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(54) **Title**: METHOD FOR THE VALIDATION OF CONSUMABLE ELEMENTS SUITED TO BE INSTALLED ON A STEREOLITHOGRAPHY MACHINE AND METHOD FOR ENABLING SAID STEREOLITHOGRAPHY MACHINE TO CARRY OUT THE PRINTING PROCESS

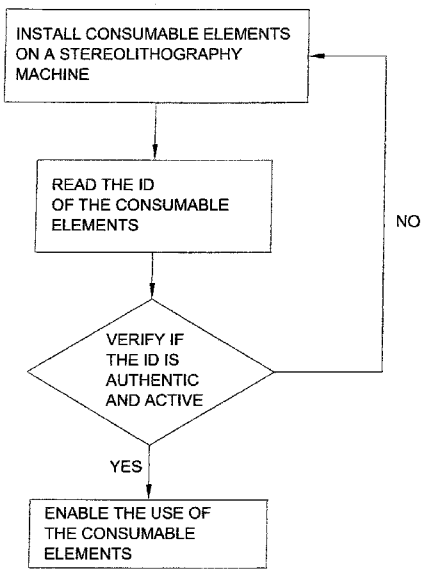

Fig.1

(57) **Abstract**: The invention is a method for the validation of one or more consumable elements (4) suited to be installed on a stereolithography machine (2) for printing three-dimensional objects through a stereolithography process. The method includes the steps of installing a consumable element (4) provided with a readable univocal identification code (ID) on the stereolithography machine (2), reading said univocal identification code (ID), verifying that the univocal identification code (ID) is authentic and active by making a comparison against a predefined list (L) of authentic and active identification codes and enabling the use of the consumable element (4) on the stereolithography machine (2) in the case where the corresponding univocal identification code (ID) is authentic and active.

METHOD FOR THE VALIDATION OF CONSUMABLE ELEMENTS SUITED TO BE INSTALLED ON A STEREOLITHOGRAPHY MACHINE AND METHOD FOR ENABLING SAID STEREOLITHOGRAPHY MACHINE TO CARRY OUT THE PRINTING PROCESS.

DESCRIPTION

The present invention concerns a method for the validation for use of consumable elements suited to be installed on a stereolithography machine belonging to a printing unit.

The invention concerns also a method for enabling the printing of three-dimensional objects through a stereolithography machine belonging to a printing unit.

Furthermore, the invention concerns a printing unit comprising at least one stereolithography machine and configured in such a way as to carry out the steps of said methods for the validation of consumable elements and for enabling the printing of three-dimensional objects.

As is known, the stereolithography technique makes it possible to produce a three-dimensional object through the superimposition of a plurality of layers of a base material, liquid or pasty, which is solidified through exposure to predefined radiation, generally light radiation.

A stereolithography machine of the known type comprises a vat suited to contain the base material, which is provided with a bottom that is transparent to the predefined radiation.

The machine furthermore comprises emitter means suited to emit said predefined radiation and arranged under the vat, which selectively solidify the layer of base material that is adjacent to the bottom of the vat.

The solidified layers are supported by a modelling platform that is motorized so that it moves in the vertical and orthogonal direction with respect to the bottom of the vat in order to arrange the last solidified layer so that it is adjacent to said layer of base material before its solidification.

It is also known that in the most recent stereolithography machines said vat is of the removable and replaceable type, since after an undetermined number of printing processes the transparent bottom of the vat itself tends to deteriorate, consequently worsening the quality of the three-dimensional object obtained through the stereolithography process.

Furthermore, as is known, said stereolithography machines are configured

in such a way as to accommodate recharge cartridges containing said base material that, when needed, is forced out of said recharge cartridge and conveyed into the vat through valve means that connect said two elements.

Also said recharge cartridges, once they have run out, can be removed from the stereolithography machine and replaced with recharge cartridges filled with other base material.

Generally, in the common jargon, as well as in this context, the elements like said vats and the recharge cartridges of the removable type for stereolithography machines are known as consumable elements for stereolithography machines, that is, accessories that can be installed on said machines and that can be removed and replaced at the moment when they deteriorate or are no longer able to fulfil their function due to the fact that they have been used for an undetermined but however limited period of time.

The advantage offered by the use of said consumable elements lies in that the use and maintenance of the stereolithography machine are considerably simplified, making it suited to be used also by an unskilled operator like, for example, an operator who works in the jewellery or dental sector.

However, to disadvantage, the sale and use of the so-called consumable elements known as “compatible” or “remanufactured” elements is spreading increasingly.

“Compatible” consumable elements are those consumable elements which are produced by a given company and are suited to be installed on a type of stereolithography machine produced by a different manufacturer. “Remanufactured” consumable elements, instead, are those elements, like exhausted recharge cartridges, which are produced by the same company that markets the stereolithography printers but recharged with a base material produced by other manufacturers, so that they can be reused.

In both cases, it can very often be observed that the quality of the “compatible” or “remanufactured” consumable elements is much lower than that of the so-called authentic elements, meaning those produced and marketed by the manufacturer of the stereolithography machines. Consequently, it can be observed that the use of said non-authentic consumable elements very often leads to a worsening of the quality of the three-dimensional objects produced, even if high-quality stereolithography machines are used.

In particular, in the case of use of the so-called “compatible” or

"remanufactured" recharge cartridges, there is actually the risk that the base material contained therein may not be appropriate and may not be compatible with the characteristics of said stereolithography machine.

Furthermore, the use of "compatible" consumable elements may also lead to the rapid deterioration of the internal components that make up the stereolithography machine itself.

The present invention intends to overcome all of the drawbacks mentioned above.

In particular, it is one of the objects of the invention to provide a method for the validation of consumable elements and a method for enabling the printing of three-dimensional objects that prevent the use of consumable elements that, even if they are sold as compatible elements, are not perfectly suited to be used with certain types of stereolithography machines.

It is thus the object of the present invention to provide a validation method and a method for enabling the printing process that make it impossible to use low-quality consumable elements and, in particular, low-quality base materials.

It is another, yet not the least important object of the invention to provide a validation method and a method for enabling the printing process that make it impossible to use consumable elements that may deteriorate the internal components of the stereolithography machine on which they are installed.

The said objects are achieved by the validation method developed according to the main claim.

The said objects are also achieved by the method for enabling the printing process developed according to claim 8, by the printing unit according to claim 9 and by the computer program product according to claim 17.

Variant embodiments of the invention are specifically described in the corresponding dependent claims.

Advantageously, the implementation of the methods that are the subjects of the invention and the use of the printing unit of the invention allow the manufacturer of the stereolithography machines and of the consumable elements to monitor the consumption of said consumable elements, in particular of the base material used by the users and by the companies that own said stereolithography machines. Said monitoring activity is however carried out while at the same time guaranteeing the privacy of said users and companies.

Said objects and advantages, together with others that will be mentioned here below, will be evident in the description of a preferred embodiment of the invention that is provided by way of non-limiting example with reference to the attached drawings, wherein:

- Figure 1 shows the flow diagram illustrating the operational steps belonging to the method that is the subject of the invention for the validation of consumable elements suited to be installed on a stereolithography machine;
- Figure 2 shows the flow diagram illustrating the operational steps belonging to the method of the invention for enabling a stereolithography machine to carry out the printing process;
- Figure 3 shows a schematic structural diagram of the printing unit that is the subject of the invention according to the preferred embodiment of the invention;
- Figure 4 shows a schematic structural diagram of the printing unit of the invention according to a first alternative embodiment;
- Figure 5 shows a schematic structural diagram of the printing unit of the invention according to a second alternative embodiment;
- Figure 6 shows a schematic view of the detail comprising a data processing unit and a stereolithography machine belonging to the printing unit of the invention.

Method for the validation of consumable elements provided with a univocal identification code.

The method that is the subject of the invention, whose operational steps are illustrated in the flow diagram shown in Figure 1, has been developed for the purpose of making it possible to validate and, consequently, enable the use of one or more consumable elements installed on a stereolithography machine for printing three-dimensional objects through a stereolithography process. As stated during the description of the known art, consumable elements are those accessories for stereolithography machines, such as recharge cartridges containing the base material to be used to make the three-dimensional objects and vats suited to contain said base material during the printing process, which deteriorate or are no longer able to fulfil their function after they have been used for an undetermined but limited period of time, and therefore need to be replaced.

According to the invention, the present validation method includes the step

of installing at least one consumable element provided with a readable univocal identification code on said stereolithography machine.

Clearly, the use of said univocal identification code allows each consumable element to be made univocally identifiable with respect to other consumable elements. Usually, the univocal identification code is assigned to and is reproduced on each consumable element by the company the produces and markets it. Furthermore, this company is usually the manufacturer and seller of said stereolithography machines.

Furthermore, in the present context and as will be defined in greater detail below, the adjective "readable" means that said univocal identification code can be "read" by human beings or by suitable automatic reading devices.

According to the preferred embodiment of the invention, the method includes the installation on the stereolithography machine, and therefore the validation, of at least one recharge cartridge provided with said univocal identification code and containing the base material to be used for making three-dimensional objects, and of at least one vat suited to contain the same base material, which is also provided with a univocal identification code. It cannot be excluded, however, that the method of the invention may be implemented only and exclusively to verify the validity of one or more recharge cartridges or, alternatively, one or more vats. Furthermore, it cannot be excluded that the method of the invention may be implemented to verify the validity of consumable elements of a different type with respect to the recharge cartridges and the vats, on condition that they are provided with their own univocal identification code and on condition that they can be installed on a stereolithography machine.

In any case, according to the method of the invention, the univocal identification codes that are associated with the consumable elements are read once the latter have been installed on the stereolithography machine.

In particular, according to the preferred embodiment of the invention, the univocal identification codes of the recharge cartridge and of the vat that are installed on the stereolithography machine are read.

The procedures based on which said reading operation is performed are illustrated in detail here below, in the description of the printing unit that is the subject of the invention and that, according to a preferred embodiment, is configured in such a way as to carry out the steps of this validation method.

Going back to the method of the invention, the step which follows the reading of the univocal identification codes is the step of verifying if each one of them is authentic and active.

In this context, as already mentioned above, the univocal identification code and, consequently, the consumable element with which it is associated are considered "authentic", or even "original", if the first is defined and the second is produced and marketed by the same company that manufactures and sells the stereolithography machines on which said consumable element is intended to be installed.

Furthermore, a univocal identification code and, consequently, the corresponding consumable element are defined as "active" if the same code has not been previously read and verified, or, even if it has already been read, the number of readings is smaller than a pre-established number of readings, or if the conditions of the consumable element are still within pre-established limits, as will be specifically clarified below with regard to the recharge cartridges and the vats. Said pre-established number of readings can be equal to or higher than one.

Advantageously, as stated before, the operation of verifying whether the consumable element is associated with an authentic univocal identification code makes it possible to avoid the use, on a particular stereolithography machine, of accessories and, in the case of recharge cartridges, of base materials for making three-dimensional objects that are not compatible with and of lower quality than those produced and marketed by the company that sells also the stereolithography machine itself. In particular, the validation method of the invention makes it possible to avoid the use of low-quality light sensitive resins for making three-dimensional objects through a stereolithograpy process, or the use of light sensitive resins which are not compatible with the characteristics of the radiation emitter with which the stereolithography machine is provided.

Furthermore, the operation of determining whether a specific univocal identification code associated with a consumable element, although authentic, has already been read and verified or whether it has exceeded the limits of use, as specified below, a condition hereinafter defined as "inactive", makes it possible to prevent a user from reusing, for example, an authentic recharge cartridge by filling it, after it has been used for a given, authorized number

of times, with resins or, in general, with base materials produced and marketed by other companies. If this last operation were permitted, in fact, the situation may occur, where resins are used which are not compatible with the characteristics of a specific stereolithography machine and whose quality is probably low.

According to the method of the invention, in order to implement said verification step a predefined list of univocal identification codes must be made available, wherein said univocal identification codes are considered authentic and active and are associated with the consumable elements produced and marketed by a specific company.

Therefore, a univocal identification code is considered authentic simply when it is included in said predefined list.

Therefore, the verification step consists in comparing the univocal identification code read on the consumable element with the univocal identification codes, considered authentic and active, which are included in said predefined list.

Preferably, said list is defined by the same company that produces and markets the consumable elements provided with said univocal identification codes as well as the specific stereolithography machines.

Still preferably, as is described in detail below, the list is made available on a server, usually a remote server, capable of communicating autonomously with each one of said stereolithography machines, in such a way as to allow said verification step to be carried out.

Furthermore, according to the method of the invention, if each univocal identification code is authentic and active, the use of the corresponding consumable elements installed on said stereolithography machine is enabled.

It cannot be excluded, however, that according to an alternative embodiment of the validation method of the invention, the enabling procedure may be managed independently for each consumable element. In other words, according to said alternative embodiment of the invention, in the case where several consumable elements are installed on a stereolithography machine, the enabling of each one of them depends exclusively on whether the corresponding univocal identification code is authentic and active, independently of the outcome of the verification of the other univocal identification codes associated with the remaining consumable elements.

According to the method of the invention, in the specific case where a

consumable element installed on the stereolithography machine corresponds to a recharge cartridge, said enabling step first of all includes the at least partial transfer of the material contained in the same recharge cartridge into a vat arranged on the stereolithography machine. As described in greater detail below, said transfer is preferably but not necessarily carried out by the stereolithography machine in an automated manner.

Furthermore, the enabling step includes the calculation of the value of the total quantity of material available for the stereolithography machine, also called "print credit" in technical jargon, by adding the quantity of material transferred during said transfer operation to the quantity of material previously associated with the same stereolithography machine.

Clearly, if no "print credit" were associated with the stereolithography machine before said transfer operation, the value of the total quantity of material calculated would be equivalent to the quantity of material transferred.

Successively, the enabling step belonging to the method of the invention also includes the step of associating the calculated value with the specific stereolithography machine and storing this association in such a way as to be able to use this information at a later moment, as is shortly explained in greater detail.

As for the predefined list of univocal identification codes, also this information, according to the preferred embodiment of the printing unit of the invention described below, is preferably stored in a remote server made available by the company that manufactures and sells said consumable elements and the stereolithography machines.

Finally, as regards, again, the specific enabling step related to a recharge cartridge, it includes the modification of the state of the corresponding univocal identification code from active to inactive in said predefined list, in the case where said base material has been completely transferred from the recharge cartridge into the vat.

As already stated, this last operation advantageously makes it possible to prevent a recharge cartridge from being reused once the respective base material originally contained therein has been completely transferred into one or more vats.

As regards, instead, the specific enabling step related to a vat provided with a univocal identification code and installed on said stereolithography machine,

according to the invention it includes the step of associating said univocal identification code with the number of times the same vat has been used. In other words, according to the invention the number of readings of the code is increased, and consequently also the number of times the specific vat has been installed and used on a stereolithography machine is also increased. The enabling step successively includes the step of storing said association, preferably in said remote server. Said information advantageously makes it possible to limit the use of the specific vat to a predefined number of times. In fact, the enabling step belonging to the method of the invention furthermore includes, for the vats, the step of modifying the state of the corresponding univocal identification codes from active to inactive in said predefined list, at the moment when the stored number of times a specific vat has been used reaches or exceeds said predefined number of times.

Preferably but not necessarily, the validation method of the invention, in particular the enabling step related to the vats, furthermore includes the step of associating the univocal identification code of each vat with the type of base material transferred inside it from one or more recharge cartridges during said transfer operation. The method of the invention finally includes the step of storing said association, preferably in said remote server.

