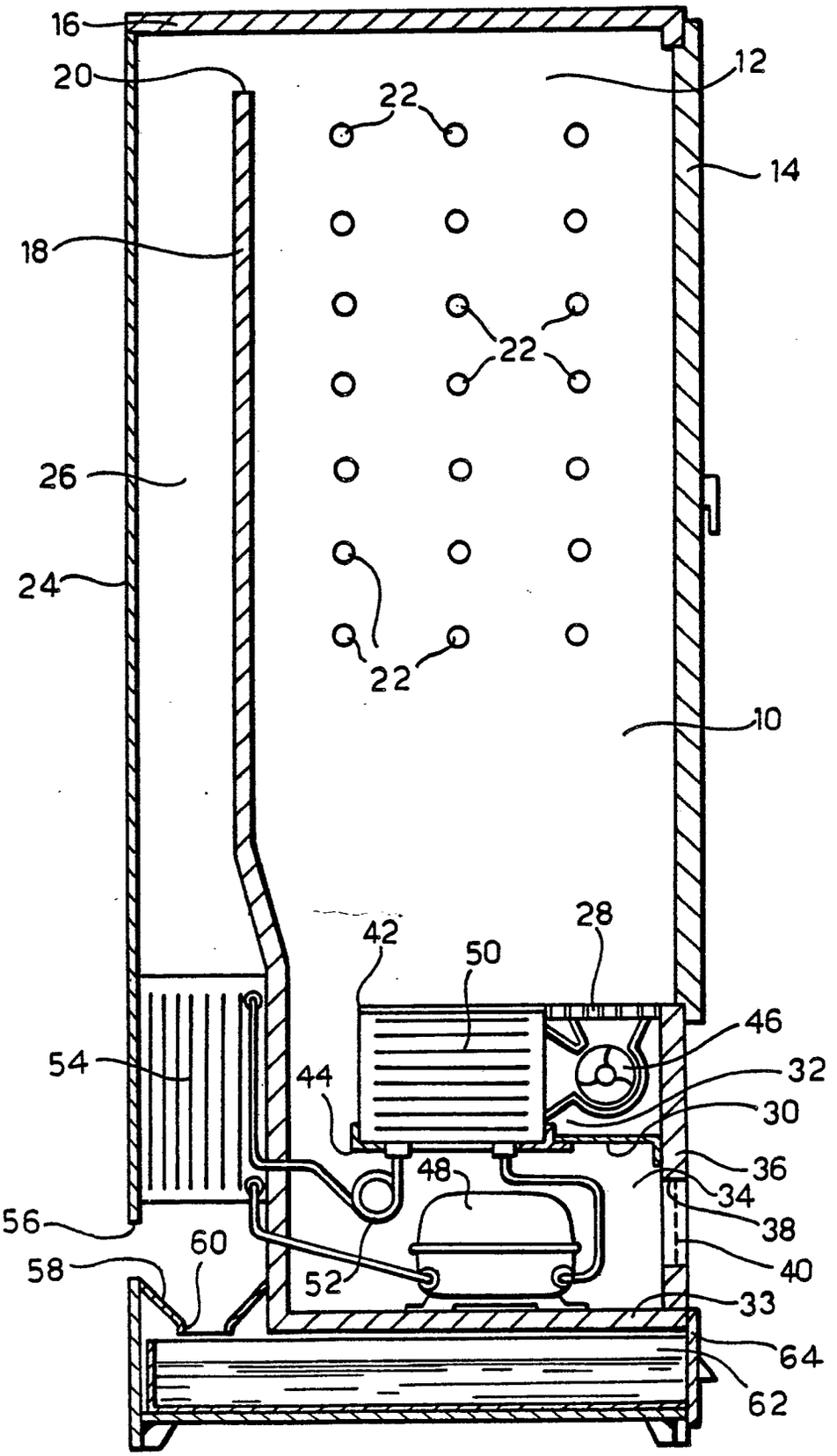
Revendications

1. Séchoir comprenant une enceinte qui contient une chambre de séchage (10) destinée à recevoir des articles à sécher, un passage de chauffage d'air (42) et une passage de refroidissement d'air (26) communiquant avec ladite chambre (10), dans lequel le passage de chauffage (42) présente des moyens d'entrée et des moyens de sortie (28) communiquant avec lui, des moyens de chauffage d'air (50) étant prévus dans le passage de chauffage (42) entre les moyens d'entrée et de sortie (28) de celui-ci pour chauffer l'air traverserant ledit passage de chauffage, et dans lequel le passage de refroidissement (26) présente des moyens d'entrée (20) à travers lesquels le haut de la chambre de séchage (10) communique avec le haut du passage de refroidissement (26) et des moyens de sortie (56) situés à la base du passage de refroidissement, des moyens de refroidissement d'air (54) étant prévus dans le passage de refroidissement (26), entre les moyens d'entrée (20) et de sortie (56) de celui-ci, pour condenser l'humidité de l'air s'écoulant dans le passage de refroidissement (26), et des moyens collecteurs d'eau (60) étant prévus au-dessous des moyens de sortie (56) du passage de refroidissement (26) pour recueillir l'eau dégouttant des moyens de refroidissement (54), l'agencement étant tel qu'un courant d'air majeur circule entre la chambre de séchage (10) et le passage de chauffage (42) et qu'un courant d'air mineur circulaire circule de la chambre de séchage (10) au passage de refroidissement (26), et dans lequel l'enceinte comprend une entrée d'air extérieur (38) qui communique avec le fond de la chambre de séchage (10) et l'extrémité inférieure du passage de refroidissement (26) débouche dans l'air extérieur.

2. Séchoir selon la revendication 1, caractérisé en ce que les moyens d'entrée (20) dudit passage de refroidissement (26) sont faiblement espacés de, et en communication directe avec, le haut de la chambre de séchage (10) et sont disposés en haut du passage de refroidissement (26) et en ce que les moyens d'entrée (42) du passage de chauffage débouchent dans la chambre de séchage (10) à un niveau inférieur au niveau auquel sont situés les moyens d'entrée (20) du passage de refroidissement (28).

3. Séchoir selon la revendication 1 ou 2, caractérisé en ce que des moyens de circulation (46) sont situés dans le passage de chauffage (41), sous la chambre de séchage (10) et au-dessus de l'entrée d'air extérieur (38).

4. Séchoir selon l'une quelconque des revendications précédentes, caractérisé en ce que lesdites entrée d'air extérieur (38) et sortie d'air extérieur (56) situées en bas du passage de refroidissement (26) sont garnies de persiennes destinées à empêcher des échanges d'air entre l'armoire et l'atmosphère extérieure pendant la partie moyenne du cycle de fonctionnement de l'appareil.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