Advantageously, said last association makes it possible to also check, during said operation of verification, the type of material possibly contained therein before, independently of whether the univocal identification code related to the vat is active or not. Therefore, said association and the related verification make it possible to avoid the use, at different moments, of a specific vat to contain different types of base material. This, in particular, makes it possible to advantageously avoid the risk of mixing in the same vat and contaminating, for example, two different types of resins that are incompatible with each other.

It cannot be excluded, in general, that, according to alternative embodiments of the method of the invention, the enabling step related to consumable elements different from recharge cartridges and from vats may include the execution of further and different operations. Nevertheless, in respect of all the consumable elements provided with a univocal identification code and suited to be installed on a specific stereolithography machine, the enabling step of the validation method must include the modification of the state of said univocal identification code from active to inactive in said predefined list, in the case where it is not

possible to observe specific pre-established conditions for each type of consumable element.

Method for enabling the printing process.

Once said series of steps related to the method of the invention for the validation of one or more consumable elements has been completed, the stereolithography machine is ready to print three-dimensional objects through a stereolithography process. However, according to the present invention, further steps must be performed before allowing the execution of said printing process, wherein said further steps described in detail below and represented in the flow diagram shown in Figure 2 belong to a further method for enabling, in fact, the printing process.

It should be first stated that, for the sake of simplicity, the steps of said method are described making reference to a single stereolithography machine. However, as specified below, said steps may be related to a plurality of stereolithography machines considered as a single entity, that is, as a set of machines at the disposal of a single company. First of all, the method for enabling the printing process that is the subject of the invention includes the step of reading the previously stored value related to the total quantity of base material associated with the specific stereolithography machine to be used. In other words, the method includes the reading of the print credit of the specific stereolithography machine. Furthermore, the method of the invention includes the step of calculating the quantity of base material that is necessary for making a specific three-dimensional object. Having said two pieces of information available, the method of the invention provides for comparing them, in such a way as to verify whether the total quantity of base material, that is, the print credit, associated with the stereolithography machine exceeds the quantity of base material that is necessary for making said three-dimensional object. In the case where the outcome of said verification is positive, the method of the invention provides for enabling the use of the stereolithography machine for printing the three-dimensional object.

In practice, said series of steps making up the enabling method of the invention advantageously makes it possible to verify whether a user or a company that is the owner of the stereolithography machine has acquired a quantity of the so-called “authentic” base material that is sufficient to produce a specific three-dimensional object. If not, the printing process is not enabled.

Consequently, said method advantageously makes it possible to prevent a user or a company from printing three-dimensional objects by means of said stereolithography machines using a non-authentic base material.

Going back to the method of the invention, once the use of the stereolithography machine has been enabled, according to said method it is possible to proceed with the production of the three-dimensional object in question. It may happen that, for any reason, the object is carried out only partially. In any case, according to the method of the invention, at the end of said step of production of the object, even if partial, the quantity of base material actually used during said production step is calculated and said actual quantity is deducted from the total quantity of base material previously associated with the stereolithography machine. The result obtained from said operation is associated with the same stereolithography machine and stored as a print credit for the successive uses.

As already mentioned above, according to a variant embodiment of the invention, the method for enabling the printing process could be applied to a plurality of stereolithography machines located in the same site and for this reason managed as a single entity. In other words, according to said variant embodiment of the method, said plurality of stereolithography machines is associated with a single print credit, independently of the quantity of material actually contained in the vat of each one of them. Consequently, the printing process is enabled at the moment when said print credit associated with the plurality of stereolithography machines is sufficient to make the object or the specific objects that have to be produced.

Printing unit.

As already mentioned above, the invention includes also the printing unit **1** configured in such a way as to implement the validation method and the method for enabling the printing process described above.

In particular, as shown in the diagram of Figure 3, according to the preferred embodiment of the invention, the printing unit **1** comprises a stereolithography machine **2** and a data processing unit **3** configured to manage the functions of the stereolithography machine **2**, so that it is possible to print three-dimensional objects through a stereolithography process.

It cannot be excluded, however, that in alternative variant embodiments of the invention the printing unit **1** may comprise more than one stereolithography

machine **2**, each one of which is associated with a corresponding data processing unit **3**, as shown in the diagram of Figure 4.

Furthermore, according to other alternative embodiments of the invention that are not represented in the figures, a plurality of stereolithography machines **2** may be associated with a single data processing unit **3** capable of managing the functions of all of said machines at the same time.

With regard to the data processing unit **3**, as schematically shown in Figure 6, it comprises a computer **31** operatively connected to the corresponding stereolithography machine **2** or, alternatively, to more than one stereolithography machine **2**. Said computer **31** comprises, in turn, a microprocessor **311** and storage means **312** in which a specific computer program is stored that is capable of managing the printing operations of the stereolithography machine **2**, when said computer program is being executed in the same computer **31**.

As regards, instead, the stereolithography machine **2**, as can be observed always in Figure 6, it comprises first coupling means **21** suited to allow it to be coupled with at least one recharge cartridge **41** of the base material to be used for making three-dimensional objects and second coupling means **22** suited to allow it to be coupled with at least one vat **42** containing said base material during the execution of said stereolithography process.

According to the invention, the printing unit **1** comprises a validation system, indicated as a whole by **5** in Figures from 3 to 5, suited to validate one or more consumable elements **4**, preferably a recharge cartridge **41** and a vat **42**, which are suited to be installed on said stereolithography machine **2** and each one of which is provided with a readable univocal identification code **ID**.

In particular, the validation system **5** is configured to read the univocal identification code **ID** of each one of said consumable elements **4** and to compare each univocal identification code **ID** read against a predefined list **L** of univocal identification codes **ID** considered authentic and active and related to the consumable elements **4** produced and marketed by one or more companies. Therefore, said comparison makes it possible to verify whether each univocal identification code **ID** is authentic and active or not. The validation system **5** is configured in such a way that, only in the case where all of said univocal identification codes **ID** are authentic and active, it will be capable of enabling the use of the consumable elements **4**.

According to the preferred embodiment of the printing unit **1** of the invention, the validation system **5** comprises, first of all, said data processing unit **3** provided with reading means **32** suited to read the univocal identification code **ID** of the various consumable elements **4**. Preferably, said reading means **32** are located on the stereolithography machine **2**, in proximity to the recharge cartridge **41** and to the vat **42**, in such a way that they can read the univocal identification codes **ID** reproduced therein, when both of them are installed on said stereolithography machine **2**.

Preferably, the means **32** for reading the univocal identification code **ID** comprise a Near Field Transceiver, preferably a RFID transceiver **321** of the known type. In turn, each one of the consumable elements **4**, in particular the recharge cartridge **41** and the vat **42**, comprises a storage and transmission device **7**, preferably a RFID tag **71**, in which said univocal identification code **ID** is previously stored.

It cannot be excluded, however, that in alternative embodiments of the invention the reading means **32** suited to read the code **ID** and the storage and transmission devices **7** can be implemented with different known technologies, provided that they are capable of establishing Near Field Communication with each other or, even more generally, provided that the first ones are capable of reading the univocal identification code **ID** reproduced on the second ones.

Regarding, furthermore, the data processing unit **3**, it is provided with transceiver means **33** configured to transmit the univocal identification code or codes **ID** read to a data processing control apparatus **6** also belonging to the validation system **5** of the invention and described in detail here below.

In particular, depending on the type of data processing control apparatus **6** used, as defined in detail below, said transceiver means **33** can be configured in such a way as to establish communication through a wired network of the local (Intranet) or remote (Internet) type or to allow communication of the wireless type, for example through a WLAN or cellular network.

As far as the data processing control apparatus **6** is concerned, according to the preferred embodiment of the invention represented in Figures 3 and 4, it comprises a remote server **61** operatively connected to said data processing unit **3** through its own transceiver means **613** and the Internet. Preferably, said remote server **61** is provided by the same company that produces and markets said stereolithography machines **2** and the consumable elements **4** provided

with a univocal identification code **ID**.

According to the invention, said remote server **61** is also provided with a microprocessor **611** and storage means **612** suited to store said predefined list **L** of univocal identification codes **ID**, considered authentic and active and related to the consumable elements **4** produced and marketed by said company.

In particular, the predefined list **L** of univocal identification codes **ID** is stored and organized in said storage means **612** inside an appropriate database **8** defined by said company.

Preferably, the predefined list **L** is divided into sub-lists L_1, L_2, L_3..., each one of which comprises the univocal identification codes **ID** of specific consumable elements **4** of the same type, for example a list L_1 of the recharge cartridges **41** and a list L_2 of the vats **42**.

As regards, furthermore, the remote server **61**, it is configured to receive the univocal identification code **ID** of the consumable element **4** from said data processing unit **3**. Furthermore, the remote server **61** is configured to proceed to compare said univocal identification code **ID** received with the univocal identification codes included in the predefined list **L**.

As already described above with regard to the validation method of the invention, said comparison makes it possible to verify if the univocal identification code **ID** read on the consumable element **4** is authentic and active. The remote server **61**, furthermore, is configured in such a way as to send the data processing unit **3**, from which it received the univocal identification code or codes **ID**, a signal confirming the validity of the univocal identification code or codes **ID**, in the case where each one of them is authentic and active.

It cannot be excluded, however, that according to alternative embodiments of the invention the remote server **61** may be configured to send a validity signal related to each single consumable element **4**, in the case where the corresponding univocal identification code **ID** has been found to be authentic and active, independently of the outcome of the verification of any other univocal identification codes **ID** belonging to different consumable elements **4** installed, in any case, on the same stereolithography machine **2**.

Concerning, again, the data processing unit **3**, the corresponding transceiver means **33** are configured to receive said validity signal from the remote server

61 and the data processing unit **3** itself is configured in such a way that, if said validity signal is received, it will be capable of enabling the use of the consumable element or elements **4**. In particular, the same data processing unit **3** is configured in such a way as to manage the operation of transferring the base material contained therein into a vat **42** present on the stereolithography machine **2**, in the case where said enabling procedure is related to the specific use of a recharge cartridge **41**. Said transfer operation is preferably but not necessarily carried out in an automatic manner through said first coupling means **21** that in turn comprise a mechanism **211** of the known type capable of performing the so-called "squeezing" of the recharge cartridge **41**.

Concerning, again, the remote server **61**, it is configured in such a way that, in the case where the univocal identification code **ID** received and verified belongs to a recharge cartridge **41**, it will calculate the value of the total quantity of base material available for the stereolithography machine **2**, the so-called "print credit", by adding the quantity of base material transferred during said transfer operation to the total quantity of material previously associated with said machine.

In particular, according to the preferred embodiment of the invention, said last piece of information is stored in a memory allocation **81** of the database **8** reserved to that specific stereolithography machine **2**.

The remote server **61** is configured in such a way as to associate said new calculated value of the print credit with the stereolithography machine **2**, storing it in said memory allocation **81**.

Clearly, as already described with reference to the validation method of the invention, if the stereolithography machine **2**, before the transfer operation, had a print credit equal to zero, the new value calculated and stored after the transfer operation would be equivalent to the quantity of base material transferred.

Furthermore, according to the invention, the remote server **61** is configured in such a way as to modify the state of the univocal identification code **ID** related to said recharge cartridge **41** from active to inactive in the predefined list **L**, in the case where the base material has been completely transferred into a vat **42** from said recharge cartridge **41**.

In this way, the same recharge cartridge **41** cannot be reused any more,

as explained above.

According to the preferred embodiment of the printing unit **1** of the invention, also the data processing unit **3** is configured in such a way that, following the reception of said validity signal and simultaneously with the modification carried out by the remote server **61**, it will modify, through the RFID transceiver **321**, the state of the univocal identification code **ID** of the same recharge cartridge **41** from active to inactive in the RFID tag **71** of the latter.

It cannot be excluded, however, that in alternative embodiments of the invention the data processing unit **3** may not be configured to carry out said last operation.

Concerning, again, the remote server **61**, it is configured in such a way as to associate a vat **42** with the number of times the latter has been used, in the case where the univocal identification code **ID** received and verified belongs to said vat **42** properly installed on the stereolithography machine **2**.

In other words, as already mentioned, according to the invention the number of times the univocal identification code **ID** related to a specific vat **42** has been read can be increased and therefore the number of times the same vat **42** has been installed and used on a stereolithography machine **2** can be updated.

Furthermore, still preferably but not necessarily, the remote server **61** is configured to associate the vat **42** with the type of base material transferred into the same vat. Both of said operations of association, in particular, are carried out by storing the number of uses and the type of material transferred in an appropriate memory allocation **82** of the database **8** reserved for that specific vat **42**. In greater detail, the information concerning the type of material transferred into said vat **42** is preferably but not necessarily read from the RFID tag **71** of the recharge cartridge **41** from which said material is extracted. For this purpose, according to the invention said information is previously stored in said RFID tag **71** of the recharge cartridge **41** simultaneously with the operation of storage of the corresponding univocal identification code in the same RFID tag **71**.

Finally, the remote server **61** is configured in such a way that, also in the case of reception of a univocal identification code **ID** related to a vat **42**, it will modify the respective state from active to inactive in the predefined list **L**, in the case where the corresponding number of times said vat has been used reaches or exceeds a predefined number of times.

Furthermore, according to the preferred embodiment of the invention, the data processing unit **3** is configured in such a way as to enable the use of the consumable element also in the case where the univocal identification code **ID** read is related to a vat **42**. In particular, said enabling step is performed once said data processing unit **3** has received the validity signal sent by the remote server **61** and verified the compatibility of the material to be transferred into said vat **42** with the material that is present therein, if any. Clearly, said verification is carried out by the data processing unit **3** by comparing the value related to the type of material read in the RFID tag **71** of the recharge cartridge **41** with the value related to the type of material stored in the memory allocation **82** associated with that specific vat **42**. Said further verification makes it possible to avoid that two base materials that are incompatible with each other are mixed in the vat **42**.

Furthermore, according to the preferred embodiment described herein, the data processing unit **3** is configured in such a way as to modify the state of the univocal identification code **ID** of a vat **42** from active to inactive in the corresponding RFID tag **71** through said RFID transceiver **321**, also in the case where the consumable element **4** corresponds to the vat **42** itself.

Furthermore, the data processing unit **3** is configured to store in the same RFID tag **71** of the vat **42** also the number of times the latter has been used and the type of base material transferred therein, simultaneously with the operation performed by the remote server **61** in the memory allocation **82** related to the same vat **42**.

The validation system **5** belonging to the printing unit **1**, furthermore, is configured to carry out the steps of the method of the invention for enabling said stereolithography machine **2** to carry out the printing process.

In particular, in order to implement said method, the data processing unit **3** is configured to compare the value of the total quantity of material associated with the stereolithography machine **2** and stored in the memory allocation **81** with the quantity of base material that is necessary for making the three-dimensional object or objects that have to be produced. The data processing unit **3** is also configured in such a way as to enable the stereolithography machine **2** to carry out the printing process, in the case where said total quantity of base material is equal to or exceeds the quantity of base material necessary for making said three-dimensional object or objects.

It cannot be excluded, however, that according to an alternative embodiment of the invention said comparison may be carried out by the remote server **61**. In particular, according to this last alternative embodiment, the data processing unit **3** may be configured to send the remote server **61** the information concerning the quantity of base material necessary for making a specific three-dimensional object. In turn, the remote server **61** is configured in such a way that it can compare the information it has received with the total quantity of base material associated with that specific stereolithography machine **2**, stored in said memory allocation **81**.

The remote server **61** may be configured in such a way that if, following said comparison, the total quantity of base material associated with the stereolithography machine **2** is equal to or exceeds the quantity of base material that is necessary for making the three-dimensional object, it will send the data processing unit **3** a signal intended to enable the printing process.

In any way, according to both the preferred embodiment of the invention and said alternative embodiment, the data processing unit **3** is configured in such a way that it can manage the printing operations in order to print, even partially, the three-dimensional object by means of said sterolithography machine **2**, in case of a positive outcome of said comparison. The data processing unit **3**, furthermore, is configured in such a way that, at the end of the printing step, it will calculate, together with the remote server **61**, the quantity of base material actually used during said step and update the total quantity of base material associated with the stereolithography machine **2**, deducting said quantity of base material actually used from the total quantity.

Finally, the remote server **61** is configured to proceed with the storage of said new value of the total quantity of base material, or of the print credit, in said memory allocation **81** reserved for that specific stereolithography machine **2**.

According to an alternative embodiment of the invention, the printing unit **1** may comprise a plurality of stereolithography machines **2** located in the same site, as shown in Figure 4, and the remote server **61** may be configured to carry out the steps described above and assigned to it, in such a way as to manage said plurality of stereolithography machines **2** as a single entity.

This alternative solution would make it possible to consider a single print credit for said plurality of stereolithography machines **2**, independently of the quantity of material actually available for each single stereolithography machine **2**.

Consequently, the procedure for enabling the printing process would be managed for the plurality of stereolithography machines **2** as a whole. In other words, with this configuration two different situations would be possible: either all of the stereolithography machines **2** belonging to said plurality are potentially enabled to carry out the printing process, or none of them can proceed to printing a three-dimensional object. This would advantageously make it possible to considerably simplify the implementation of the methods of the invention described above and also to increase the margin of freedom allowed to the user or to the company that owns said plurality of stereolithography machines.

Furthermore, according to another alternative embodiment of the printing unit **1** of the invention, as shown in Figure 5, the data processing control apparatus **6** may comprise, in addition to the remote server **61** described above, also a local server **62** located in the same site where one or more stereolithography machines **2** are located. Said local server **62**, in particular, is operatively connected, preferably through an Intranet connection, to the data processing unit or units **3** that in turn are associated with said stereolithography machines **2**. Said two servers **61** and **62**, furthermore, are configured in such a way that they can communicate with each other through the Internet.

Differently from the preferred embodiment described above, in this case both of the servers **61** and **62** are provided with the database **8**, stored in the corresponding storage means **612** and **622** and comprising the predefined list **L** of univocal identification codes **ID** and the various memory allocations **81** and **82** reserved for the stereolithography machines **2** and the vats **42**. However, according to said alternative embodiment of the invention, the database **8** present in the remote server **61** includes the memory allocations of all the stereolithography machines **2** present on the market and produced by a specific company, while the database **8** present in the local server **62** includes exclusively the memory allocations **81** reserved for the stereolithography machines **2** located in the same site where the local server **62** itself is located.

According to said alternative embodiment of the printing unit **1** of the invention, furthermore, the local server **62** is configured in such a way that it can carry out all the steps assigned to the remote server **61** according to the preferred embodiment of the invention described above. In addition to the above, according to said alternative embodiment of the invention, both of the servers

61 and **62** are configured to synchronize the respective databases **8** at predefined time intervals.

Said particular embodiment of the invention advantageously makes it possible to carry out the steps of the validation method and of the method for enabling the printing process that are the subjects of the invention also in case of absence of an Internet connection, as all the procedures are managed by the local server **62** together with the data processing units **3** associated with the various stereolithography machines **2**. Clearly, once communication between the local server **62** and the remote server **61** has been re-established, it is necessary to resynchronize the information contained in the respective databases **8**, in such a way as to update and share at a global level the various situations which occurred at a local level.

Going back, finally, to the preferred embodiment of the printing unit **1** of the invention, according to the same, each consumable element **4**, in addition to being provided with the RFID tag **71**, in which the related univocal identification code **ID** is stored, is provided with said univocal identification code **ID** also in a different form suited to be read by a human being or by means of an electronic reading device. For example, the univocal identification code **ID** may be reproduced on the consumable element **4** in the form of alphanumeric characters or in the form of a bar code, more specifically a QR code.

As is defined in detail here below, the combination of said univocal identification code **ID** which is reproduced as an alphanumeric code or a bar code with an external mobile device provided with a connection to the cellular network like, for example, a smartphone, and with a particular configuration of the remote server **61** and the data processing unit **3** makes it possible to define a redundant system that, in case of absence of direct communication between the remote server **61** and the data processing unit **3**, makes it possible to proceed with the validation of the consumable elements **4** and to enable the stereolithography machine **2** to carry out the printing process.

In particular, said mobile device, through the installation and execution of an appropriate application, makes it possible to read or enter manually the univocal identification code **ID** present in a consumable element **4** and to send said code to the remote server **61**.

In turn, the remote server **61** is configured to receive said univocal identification code **ID**, so that it can process it and compare it against

the predefined list **L** of univocal identification codes **ID**. The remote server **61** is configured to send a validity code to the same mobile device in the case where said code which has been received is actually authentic and active.

Furthermore, the data processing unit **3**, which is associated with the stereolithography machine **2** where said consumable element **4** has been installed, is properly configured so as to allow said validity code to be entered by a user in a user interface loaded in the same data processing unit **3**. The data processing unit **3** is configured in such a way that, once said validity code has been received, it will compare the latter with the univocal identification code **ID** read by the RFID tag **71** of the same consumable element **4**. The data processing unit **3** is configured in such a way as to enable the use of said consumable element **4**, with no need to directly interrogate said remote server **61**, in the case where said comparison determines a correspondence between the two codes.

Computer program and computer program product.

The invention includes also a computer program comprising a plurality of data processing instructions capable of carrying out all the steps of the methods described above when said computer program is being executed in one or more computers.

Finally, the invention includes also a computer program product comprising a plurality of data processing information stored in storage means of the readable type for the implementation of the methods described above when said computer program product is being executed in one or more computers.

In particular, according to the preferred embodiment of the invention, said computer program and said computer program product are executed partially in said data processing control apparatus and partly in the data processing unit associated with a stereolithography machine.

Based on what has been stated above, therefore, the method for validating consumable elements and the method for enabling a stereolithography machine to carry out the printing process that are the subjects of the invention achieve all of the preset objects.

In particular, the invention achieves the object to provide a method for validating consumable elements and a method for enabling the printing of three-dimensional objects that prevent the use of consumable elements that, although being sold as compatible, are not perfectly suited to be used with

certain types of stereolithography machines.

The invention also achieves the object to provide a validation method and a method for enabling the printing process that prevent the use of low quality consumable elements and, in particular, of low quality base materials.

Finally, the invention also achieves the object to provide a validation method and a method for enabling the printing process that prevent the use of consumable elements that can deteriorate the internal components of the stereolithography machine on which they are installed.

CLAIMS

1) Method for the validation of one or more consumable elements (4) suited to be installed on a stereolithography machine (2) for printing three-dimensional objects through a stereolithography process, **characterized in that** it comprises the following steps:

- installing at least one of said consumable elements (4) on said stereolithography machine (2), said consumable element (4) being provided with a readable univocal identification code (ID);
- reading said univocal identification code (ID) of said consumable element (4);
- verifying that said univocal identification code (ID) is authentic and active by making a comparison against a predefined list (L) of authentic and active identification codes corresponding to said consumable elements (4), said univocal identification code (ID) being considered authentic when it is included in said predefined list (L) and said univocal identification code (ID) being considered active when it has been read a number of times that is smaller than a pre-established number of readings, said pre-established number of readings being selected in advance as equal to or greater than one;
- enabling the use of said consumable element (4) on said stereolithography machine (2) in the case where said univocal identification code (ID) is authentic and active.

2) Method according to claim 1, **characterized in that** it includes the step of modifying the state of said univocal identification code (ID) related to said consumable element (4) in said predefined list (L) from active to inactive in the case where the number of readings of said univocal identification code (ID) reaches said pre-established number of readings.

3) Method according to any of the preceding claims, **characterized in that** it includes the installation of two or more of said consumable elements (4) on said stereolithography machine (2), each one of said consumable elements (4) being provided with a readable univocal identification code (ID), wherein said method furthermore comprises the following operations:

- carrying out said steps of reading and verifying said univocal identification code (ID) for each one of said installed consumable elements (4);
- enabling the use of said consumable elements (4) on said stereolithography

machine (2) in the case where each one of said univocal identification codes (ID) is authentic and active.

4) Method according to any of the preceding claims, **characterized in that**:

- said installation step includes the installation of at least one recharge cartridge (41) as at least one consumable element (4) provided with a univocal identification code (ID), said recharge cartridge containing the base material to be used for making said three-dimensional objects;
- said step of enabling said recharge cartridge (41) includes the following operations:
  - transferring at least partially said base material from said recharge cartridge (41) into a vat (42) arranged on said stereolithography machine (2);
  - calculating the value of the total quantity of base material available for said stereolithography machine (2) by adding the quantity of material transferred during said transfer operation to the total quantity of material previously associated with said stereolithography machine (2);
  - associating said calculated value related to the total quantity of base material with said stereolithography machine (2);
  - storing said association;
  - modifying the state of said univocal identification code (ID) related to said recharge cartridge (41) from active to inactive in said predefined list (L) in the case where said base material was completely transferred from said recharge cartridge (41) into said vat (42).

5) Method according to any of the preceding claims, **characterized in that** said installation step includes the installation of at least one vat (42) as at least one consumable element (4) provided with a univocal identification code (ID), wherein said vat is suited to contain the base material to be used for making said three-dimensional objects with said stereolithography machine (2).

6) Method according to claim 5, **characterized in that** said step of enabling said vat (42) includes at least the operations of:

- associating said univocal identification code (ID) of said vat (42) with the number of uses of said vat (42);
- storing said association;
- modifying the state of said univocal identification code (ID) related to said

vat (42) from active to inactive in said predefined list (L) in the case where said number of uses reaches or exceeds a predefined number of uses.

7) Method according to claim 6, **characterized in that** said step of enabling said vat (42) furthermore includes the step of associating said univocal identification code (ID) of said vat (42) with the type of base material transferred from one or more recharge cartridges (41) into said vat (42) and storing said association.

8) Method for enabling the printing of three-dimensional objects through a stereolithography machine (2), **characterized in that** it includes the execution of the steps of the validation method according to any of the preceding claims and at the same time or successively the execution of the following steps:

- reading said stored value of the total quantity of base material associated with said stereolithography machine (2);
- calculating the quantity of base material necessary for making a specific three-dimensional object;
- comparing said total quantity of material with said quantity of base material necessary for making said three-dimensional object;
- in the case where said total quantity of base material is equal to or exceeds said necessary quantity of base material:
  - enabling the use of said stereolithography machine (2);
  - making said three-dimensional object at least partially;
  - calculating the new value of the total quantity of base material available for said stereolithography machine (2) by deducting the quantity of base material used for making said three-dimensional object, at least partially, from said total quantity of material previously associated with said stereolithography machine (2);
  - storing said calculated value of the total quantity of base material associated with said stereolithography machine (2).

9) Printing unit (1) comprising at least one stereolithography machine (2) and a data processing unit (3, 31) configured in such a way as to manage the functions of said stereolithography machine (2) for printing three-dimensional objects through a stereolithography process, **characterized in that** it comprises a validation system (5) of at least one consumable element (4, 41, 42) suited to be installed on said stereolithography machine (2) and provided with a readable univocal identification code (ID), said validation

system (5) being provided with:

- said data processing unit (3, 31) comprising reading means (32, 321) configured to read said univocal identification code (ID) of said consumable element (4, 41, 42) and transceiver means (33) configured in such a way as to transmit said univocal identification code (ID) to a data processing control apparatus (6, 61, 62);
- said data processing control apparatus (6, 61, 62) comprising storage means (612, 622) having a predefined list (L) of univocal identification codes (ID), considered authentic and active, related to said consumable elements (4, 41, 42) stored therein, said data processing control apparatus (6, 61, 62) being configured to:
  - receive said univocal identification code (ID) related to said consumable element (4, 41, 42) from said data processing unit (3, 31);
  - compare said univocal identification code (ID) with said predefined list (L) in order to verify that said univocal identification code (ID) is authentic and active;
  - send a signal of validity of said univocal identification code (ID) to said data processing unit (3, 31) in the case where said univocal identification code (ID) is authentic and active;

said transceiver means (33) of said data processing unit (3, 31) furthermore being configured to receive said signal of validity,

and said data processing unit (3, 31) being configured to enable the use of said consumable element (4, 41, 42) in said stereolithography machine (2) in case of reception of said signal of validity.

10) Printing unit (1) according to claim 9, **characterized in that** said data processing control apparatus (6, 61, 62) is configured in such a way that, in the case where two or more consumable elements (4, 41, 42) are installed on said stereolithography machine (2), it will send said signal of validity to said data processing unit (3, 31), on condition that the univocal identification codes (ID) of each one of said consumable elements (4, 41, 42) are authentic and active.

11) Printing unit (1) according to claim 9 or 10, wherein said stereolithography machine (2) comprises first coupling means (21) for the installation of at least one recharge cartridge (41) of the base material to be used for making said three-dimensional object as consumable element (4), said recharge cartridge (41) being provided with a univocal identification code

(ID), said printing unit (1) being **characterized in that**:

- said data processing unit (3, 31) is configured so as to receive said signal of validity and, after receiving said signal of validity, to transfer said base material from said recharge cartridge (41) to a vat (42) arranged on said stereolithography machine (2);
- said data processing control apparatus (6, 61, 62) has a memory allocation (81) in said storage means (612, 622) that is reserved to said stereolithography machine (2), said data processing control apparatus (6, 61, 62) being furthermore configured to:
  - calculate the value of the total quantity of base material available for said stereolithography machine (2) by adding the quantity of base material transferred during said transfer operation to the total quantity of base material previously associated with said stereolithography machine (2) and stored in said memory allocation (81);
  - associate said calculated value of the total quantity of material with said stereolithography machine (2), storing said value in said memory allocation (81);
  - modify the state of said univocal identification code (ID) related to said recharge cartridge (41) from active to inactive in said predefined list (L), in the case where said base material was completely transferred from said recharge cartridge (41) into said vat (42).

12) Printing unit (1) according to any of the claims from 9 to 11, wherein said stereolithography machine (2) comprises second coupling means (22) for installing, as at least one consumable element (4), at least one vat (42) suited to contain the material to be used for making said three-dimensional object, said vat (42) being provided with a univocal identification code (ID), said printing unit (1) being **characterized in that**:

- said data processing control apparatus (6, 61, 62) has a memory allocation (82) in said storage means (612, 622) that is reserved for said vat (42) with said univocal identification code (ID), said data processing control apparatus (6, 61, 62) being configured to:
  - associate said vat (42) with the number of uses of said vat (42) by storing said number in said memory allocation (82);
  - associate said vat (42) with the type of base material transferred therein by storing said type of base material in said memory allocation (82);

- modify the state of said univocal identification code (ID) related to said vat (42) from active to inactive in said predefined list (L), in the case where said number of uses reaches or exceeds a predefined number of uses.

13) Printing unit (1) of the type according to any of the claims from 9 to 12, **characterized in that** said data processing unit (3, 31) is configured to:

- compare said value of the total quantity of base material associated with said stereolithography machine (2) and stored in said memory allocation (81) with the quantity of base material necessary for making said three-dimensional object;
- enable said stereolithography machine (2) to carry out the printing process, in the case where said total quantity of base material is equal to or exceeds said quantity of base material necessary for making said three-dimensional object.

14) Printing unit (1) according to any of the claims from 9 to 13, **characterized in that** each one of said consumable elements (4, 41, 42) is provided with a storage and transmission device (7, 71) in which said univocal identification code (ID) is stored.

15) Printing unit (1) according to claim 14, **characterized in that**:

- said storage and transmission device (7, 71) present in each one of said consumable elements (4, 41, 42) is a RFID tag (71);
- said reading means (32, 321) are constituted by a RFID transceiver (321).

16) Printing unit (1) according to any of the claims from 9 to 15, **characterized in that** said data processing control apparatus (6, 61, 62) comprises a remote server (61) configured to communicate with said data processing unit (3, 31) through an Internet connection.

17) Computer program product comprising a plurality of data processing instructions stored in storage means of the readable type for the implementation of the methods according to any of the claims from 1 to 8 when said computer program product is being executed in at least one computer.

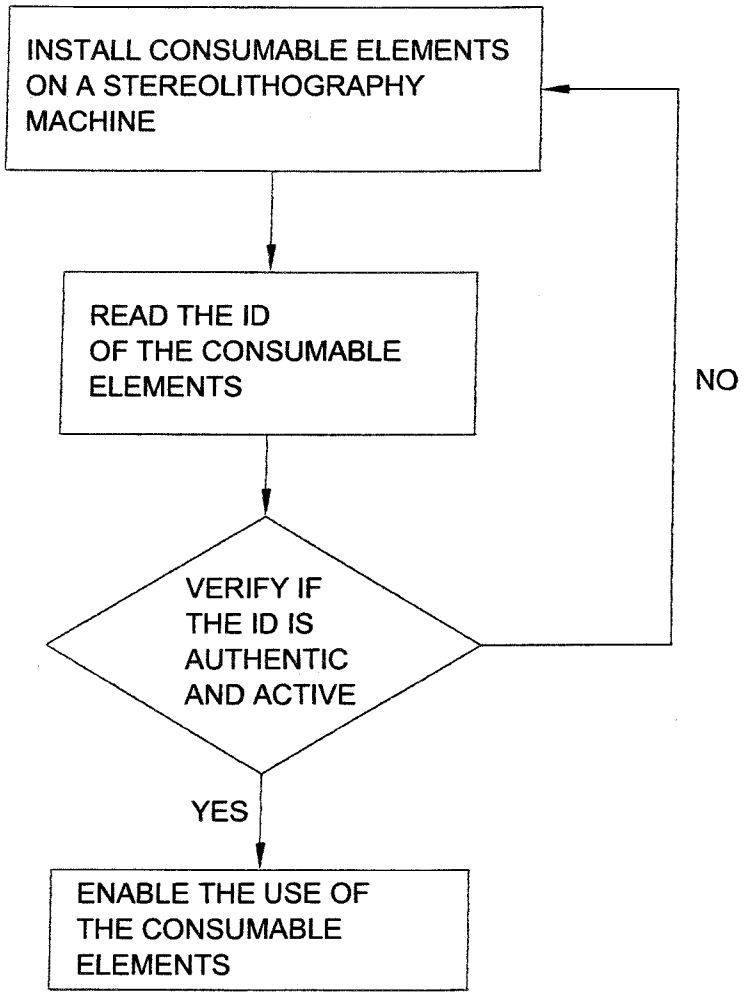
INSTALL CONSUMABLE ELEMENTS ON A STEREOLITHOGRAPHY MACHINE
READ THE ID OF THE CONSUMABLE ELEMENTS
VERIFY IF THE ID IS AUTHENTIC AND ACTIVE
NO
YES
ENABLE THE USE OF THE CONSUMABLE ELEMENTS

Fig.1

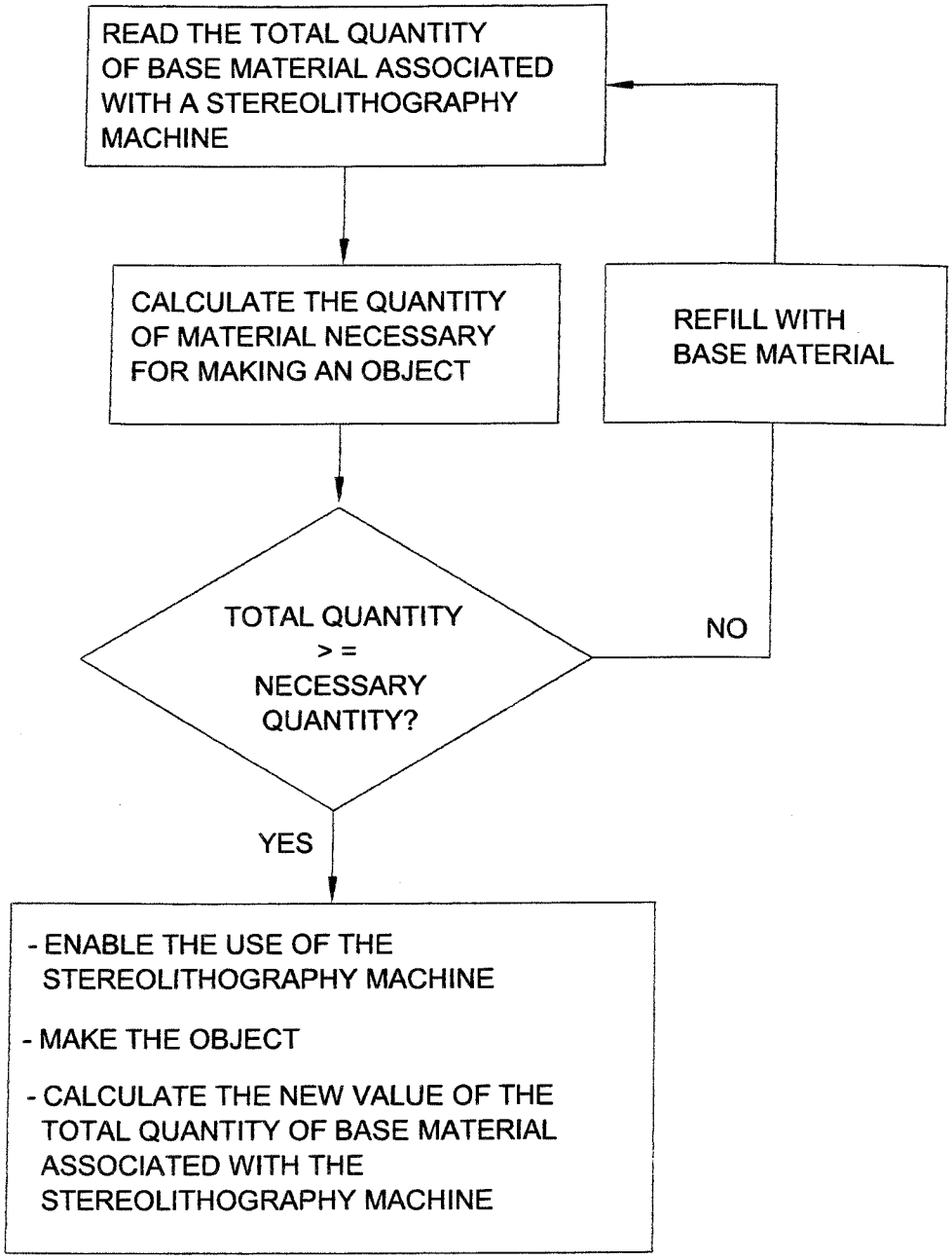
READ THE TOTAL QUANTITY OF BASE MATERIAL ASSOCIATED WITH A STEREOLITHOGRAPHY MACHINE
CALCULATE THE QUANTITY OF MATERIAL NECESSARY FOR MAKING AN OBJECT
REFILL WITH BASE MATERIAL
TOTAL QUANTITY > = NECESSARY QUANTITY?
NO
YES
- ENABLE THE USE OF THE STEREOLITHOGRAPHY MACHINE
- MAKE THE OBJECT
- CALCULATE THE NEW VALUE OF THE TOTAL QUANTITY OF BASE MATERIAL ASSOCIATED WITH THE STEREOLITHOGRAPHY MACHINE

Fig.2

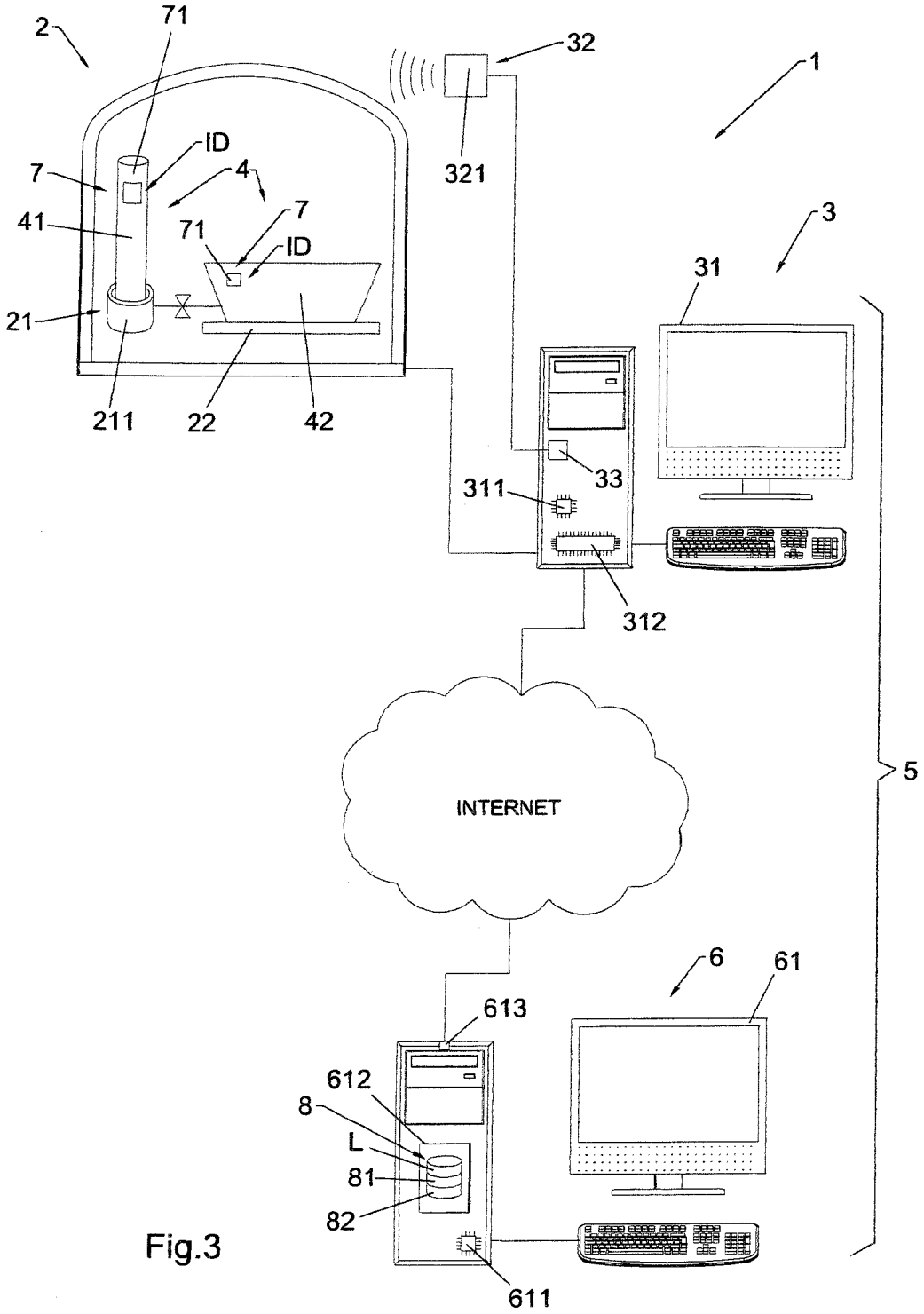
2
71
32
1
ID
7
4
321
41
7
71
ID
3
31
21
211
22
42
33
311
312
INTERNET
5
6
61
613
612
8
L
81
82
611

Fig.3

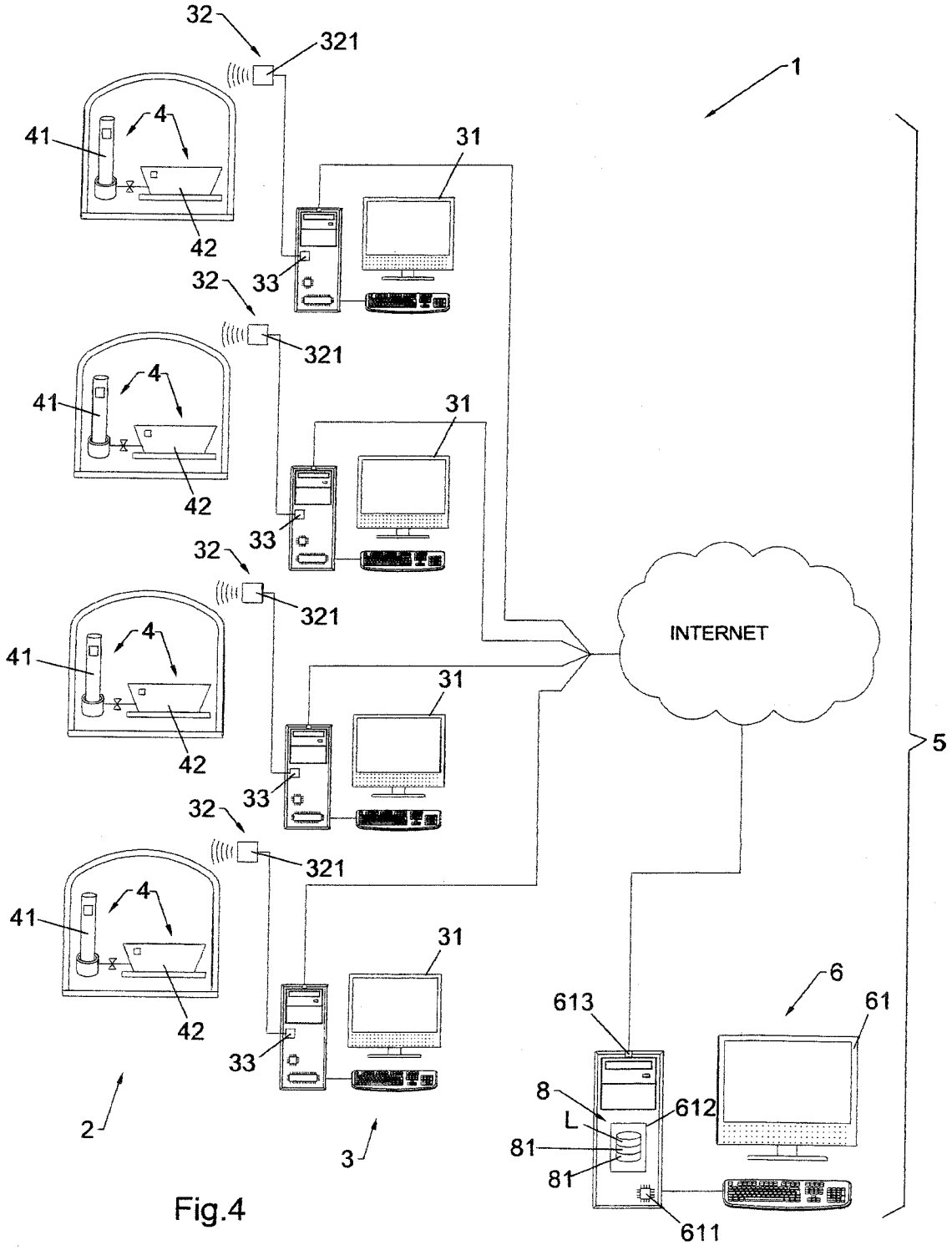

Fig.4

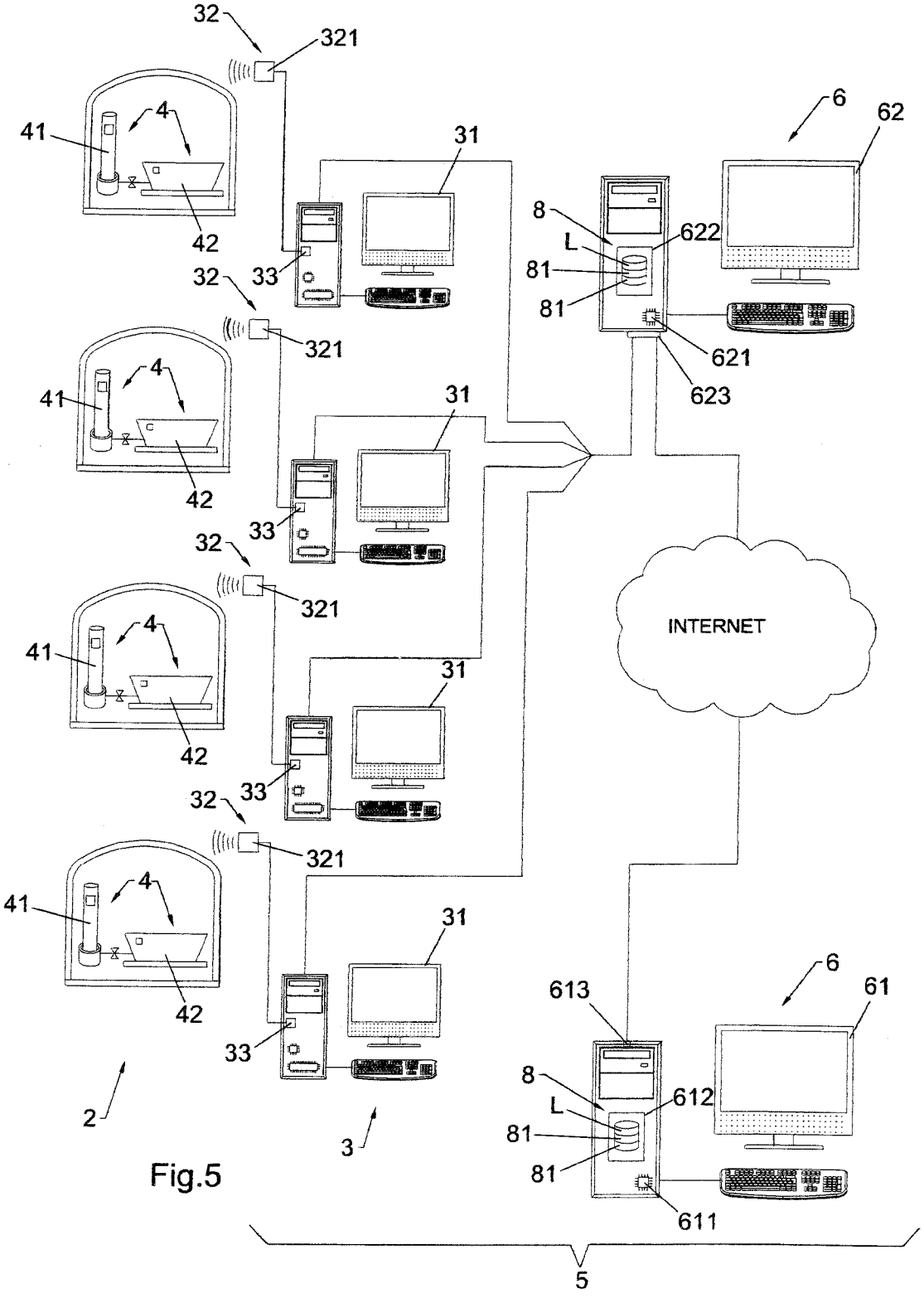
32
321
41
4
42
31
33
6
62
8
L
622
81
81
621
623
INTERNET
613
61
612
611
2
3
5

Fig.5

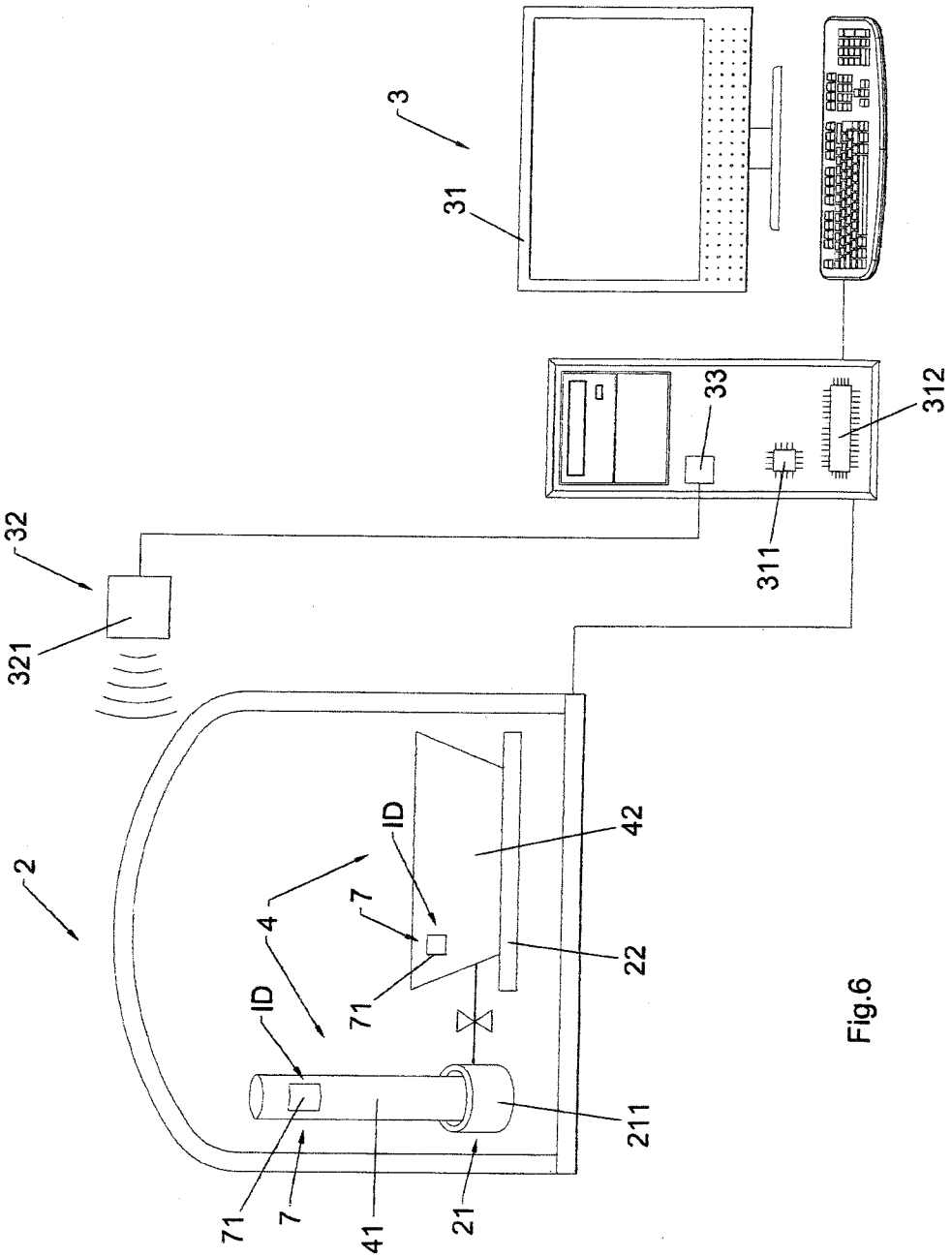

Fig.6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/053659

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C67/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 769 904 A2 (3D SYSTEMS INC [US]) 4 April 2007 (2007-04-04) paragraph [0017] paragraph [0024] paragraph [0051] paragraph [0054] paragraph [0072] claims 6-12 -----	1-17
X	WO 2014/020401 A1 (DWS SRL [IT]) 6 February 2014 (2014-02-06) page 1, line 1 - line 2 page 3, line 14 - line 28 page 6, line 23 - line 32 page 8, line 15 - line 16 page 8, line 31 - line 32 page 9, line 10 - line 11 -----	1-4,8, 14,15,17

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 October 2016	14/10/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Whelan, Natalie

2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/053659

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 950 032 A2 (3D SYSTEMS INC [US]) 30 July 2008 (2008-07-30) paragraph [0040] paragraph [0004] - paragraph [0008] claims -----	1,8,14, 15,17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2016/053659

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1769904 A2	04-04-2007	CN 1939704 A	04-04-2007
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		JP 5192676 B2	08-05-2013
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EP 1950032 A2	30-07-2008	EP 1950032 A2	30-07-2008
		JP 5096937 B2	12-12-2012
		JP 2008173974 A	31-07-2008
		TW 200835592 A	01-09-2008
		US 2008231731 A1	25-09-2008

(19)中华人民共和国国家知识产权局

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B33Y 10/00(2015.01)
B33Y 50/00(2015.01)

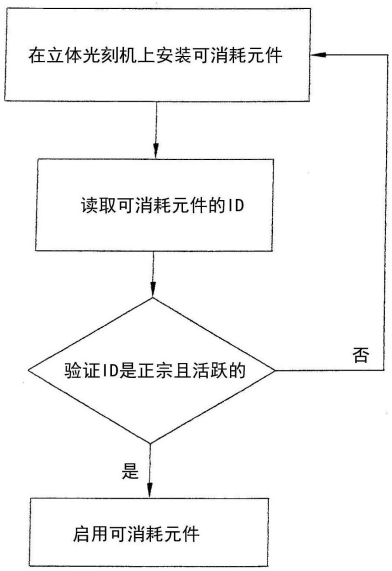
权利要求书4页 说明书12页 附图6页

(54)发明名称

用于核验适合于被安装在立体光刻机上的可消耗元件的方法和用于启用该立体光刻机来执行打印过程的方法

(57)摘要

本发明是用于核验适合于被安装在用于通过立体光刻工艺来打印三维物体的立体光刻机(2)上的一个或多个可消耗元件(4)的方法。该方法包括以下步骤:在立体光刻机(2)上安装被提供有可读单义标识码(ID)的可消耗元件(4),读取所述单义标识码(ID),通过对照正宗且活跃的标识码的预定义列表(L)进行比较来验证单义标识码(ID)是正宗且活跃的,并且在对应的单义标识码(ID)是正宗且活跃的情况下启用立体光刻机(2)上的可消耗元件(4)。



CN 107820460 A

1.一种用于核验一个或多个可消耗元件(4)的方法,所述一个或多个可消耗元件(4)适合于被安装在用于通过立体光刻工艺来打印三维物体的立体光刻机(2)上,其特征在于,所述方法包括以下步骤:

-在所述立体光刻机(2)上安装所述可消耗元件(4)中的至少一个可消耗元件(4),所述可消耗元件(4)被提供有可读单义标识码(ID);

-读取所述可消耗元件(4)的所述单义标识码(ID);

-通过对照与所述可消耗元件(4)相对应的正宗且活跃标识码的预定义列表(L)进行比较来验证所述单义标识码(ID)是正宗且活跃的,所述单义标识码(ID)在它被包括在所述预定义列表(L)中时被视为正宗的,并且所述单义标识码(ID)在它已被读取小于预先确立的读取次数的次数时被视为活跃的,所述预先确立的读取次数事先被选择为等于或大于一;

-在所述单义标识码(ID)是正宗且活跃的情况下,启用所述立体光刻机(2)上的所述可消耗元件(4)。

2.如权利要求1所述的方法,其特征在于,所述方法包括以下步骤:在所述单义标识码(ID)的读取次数达到所述预先确立的读取次数的情况下,在所述预定义列表(L)中将与所述可消耗元件(4)相关的所述单义标识码(ID)的状态从活跃修改为不活跃。

3.如前述权利要求中任一项所述的方法,其特征在于,所述方法包括:在所述立体光刻机(2)上安装两个或更多个所述可消耗元件(4),所述可消耗元件(4)中的每一者被提供有可读单义标识码(ID),其中,所述方法进一步包括以下操作:

-针对所述经安装的可消耗元件(4)中的每一者执行读取并验证所述单义标识码(ID)的所述步骤;

-在所述单义标识码(ID)中的每一者是正宗且活跃的情况下,启用所述立体光刻机(2)上的所述可消耗元件(4)。

4.如前述权利要求中任一项所述的方法,其特征在于:

-所述安装步骤包括:安装至少一个再填充盒(41)作为被提供有单义标识码(ID)的至少一个可消耗元件(4),所述再填充盒容纳要用于制造所述三维物体的基础材料;

-启用所述再填充盒(41)的所述步骤包括以下操作:

-将所述基础材料从所述再填充盒(41)至少部分地转移到被布置在所述立体光刻机(2)上的桶(42)中;

-通过将在所述转移操作期间转移的材料量加到先前与所述立体光刻机(2)相关联的材料总量,来计算能用于所述立体光刻机(2)的基础材料总量的值;

-将所计算的与基础材料总量相关的值与所述立体光刻机(2)进行关联;

-存储所述关联;

-在所述基础材料已从所述再填充盒(41)完全转移到所述桶(42)中的情况下,在所述预定义列表(L)中将与所述再填充盒(41)相关的所述单义标识码(ID)的状态从活跃修改为不活跃。

5.如前述权利要求中任一项所述的方法,其特征在于,所述安装步骤包括:安装至少一个桶(42)作为被提供有单义标识码(ID)的至少一个可消耗元件(4),其中,所述桶适合于容纳要用于利用所述立体光刻机(2)来制造所述三维物体的基础材料。

6.如权利要求5所述的方法,其特征在于,启用所述桶(42)的所述步骤包括至少以下操

作：

-将所述桶(42)的所述单义标识码(ID)与所述桶(42)的使用次数进行关联；

-存储所述关联；

-在所述使用次数达到或超过预定义的使用次数的情况下，在所述预定义列表(L)中将与所述桶(42)相关的所述单义标识码(ID)的状态从活跃修改为不活跃。

7.如权利要求6所述的方法，其特征在于，启用所述桶(42)的所述步骤进一步包括以下步骤：将所述桶(42)的所述单义标识码(ID)与从一个或多个再填充盒(41)转移到所述桶(42)中的基础材料的类型进行关联，以及存储所述关联。

8.一种用于通过立体光刻机(2)启用对三维物体的打印的方法，其特征在于，所述方法包括执行根据前述权利要求中任一项的所述核验方法的步骤并且同时或相继执行以下步骤：

-读取所述经存储的与所述立体光刻机(2)相关联的基础材料总量的值；

-计算制造特定的三维物体所必需的基础材料量；

-将所述材料总量与制造所述三维物体所必需的所述基础材料量进行比较；

-在所述基础材料总量等于或超过所述必需的基础材料量的情况下：

-启用所述立体光刻机(2)；

-至少部分地制造所述三维物体；

-通过将用于至少部分地制造所述三维物体的基础材料量从先前与所述立体光刻机(2)相关联的所述材料总量中扣除，来计算能用于所述立体光刻机(2)的基础材料总量的新值；

-存储所计算的与所述立体光刻机(2)相关联的基础材料总量的值。

9.一种打印单元(1)，包括至少一个立体光刻机(2)和数据处理单元(3,31)，所述数据处理单元(3,31)被配置成管理所述立体光刻机(2)的功能以用于通过立体光刻工艺来打印三维物体，其特征在于，所述打印单元(1)包括至少一个可消耗元件(4,41,42)的核验系统(5)，所述至少一个可消耗元件(4,41,42)适合于被安装在所述立体光刻机(2)上并被提供有可读单义标识码(ID)，所述核验系统(5)被提供有：

-所述数据处理单元(3,31)，其包括被配置成读取所述可消耗元件(4,41,42)的所述单义标识码(ID)的读取装置(32,321)以及被配置成向数据处理控制装备(6,61,62)传送所述单义标识码(ID)的收发机装置(33)；

-所述数据处理控制装备(6,61,62)，其包括存储装置(612,622)，所述存储装置(612,622)中存储有与所述可消耗元件(4,41,42)相关的被视为正宗且活跃的单义标识码(ID)的预定义列表(L)，所述数据处理控制装备(6,61,62)被配置成：

-从所述数据处理单元(3,31)接收与所述可消耗元件(4,41,42)相关的所述单义标识码(ID)；

-将所述单义标识码(ID)与所述预定义列表(L)进行比较，以便验证所述单义标识码(ID)是正宗且活跃的；

-在所述单义标识码(ID)是正宗且活跃的情况下，向所述数据处理单元(3,31)发送所述单义标识码(ID)的有效性信号；

所述数据处理单元(3,31)的所述收发机装置(33)进一步被配置成接收所述有效性信

号，

并且所述数据处理单元(3,31)被配置成：在接收到所述有效性信号的情况下，启用所述立体光刻机(2)中的所述可消耗元件(4,41,42)。

10.如权利要求9所述的打印单元(1)，其特征在于，所述数据处理控制装备(6,61,62)被配置成：在两个或更多个可消耗元件(4,41,42)被安装在所述立体光刻机(2)上的情况下，所述数据处理控制装备(6,61,62)在所述可消耗元件(4,41,42)中的每一者的单义标识码(ID)是正宗且活跃的情况下将向所述数据处理单元(3,31)发送所述有效性信号。

11.如权利要求9或10所述的打印单元(1)，其特征在于，所述立体光刻机(2)包括用于安装要用于制造所述三维物体的基础材料的至少一个再填充盒(41)作为可消耗元件(4)的第一耦合装置(21)，所述再填充盒(41)被提供有单义标识码(ID)，所述打印单元(1)的特征在于：

-所述数据处理单元(3,31)被配置成：接收所述有效性信号，并且在接收所述有效性信号之后，将所述基础材料从所述再填充盒(41)转移到被布置在所述立体光刻机(2)上的桶(42)中；

-所述数据处理控制装备(6,61,62)在所述存储装置(612,622)中具有被保留用于所述立体光刻机(2)的存储器分配(81)，所述数据处理控制装备(6,61,62)被进一步配置成：

-通过将在所述转移操作期间转移的基础材料量加到先前与所述立体光刻机(2)相关联并存储在所述存储器分配(81)中的基础材料总量，来计算能用于所述立体光刻机(2)的基础材料总量的值；

-通过将所计算的材料总量的值存储在所述存储器分配(81)中，来将所述值与所述立体光刻机(2)进行关联；

-在所述基础材料已从所述再填充盒(41)完全转移到所述桶(42)中的情况下，在所述预定义列表(L)中将与所述再填充盒(41)相关的所述单义标识码(ID)的状态从活跃修改为不活跃。

12.如权利要求9至11中任一项所述的打印单元(1)，其特征在于，所述立体光刻机(2)包括用于安装适合于容纳要用于制造所述三维物体的材料的至少一个桶(42)作为至少一个可消耗元件(4)的第二耦合装置(22)，所述桶(42)被提供有单义标识码(ID)，所述打印单元(1)的特征在于：

-所述数据处理控制装备(6,61,62)在所述存储装置(612,622)中具有被保留用于具有所述单义标识码(ID)的所述桶(42)的存储器分配(82)，所述数据处理控制装备(6,61,62)被进一步配置成：

-通过将所述桶(42)的使用次数存储在所述存储器分配(82)中，来将所述桶(42)与所述次数进行关联；

-通过将转移到所述桶(42)中的基础材料的类型存储在所述存储器分配(82)中，来将所述桶(42)与所述基础材料的类型进行关联；

-在所述使用次数达到或超过预定义的使用次数的情况下，在所述预定义列表(L)中将与所述桶(42)相关的所述单义标识码(ID)的状态从活跃修改为不活跃。

13.如权利要求9至12中任一项所述的类型的打印单元(1)，其特征在于，所述数据处理单元(3,31)被配置成：

-将与所述立体光刻机(2)相关联并且存储在所述存储器分配(81)中的所述基础材料总量的值与制造所述三维物体所必需的基础材料量进行比较；

-在所述基础材料总量等于或超过制造所述三维物体所必需的所述基础材料量的情况下，启用所述立体光刻机(2)来执行所述打印过程。

14.如权利要求9至13中任一项所述的打印单元(1)，其特征在于，所述可消耗元件(4,41,42)中的每一者被提供有存储和传输设备(7,71)，所述单义标识码(ID)被存储在所述存储和传输设备(7,71)中。

15.如权利要求14所述的打印单元(1)，其特征在于：

-存在于所述可消耗元件(4,41,42)中的每一者中的所述存储和传输设备(7,71)是RFID标签(71)；

-所述读取装置(32,321)由RFID收发机(321)构成。

16.如权利要求9至15中任一项所述的打印单元(1)，其特征在于，所述数据处理控制装备(6,61,62)包括远程服务器(61)，所述远程服务器(61)被配置成：通过因特网连接与所述数据处理单元(3,31)通信。

17.一种包括多个数据处理指令的计算机程序产品，所述多个数据处理指令被存储在可读类型的存储装置中以用于当所述计算机程序产品在至少一个计算机中被执行时实现根据权利要求1至8中任一项所述的方法。

用于核验适合于被安装在立体光刻机上的可消耗元件的方法和用于启用该立体光刻机来执行打印过程的方法

[0001] 描述

[0002] 本发明涉及一种用于对适合于被安装在属于打印单元的立体光刻机上的可消耗元件的使用进行核验的方法。

[0003] 本发明还涉及一种用于通过属于打印单元的立体光刻机来启用对三维物体的打印的方法。

[0004] 此外，本发明涉及一种打印单元，该打印单元包括至少一个立体光刻机并且被配置成执行用于核验可消耗元件以及用于启用对三维物体的打印的所述方法的各步骤。

[0005] 如所知的，立体光刻技术使得有可能通过叠加多层液态或糊状的基础材料(其通过暴露于预定义辐射(一般为光辐射)而被固化)来生产三维物体。

[0006] 已知类型的立体光刻机包括适合于容纳基础材料的桶，该桶被提供有对于预定义辐射透明的底部。

[0007] 该机器进一步包括发射器装置，该发射器装置适合于发射所述预定义辐射并且被布置在桶下方，该发射器装置选择性地固化与桶的底部毗邻的基础材料层。

[0008] 经固化的层由建模平台支撑，该建模平台被机动化以使得它在相对于桶底部的垂直和正交方向上移动，以便布置最后固化的层以使得该层在其固化之前与所述基础材料层毗邻。

[0009] 还已知，在最新近的立体光刻机中，所述桶是可移除且可替换的类型，这是因为在不确定数目的打印过程之后，桶的透明底部自身趋于劣化，从而使通过立体光刻工艺获得的三维物体的质量变差。

[0010] 此外，如所知的，所述立体光刻机被配置成容适容纳所述基础材料的再填充盒，所述基体材料在需要时被迫离开所述再填充盒并被运送到桶中(通过连接所述两个元件的阀装置来运送)。

[0011] 此外，所述再填充盒一旦已耗尽就可以从立体光刻机移除并利用填充有其他基础材料的再填充盒替换。

[0012] 一般而言，在常见术语中以及在该上下文中，像用于立体光刻机的所述可移除类型的桶和再填充盒被称为立体光刻机的可消耗元件，即，如下附件：这些附件可以被安装在所述机器上并且在它们由于已使用达未确定但有限时间段而劣化或不再能够履行它们的功能时可以被移除并替换。

[0013] 使用所述可消耗元件所提供的优点在于，立体光刻机的使用和维护显著简化，从而使得立体光刻机也适合于由不熟练的操作者使用，像例如在珠宝或牙科领域工作的操作者。

[0014] 然而，关于缺点，对被称为“兼容的”或“再制造”元件的所谓可消耗元件的销售和使用正在日益扩大。

[0015] “兼容的”可消耗元件是由给定的公司生产并适合于被安装在由不同制造商生产的一类立体光刻机上的那些可消耗元件。相反，“再制造”可消耗元件是由营销立体光刻打

印机的相同公司生产、但利用由其他制造商生产的基础材料进行再填充的那些元件(以使得它们可以被重新使用)。

[0016] 在两种情况下,经常可以观察到,“兼容的”或“再制造”可消耗元件的质量比所谓的正宗(authentic)元件低得多,正宗元件表示由立体光刻机的制造商生产并营销的那些元件。因此,可以观察到,即使使用高质量的立体光刻机,所述非正宗可消耗元件的使用也经常导致所生产的三维物体质量变差。

[0017] 具体而言,在使用所谓的“兼容的”或“再制造”再填充盒的情况下,实际上存在容纳在再填充盒中的基础材料可能不合适并且可能与所述立体光刻机的特性不兼容的风险。

[0018] 此外,“兼容的”可消耗元件的使用还可导致构成立体光刻机自身的内部组件的快速劣化。

[0019] 本发明旨在克服上面提到的所有缺陷。

[0020] 具体而言,本发明的目的之一是提供一种用于核验可消耗元件的方法和一种用于启用对三维物体的打印的方法,这些方法防止使用即使作为兼容元件出售也不能完全适合于与某些类型的立体光刻机联用的可消耗元件。

[0021] 由此本发明的目的是提供一种核验方法和一种用于启用打印过程的方法,这些方法使得不可能使用低质量可消耗元件(具体而言,低质量基础材料)。

[0022] 本发明的另一目的是提供一种核验方法和一种用于启用打印过程的方法,这些方法使得不可能使用会使立体光刻机的内部组件劣化的可消耗元件(可消耗元件被安装在该立体光刻机上)。

[0023] 所述目的通过根据主要权利要求开发的核验方法来达成。

[0024] 所述目的还通过用于根据权利要求8开发的用于启用打印过程的方法、通过根据权利要求9的打印单元、以及通过根据权利要求17的计算机程序产品来达成。

[0025] 在对应的独立权利要求中特别描述了本发明的变型实施例。

[0026] 有利地,对作为本发明的主题的方法的实现以及对本发明的打印单元的使用允许立体光刻机和可消耗元件的制造商监视所述可消耗元件的消耗,具体而言,由拥有所述立体光刻机的用户和公司使用的基础材料的消耗。然而,在保证所述用户和公司的隐私的同时来执行所述监视活动。

[0027] 在通过参考附图的非限制性示例提供的对本发明的优选实施例的描述中,所述目的和优点、以及下文将提到的其他目的和优点将明显。

[0028] -图1示出解说了属于本发明的主题的用于核验适合于被安装在立体光刻机上的可消耗元件的方法的操作步骤的流程图;

[0029] -图2示出解说了属于本发明的用于启用立体光刻机以执行打印过程的方法的操作步骤的流程图;

[0030] -图3示出了根据本发明的优选实施例的作为本发明的主题的打印单元的示意性结构图;

[0031] -图4示出了根据第一替换实施例的本发明的打印单元的示意性结构图;

[0032] -图5示出了根据第二替换实施例的本发明的打印单元的示意性结构图;

[0033] -图6示出了包括属于本发明的打印单元的数据处理单元和立体光刻机的细节的示意图。

[0034] 用于核验被提供有单义标识码的可消耗元件的方法

[0035] 已开发了作为本发明的主题的方法(其操作步骤在图1中所示的流程图中解说),以便使得有可能核验并因此启用被安装在立体光刻机上的一个或多个可消耗元件,以用于通过立体光刻工艺来打印三维物体。

[0036] 如在对现有技术的描述中提及的,可消耗元件是立体光刻机的附件(诸如容纳要用于制造三维物体的基础材料的再填充盒以及适合于在打印过程期间容纳所述基础材料的桶),这些附件在已使用达未确定但有限的时间段之后劣化或不再能够履行它们的功能,并且因此需要进行替换。

[0037] 根据本发明,本发明的核验方法包括以下步骤:在所述立体光刻机上安装至少一个被提供有可读单义标识码的可消耗元件。

[0038] 显然,所述单义标识码的使用允许每个可消耗元件相对于其他可消耗元件单义地可标识。通常,由生产和营销单义标识码的公司将该单义标识码指派给每个可消耗元件并在每个可消耗元件上再现。此外,该公司通常是所述立体光刻机的制造商和销售商。

[0039] 此外,在本发明的上下文中并且如在以下将更详细定义的,形容词“可读”表示所述单义标识码可以由人类或由适当的自动读取设备“读取”。

[0040] 根据本发明的优选实施例,该方法包括在立体光刻机上安装并且因此核验至少一个再填充盒和至少一个桶,该至少一个再填充盒被提供有所述单义标识码并容纳要用于制造三维物体的基础材料,该至少一个桶适合于容纳相同的基础材料,该至少一个桶也被提供有单义标识码。然而,不能排除本发明的方法可以唯一地且排他地被实现成核验一个或多个再填充盒或者替换地一个或多个桶的有效性。此外,不能排除本发明的方法可以被实现成:验证相对于再填充盒和桶的不同类型的可消耗元件的有效性,条件是这些可消耗元件被提供有其自身的单义标识码并且它们可以被安装在立体光刻机上。

[0041] 在任何情况下,根据本发明的方法,一旦可消耗元件已被安装在立体光刻机上,与这些可消耗元件相关联的单义标识码就被读取。

[0042] 具体而言,根据本发明的优选实施例,被安装在立体光刻机上的再填充盒和桶的单义标识码被读取。

[0043] 下文在对打印单元的描述中详细解说了执行所述读取操作所基于的规程,该打印单元是本发明的主题并且根据优选实施例被配置成执行该核验方法的各步骤。

[0044] 返回到本发明的方法,在读取单义标识码之后的步骤是以下步骤:验证是否每个单义标识码正宗且活跃。

[0045] 在该上下文中,如上面已提到的,如果由制造并销售立体光刻机(所述可消耗元件旨在安装于该立体光刻机上)的相同公司来定义单义标识码并生产和营销该单义标识码所关联的可消耗元件,则该单义标识码以及因此该可消耗元件被视为“正宗”或者甚至“原装”。

[0046] 此外,如果单义标识码先前还未被读取和验证,或者即使已被读取,但读取次数小于预先确立的读取次数,或者如果对应的可消耗元件的状况仍然在预先确立的极限内,则该单义标识码以及因此对应的可消耗元件被定义为“活跃”,如下面关于再填充盒和桶将特别阐明的。所述预先确立的读取次数可以等于或大于一。

[0047] 有利地,如先前提及的,验证可消耗元件是否与正宗的单义标识码相关联的操作

使得有可能避免在特定的立体光刻机上使用与由自身也销售立体光刻机的公司生产和营销的那些附件不兼容并具有较低质量的附件(并且在再填充盒的情况下,该附件为用于制造三维物体的基础材料)。具体而言,本发明的核验方法使得有可能避免使用低质量光敏树脂通过立体光刻工艺来制造三维物体,或使用与向立体光刻机提供的辐射发射器的特性不兼容的光敏树脂。

[0048] 此外,确定与可消耗元件相关联的特定单义标识码(尽管是正宗的)是否已被读取和验证或者该单义标识码是否已超过使用极限(如以下指定的,后文被定义为"不活跃"的状况)的操作使得有可能防止用户例如在正宗的再填充盒已被使用达给定的经授权次数之后通过利用树脂或者一般地由其他公司生产和营销的基础材料来填充该再填充盒,进而重新使用该再填充盒。实际上,假如该最后操作被允许,则会出现使用与特定立体光刻机的特性不兼容并且质量很可能低的树脂的情形。

[0049] 根据本发明的方法,为了实现所述验证步骤,必须使单义标识码的预定义列表可用,其中所述单义标识码被视为正宗且活跃并且与由特定公司生产和营销的可消耗元件相关联。

[0050] 因此,仅当单义标识码被包括在所述预定义列表中时,该单义标识码才被视为正宗。

[0051] 因此,验证步骤包括:将在可消耗元件上读取的单义标识码与被包括在所述预定义列表中的被视为正宗且活跃的单义标识码进行比较。

[0052] 优选地,所述列表由生产和营销被提供有所述单义标识码的可消耗元件以及特定立体光刻机的相同公司来定义。

[0053] 仍然优选地,如以下详细描述的,在能够自发地与所述立体光刻机中的每个立体光刻机进行通信的服务器(通常为远程服务器)上可获得该列表以使得允许执行所述验证步骤。

[0054] 此外,根据本发明的方法,如果每个单义标识码正宗且活跃,则启用被安装在所述立体光刻机上的对应可消耗元件。

[0055] 然而,根据本发明的核验方法的替换实施例,不能排除可以针对每个可消耗元件独立地管理该启用规程。换言之,根据本发明的所述替换实施例,在若干可消耗元件被安装在立体光刻机上的情况下,启用它们中的每一者排他地取决于对应的单义标识码是否正宗且活跃,而独立于与其余可消耗元件相关联的其他单义标识码的验证结果。

[0056] 根据本发明的方法,在被安装在立体光刻机上的可消耗元件对应于再填充盒的特定情况下,所述启用步骤首先包括将相同再填充盒中所容纳的材料至少部分地转移到被布置在立体光刻机上的桶中。如下面更详细描述的,所述转移优选地但非必要地由立体光刻机以自动化的方式来执行。

[0057] 此外,该启用步骤包括:通过将在所述转移操作期间转移的材料量加到先前与立体光刻机相关联的材料量,来计算可用于该立体光刻机的材料总量的值,在技术术语中也称为"印刷额度(print credit)"。

[0058] 显然,如果在所述转移操作之前没有"印刷额度"与立体光刻机相关联,则所计算的材料总量的值将等于所转移的材料量。

[0059] 随后,属于本发明的方法的该启用步骤还包括以下步骤:将所计算的值与特定的

立体光刻机进行关联并存储该关联以使得能够在稍后时间使用该信息，如稍后更详细解释的。

[0060] 根据以下描述的本发明的打印单元的优选实施例，单义标识码的预定义列表以及该信息优选地被存储在远程服务器上，从制造和销售所述可消耗元件和立体光刻机的公司可获得该远程服务器。

[0061] 最后，再次关于与再填充盒相关的特定启用步骤，该步骤包括：在所述基础材料已从再填充盒完全转移到桶中的情况下，在所述预定义列表中将对应单义标识码的状态从活跃修改为不活跃。

[0062] 如已经提及的，该最后操作有利地可以防止一旦再填充盒中原始容纳的相应基础材料已被完全转移到一个或多个桶中就重新使用该再填充盒。

[0063] 相反，关于与被提供有单义标识码并被安装在所述立体光刻机上的桶相关联的特定启用步骤，根据本发明，该步骤包括以下步骤：将所述单义标识码与相同的桶已被使用的次数进行关联。

[0064] 换言之，根据本发明，码的读取次数被增加，并且因此特定的桶在立体光刻机上被安装和使用的次数也被增加。

[0065] 该启用步骤相继地包括以下步骤：存储所述关联，优选地存储在所述远程服务器中。所述信息优选地使得有可能将特定桶的使用限制于预定义次数。

[0066] 实际上，属于本发明的方法的启用步骤对于桶进一步包括以下步骤：在所存储的特定桶已被使用的次数达到或超过所述预定义次数时，在所述预定义列表中将对应的单义标识码的状态从活跃修改为不活跃。

[0067] 优选地但非必要地，本发明的核验方法、特别是与桶相关的启用步骤进一步包括以下步骤：将每个桶的单义标识码与在所述转移操作期间从一个或多个再填充盒转移到桶内部的基础材料的类型进行关联。本发明的方法最后包括以下步骤：存储所述关联，优选地存储在所述远程服务器中。

[0068] 有利地，所述最后关联使得有可能在所述验证操作期间还检查可能之前容纳在其中的材料类型，而独立于与桶相关的单义标识码是否活跃。因此，所述关联和相关的验证使得有可能避免在不同的时间使用特定的桶以容纳不同类型的基础材料。具体而言，这使得有可能有利地避免在相同的桶中混合并污染例如彼此不兼容的两种不同类型的树脂的风险。

[0069] 一般而言，根据本发明的方法的替换实施例，不能排除与不同于再填充盒以及不同于桶的可消耗元件相关的启用步骤可包括执行进一步且不同的操作。然而，关于被提供有单义标识码并适合于被安装在特定立体光刻机上的所有可消耗元件，核验方法的启用步骤必须包括：在不可能针对每个类型的可消耗元件观测特定的预先确立的状况的情况下，在所述预定义列表中将所述单义标识码的状态从活跃修改为不活跃。

[0070] 用于启用打印过程的方法

[0071] 一旦已完成与本发明的用于核验一个或多个可消耗元件的方法相关的所述一系列步骤，立体光刻机就准备好通过立体光刻工艺来打印三维物体。然而，根据本发明，在允许执行所述打印过程之前，必须执行进一步的步骤，其中，以下详细地描述并在图2中所示的流程图中表示的所述进一步的步骤实际上属于用于启用打印过程的进一步方法。

[0072] 首先应当提到，为简单起见，参考单个立体光刻机来描述所述方法的各步骤。然而，如以下指定的，所述步骤可与多个立体光刻机相关，该多个立体光刻机被视为单个实体，即，被视为由单个公司处置的一组机器。首先，作为本发明的主题的用于启用打印过程的方法包括以下步骤：读取先前存储的与关联于要使用的特定立体光刻机的基础材料总量相关的值。

[0073] 换言之，该方法包括：读取特定立体光刻机的打印额度。此外，本发明的方法包括以下步骤：计算制造特定的三维物体所必需的基础材料量。在所述两条信息可用的情况下，本发明的该方法提供对它们进行比较以使得验证与立体光刻机相关联的基础材料总量(即，打印额度)是否超过制造所述三维物体所必需的基础材料量。在所述验证的结果是肯定的情况下，本发明的该方法使得能够启用立体光刻机来打印三维物体。

[0074] 在实践中，构成本发明的启用方法的所述一系列步骤有利地使得有可能验证作为立体光刻机的拥有者的用户或公司是否已获得足以生产特定三维物体的所谓“正宗”基础材料的量。如果为否，则不启用打印过程。

[0075] 因此，所述方法有利地使得有可能防止用户或公司使用非正宗基础材料借助所述立体光刻机来打印三维物体。

[0076] 返回到本发明的方法，根据所述方法，一旦已经启用立体光刻机，就可以行进到生产有关的三维物体。出于任何原因，可能出现仅部分地执行物体。在任何情况下，根据本发明的方法，在生产(即使部分的)物体的所述步骤结束时，计算在所述生产步骤期间实际使用的基础材料量并将所述实际量从先前与立体光刻机相关联的基础材料的总量中扣除。从所述操作获得的结果与相同的立体光刻机相关联并被存储为打印额度以供随后使用。

[0077] 如上面已经提到的，根据本发明的变型实施例，用于启用打印过程的方法可以应用于位于相同地点并且因此作为单个实体来管理的多个立体光刻机。换言之，根据本发明的所述变型实施例，所述多个立体光刻机与单个打印额度相关联，而独立于每个立体光刻机的桶中实际容纳的材料量。因此，在与该多个立体光刻机相关联的所述打印额度足以制造必须生产的物体或特定物体时，启用打印过程。

[0078] 打印单元

[0079] 如上面已经提到的，本发明还包括打印单元1，该打印单元1被配置成实现上述核验方法和用于启用打印过程的方法。

[0080] 具体而言，如图3的示图中所示，根据本发明的优选实施例，打印单元1包括立体光刻机2和数据处理单元3，该数据处理单元3被配置成管理立体光刻机2的各功能，以使得有可能通过立体光刻工艺来打印三维物体。

[0081] 然而，不能排除在本发明的替换变型实施例中打印单元1可包括一个以上立体光刻机2，其中每个立体光刻机2与对应的数据处理单元3相关联，如图4的示图中所示。

[0082] 此外，根据本发明的未在附图中表示的其他替换实施例，多个立体光刻机2可与单个数据处理单元3相关联，该单个数据处理单元3能够同时管理所述机器中的所有机器的各功能。

[0083] 关于数据处理单元3，如图6中示意性示出的，它包括计算机31，该计算机31操作地连接到对应的立体光刻机2或者替换地连接到一个以上立体光刻机2。所述计算机31进而包括微处理器311和其中存储特定的计算机程序的存储装置312，当所述计算机程序在相同计

算机31中被执行时能够管理立体光刻机2的打印操作。

[0084] 相反，关于立体光刻机2，如图6中总是能够观察到的，它包括第一耦合装置21和第二耦合装置22，第一耦合装置21适合于允许该装置与要用于制造三维物体的基础材料的至少一个再填充盒41耦合，第二耦合装置22适合于允许该装置与在执行所述立体光刻工艺期间容纳所述基础材料的至少一个桶42耦合。

[0085] 根据本发明，打印单元1包括核验系统(在图3至5中用5作为整体指示)，该核验系统适合于核验一个或多个可消耗元件4(优选地再填充盒41和桶42)，这些可消耗元件适合于被安装在所述立体光刻机2上并且其中每个可消耗元件被提供有可读单义标识码ID。

[0086] 具体而言，核验系统5被配置成：读取所述可消耗元件4中的每个可消耗元件的单义标识码ID，并将所读取的每个单义标识码ID对照被视为正宗且活跃并且与由一个或多个公司生产并营销的可消耗元件4相关的单义标识码ID的预定义列表L进行比较。因此，所述比较使得有可能验证每个单义标识码ID是否正宗以及是否活跃。核验系统5被配置成：仅在所述单义标识码ID中的所有单义标识码ID是正宗且活跃的情况下才将能够启用可消耗元件4。

[0087] 根据本发明的打印单元1的优选实施例，核验系统5首先包括被提供有读取装置32的所述数据处理单元3，该读取装置32适合于读取各个可消耗元件4的单义标识码ID。优选地，所述读取装置32邻近于再填充盒41和桶42位于立体光刻机2上，以使得当再填充盒41和桶42两者都被安装在所述立体光刻机2上时这些读取装置能够读取再填充盒41和桶42中再现的单义标识码ID。

[0088] 优选地，用于读取单义标识码ID的装置32包括近场收发机，优选地为已知类型的RFID收发机321。进而，可消耗元件4(特别是再填充盒41和桶42)中的每个可消耗元件包括存储和传输设备7(优选地为RFID标签71)，所述单义标识码ID先前存储在该存储和传输设备7中。

[0089] 然而，不能排除在本发明的替换实施例中可以利用不同的已知技术来实现适合于读取码ID的读取装置32以及存储和传输设备7，条件是它们能够彼此建立近场通信，或者甚至更一般而言，条件是读取装置32能够读取在存储和传输设备7上再现的单义标识码ID。

[0090] 此外，关于数据处理单元3，该数据处理单元3被提供有收发机装置33，该收发机装置33被配置成：将所读取的一个或多个单义标识码ID传送给数据处理控制装备6，该数据处理控制装备6也属于本发明的核验系统5并在下文详细描述。

[0091] 具体而言，取决于所使用的数据处理控制装备6的类型(如以下详细定义的)，所述收发机装置33可以被配置成：通过局部(内联网)或远程(因特网)类型的有线网络建立通信或者允许例如通过WLAN或蜂窝网络的无线类型的通信。

[0092] 就数据处理控制装备6而言，根据图3和4中所表示的本发明的优选实施例，该数据处理控制装备6包括远程服务器61，该远程服务器61通过其自身的收发机装置613和因特网来操作地连接到所述数据处理单元3。优选地，所述远程服务器61由制造和营销所述立体光刻机2以及被提供有单义标识码ID的可消耗元件4的相同公司提供。

[0093] 根据本发明，所述远程服务器61还被提供有微处理器611以及适合于存储单义标识码ID的所述预定义列表L的存储装置612，单义标识码ID的所述预定义列表L被视为正宗且活跃并且与由所述公司生产和营销的可消耗元件4相关。

[0094] 具体而言，单义标识码ID的预定义列表L被存储并组织在由所述公司定义的合适数据库8内部的所述存储装置612中。

[0095] 优选地，预定义列表L被划分成子列表L_1、L_2、L_3…，其中每个子列表包括相同类型的特定可消耗元件4的单义标识码ID，例如再填充盒41的列表L_1和桶42的列表L_2。

[0096] 此外，关于远程服务器61，该远程服务器61被配置成：从所述数据处理单元3接收可消耗元件4的单义标识码ID。此外，远程服务器61被配置成：行进至将所接收到的所述单义标识码ID与预定义列表L中所包括的单义标识码进行比较。

[0097] 如上面关于本发明的核验方法已经描述的，所述比较使得有可能验证在可消耗元件4上读取的单义标识码ID是否正宗且活跃。此外，远程服务器61被配置成：在一个或多个单义标识码ID中的每一者是正宗且活跃的情况下向从其接收该一个或多个单义标识码ID的数据处理单元3发送确认该一个或多个单义标识码ID的有效性的信号。

[0098] 然而，根据本发明的替换实施例，不能排除远程服务器61可以被配置成：在已发现对应的单义标识码ID是正宗且活跃的情况下，发送与每个单个可消耗元件4相关的有效性信号，而独立于属于在任何情况下被安装在相同立体光刻机2上的不同可消耗元件4的任何其他单义标识码ID的验证结果。

[0099] 再次关于数据处理单元3，对应的收发机装置33被配置成：从远程服务器61接收所述有效性信号，并且数据处理单元3自身被配置成：如果接收到所述有效性信号，则数据处理单元3将能够启用一个或多个可消耗元件4。具体而言，相同的数据处理单元3被配置成管理以下操作：在所述启用规程与再填充盒41的特定使用相关的情况下，将其中所容纳的基础材料转移到存在于立体光刻机2上的桶42中。所述转移操作优选地但非必要地通过所述第一耦合装置21以自动化的方式来执行，该第一耦合装置21进而包括能够执行对再填充盒41的所谓“挤压”的已知类型的机构211。

[0100] 再次关于远程服务器61，该远程服务器61被配置成：在接收并验证的单义标识码ID属于再填充盒41的情况下，该远程服务器61将通过将在所述转移操作期间转移的基础材料量加到先前与立体光刻机2相关联的材料总量，来计算可用于所述机器的基础材料总量(所谓的“打印额度”)的值。

[0101] 具体而言，根据本发明的优选实施例，所述最后一条信息被存储在数据库8的被保留用于该特定立体光刻机2的存储器分配81中。

[0102] 远程服务器61被配置成：通过将所述新计算的打印额度的值存储在所述存储器分配81中，来将所述新计算的打印额度的值与立体光刻机2进行关联。

[0103] 显然，如参考本发明的核验方法已经描述的，如果立体光刻机2在转移操作之前具有等于零的打印额度，则在转移操作之后计算并存储的新值将等于所转移的基础材料量。

[0104] 此外，根据本发明，远程服务器61被配置成：在基础材料已从所述再填充盒41完全转移到桶42中的情况下，在预定义列表L中将与所述再填充盒41相关的单义标识码ID的状态从活跃修改为不活跃。

[0105] 以此方式，如上面解释的，不能再重新使用相同的再填充盒41。

[0106] 根据本发明的打印单元1的优选实施例，数据处理单元3还被配置成在接收到所述有效性信号之后并且与由远程服务器61执行的修改同时地，数据处理单元3将通过RFID收发机321将相同再填充盒41的单义标识码ID的状态在再填充盒41的RFID标签71中从活跃修

改为不活跃。

[0107] 然而，不能排除在本发明的替换实施例中数据处理单元3可以不被配置成执行所述最后操作。

[0108] 再次关于远程服务器61，该远程服务器61被配置成：在接收并验证的单义标识码ID属于被恰当安装在立体光刻机2上的桶42的情况下，将所述桶42与所述桶42已被使用的次数相关联。

[0109] 换言之，如已经提到的，根据本发明，与特定的桶42相关的单义标识码ID已被读取的次数可以被增加，并且因此相同桶42已在立体光刻机2上被安装并使用的次数可以被更新。

[0110] 此外，仍然优选地但非必要地，远程服务器61被配置成：将桶42与被转移到相同桶中的基础材料的类型进行关联。具体而言，所述关联操作两者都是通过将使用次数与所转移的材料类型存储在数据库8的被保留用于该特定桶42的存储器分配82中来执行的。更详细地，关于被转移到所述桶42中的材料类型的信息优选地但非必要地从再填充盒41(所述材料从再填充盒41中提取)的RFID标签71读取。为此，根据本发明，所述信息与将对应的单义标识码存储在再填充盒41的所述RFID标签71中的操作同时地先前存储在所述RFID标签71中。

[0111] 最后，远程服务器61被配置成：在接收到与所述桶相关的单义标识码ID的情况下，在桶42已被使用的对应次数达到或超过预定义次数的情况下，远程服务器61也将在预定义列表L中将相应状态从活跃修改为不活跃。

[0112] 此外，根据本发明的优选实施例，数据处理单元3被配置成：在所读取的单义标识码ID与桶42相关的情况下也启用可消耗元件。具体而言，一旦所述数据处理单元3已接收到由远程服务器61发送的有效应信号并验证了要转移到所述桶42中的材料与存在于桶42中的材料(如果有的话)的兼容性，就执行所述启用步骤。显然，所述验证由数据处理单元3通过将与在再填充盒41的RFID标签71中读取的材料类型相关的值和与在关联于该特定桶42的存储器分配82中所存储的材料类型相关的值进行比较来执行。所述进一步验证使得有可能避免彼此不兼容的两个基础材料在桶42中混合。

[0113] 此外，根据本文所描述的优选实施例，数据处理单元3被配置成：在可消耗元件4对应于桶42自身的情况下，也通过所述RFID收发机321在对应RFID标签71中将桶42的单义标识码ID的状态从活跃修改为不活跃。

[0114] 此外，数据处理单元3被配置成：与由远程服务器61在与桶42相关的存储器分配82中所执行的操作同时地，在相同桶42的相同RFID标签71中存储桶42已被使用的次数以及转移到其中的基础材料的类型。

[0115] 此外，属于打印单元1的核验系统5被配置成执行本发明的用于启用所述立体光刻机2以执行打印过程的方法的各步骤。

[0116] 具体而言，为了实现所述方法，数据处理单元3被配置成：将与立体光刻机2相关联并且存储在存储器分配81中的材料总量的值与制造必须生产的一个或多个三维物体所必需的基础材料量进行比较。数据处理单元3还被配置成：在所述基础材料总量等于或超过制造所述一个或多个三维物体所必需的基础材料量的情况下，启用立体光刻机2以执行打印过程。

[0117] 然而，根据本发明的替换实施例，不能排除所述比较可以由远程服务器61来执行。具体而言，根据该最后的替换实施例，数据处理单元3可以被配置成：向远程服务器61发送关于制造特定的三维物体所必需的基础材料量的信息。进而，远程服务器61被配置成：远程服务器61能够将已接收到的信息与存储在所述存储器分配81中的与该特定立体光刻机2相关联的基础材料总量进行比较。

[0118] 远程服务器61可以被配置成：如果在所述比较之后，与立体光刻机2相关联的基础材料总量等于或超过制造三维物体所必需的基础材料量，则该远程服务器61将向数据处理单元3发送旨在启用打印过程的信号。

[0119] 以任何方式，根据本发明的优选实施例和所述替换实施例两者，数据处理单元3被配置成：数据处理单元3能够管理打印操作，以便在所述比较的肯定结果的情况下借助所述立体光刻机2来打印(即使部分地)三维物体。此外，数据处理单元3被配置成：在打印步骤结束时，数据处理单元3将与远程服务器61一起计算在所述步骤期间实际使用的基础材料量，并通过将所述实际使用的基础材料量从总量中扣除来更新与立体光刻机2相关联的基础材料总量。

[0120] 最后，远程服务器61被配置成行进至将基础材料总量(或打印额度)的所述新值存储在被保留用于该特定立体光刻机2的所述存储器分配81中。根据本发明的替换实施例，打印单元1可包括位于相同地点的多个立体光刻机2(如图4中所示)，并且远程服务器61可被配置成执行上面描述的并指派给该远程服务器61的各步骤，以使得将所述多个立体光刻机2作为单个实体来管理。

[0121] 该替换解决方案将使得有可能考虑针对所述多个立体光刻机2的单个打印额度，而独立于实际可用于每个单个立体光刻机2的材料量。

[0122] 因此，将针对作为整体的多个立体光刻机2来管理用于启用打印过程的规程。换言之，在该配置情况下两种不同情形将是可能的：或者属于所述多个立体光刻机2的所有立体光刻机2潜在地被启用以执行打印过程，或者没有任何立体光刻机2能够行进至打印三维物体。这将有利地使得有可能显著简化上述本发明的各方法的实现，并且还增加对于拥有所述多个立体光刻机的用户或公司所允许的自由余量。

[0123] 此外，根据本发明的打印单元1的另一替换实施例，如图5中所示，除了上述远程服务器61之外，数据处理控制装备6还可包括本地服务器62，该本地服务器62位于与一个或多个立体光刻机2所位于的相同地点。具体而言，所述本地服务器62优选地通过内联网连接来操作地连接到一个或多个数据处理单元3，该一个或多个数据处理单元3进而与所述立体光刻机2相关联。此外，所述两个服务器61和62被配置成它们能够通过因特网彼此通信。

[0124] 与上述优选实施例不同，在该情况下，服务器61和62两者都被提供有数据库8，数据库8被存储在对应的存储装置612和622中并且包括单义标识码ID的预定义列表L以及被保留用于立体光刻机2和桶42的各个存储器分配81和82。然而，根据本发明的所述替换实施例，存在于远程服务器61中的数据库8包括市场上存在的并由特定公司生产的所有立体光刻机2的存储器分配，而存在于本地服务器62中的数据库8排他地包括被保留用于位于与本地服务器62自身所位于的相同地点的立体光刻机2的存储器分配81。

[0125] 此外，根据本发明的打印单元1的所述替换实施例，本地服务器62被配置成：本地服务器62能够执行根据上述本发明的优选实施例指派给远程服务器61的所有步骤。除了上

述内容以外，根据本发明的所述替换实施例，服务器61和62两者都被配置成以预定义的时间间隔来同步相应的数据库8。

[0126] 本发明的所述特定实施例有利地使得有可能在没有因特网连接的情况下也执行作为本发明的主题的核验方法和用于启用打印过程的方法的各步骤，这是因为所有规程由本地服务器62连同与各个立体光刻机2相关联的数据处理单元3来管理。显然，一旦本地服务器62与远程服务器61之间的通信已重新建立，则必需重新同步相应数据库8中所容纳的信息，以使得在全局级上更新并共享在本地级上发生的各种情形。

[0127] 最后，返回到本发明的打印单元1的优选实施例，根据该优选实施例，每个可消耗元件4除了被提供有其中存储相关的单义标识码ID的RFID标签71之外，还被提供有以适合于由人类或借助电子读取设备读取的不同形式的所述单义标识码ID。例如，可以字母数字字符的形式或者以条形码(更具体而言，QR码)的形式在可消耗元件4上再现单义标识码ID。

[0128] 如下文详细定义的，被再现为字母数字码或条形码的所述单义标识码ID与被提供有至蜂窝网络的连接的外部移动设备(像例如智能电话)的组合，以及利用远程服务器61与数据处理单元3的特定配置，使得有可能定义冗余系统，该冗余系统在远程服务器61与数据处理单元3之间没有直连通信的情况下使得有可能行进至核验可消耗元件4并启用立体光刻机2以执行打印过程。

[0129] 具体而言，所述移动设备通过安装并执行合适的应用使得有可能读取或手动输入存在于可消耗元件4中的单义标识码ID并将所述码发送给远程服务器61。

[0130] 进而，远程服务器61被配置成接收所述单义标识码ID，以使得远程服务器61能够对该单义标识码ID进行处理并将该单义标识码ID对照单义标识码ID的预定义列表L进行比较。远程服务器61被配置成：在已接收到的所述码实际上是正宗且活跃的情况下，向相同的移动设备发送有效性码。

[0131] 此外，与已安装所述可消耗元件4的立体光刻机2相关联的数据处理单元3被恰当地配置成：允许由用户在加载到相同数据处理单元3中的用户界面中输入所述有效性码。数据处理单元3被配置成：一旦已接收到所述有效性码，数据处理单元3就将该有效性码与由相同可消耗元件4的RFID标签71所读取的单义标识码ID进行比较。数据处理单元3被配置成：在所述比较确定这两个码之间的对应关系的情况下，启用对所述可消耗元件4的使用，而无需直接询问所述远程服务器61。

[0132] 计算机程序和计算机程序产品

[0133] 本发明还包括计算机程序，该计算机程序包括当所述计算机程序在一个或多个计算机中被执行时能够执行上述方法的所有步骤的多个数据处理指令。

[0134] 最后，本发明还包括计算机程序产品，该计算机程序产品包括被存储在可读类型的存储装置中的多个数据处理信息以用于在所述计算机程序产品在一个或多个计算机中被执行时实现上述各方法。

[0135] 具体而言，根据本发明的优选实施例，所述计算机程序和所述计算机程序产品部分地在所述数据处理控制装备中被执行，并且部分地在与立体光刻机相关联的数据处理单元中被执行。

[0136] 因此，基于上述内容，作为本发明的主题的用于核验可消耗元件的方法和用于启用立体光刻机以执行打印过程的方法达成所有预设目的。

[0137] 具体而言，本发明达成了以下目的：提供用于核验可消耗元件的方法和用于启用对三维物体的打印的方法，这些方法防止使用不完全适合于与某些类型的立体光刻机联用的可消耗元件(即使被出售为兼容的)。

[0138] 本发明还达成了以下目的：提供核验方法和用于启用打印过程的方法，这些方法防止使用低质量可消耗元件(并且具体而言，低质量基础材料)。

[0139] 最后，本发明还达成了以下目的：提供核验方法和用于启用打印过程的方法，这些方法防止使用能够劣化立体光刻机的内部组件的可消耗元件(这些可消耗元件被安装在该立体光刻机上)。

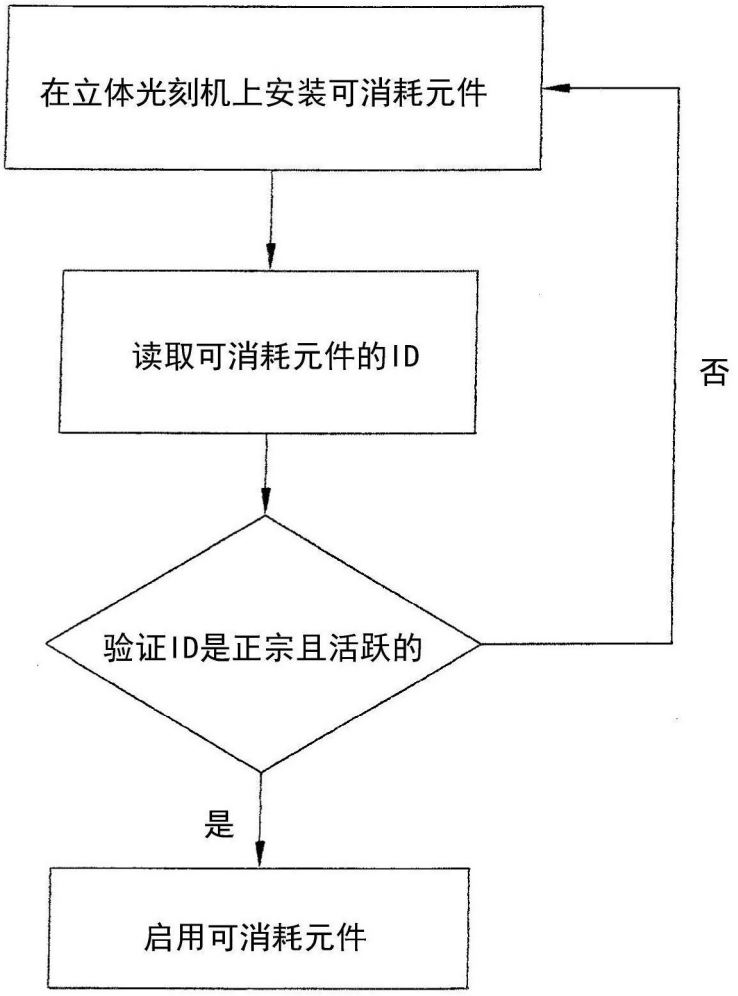


图1

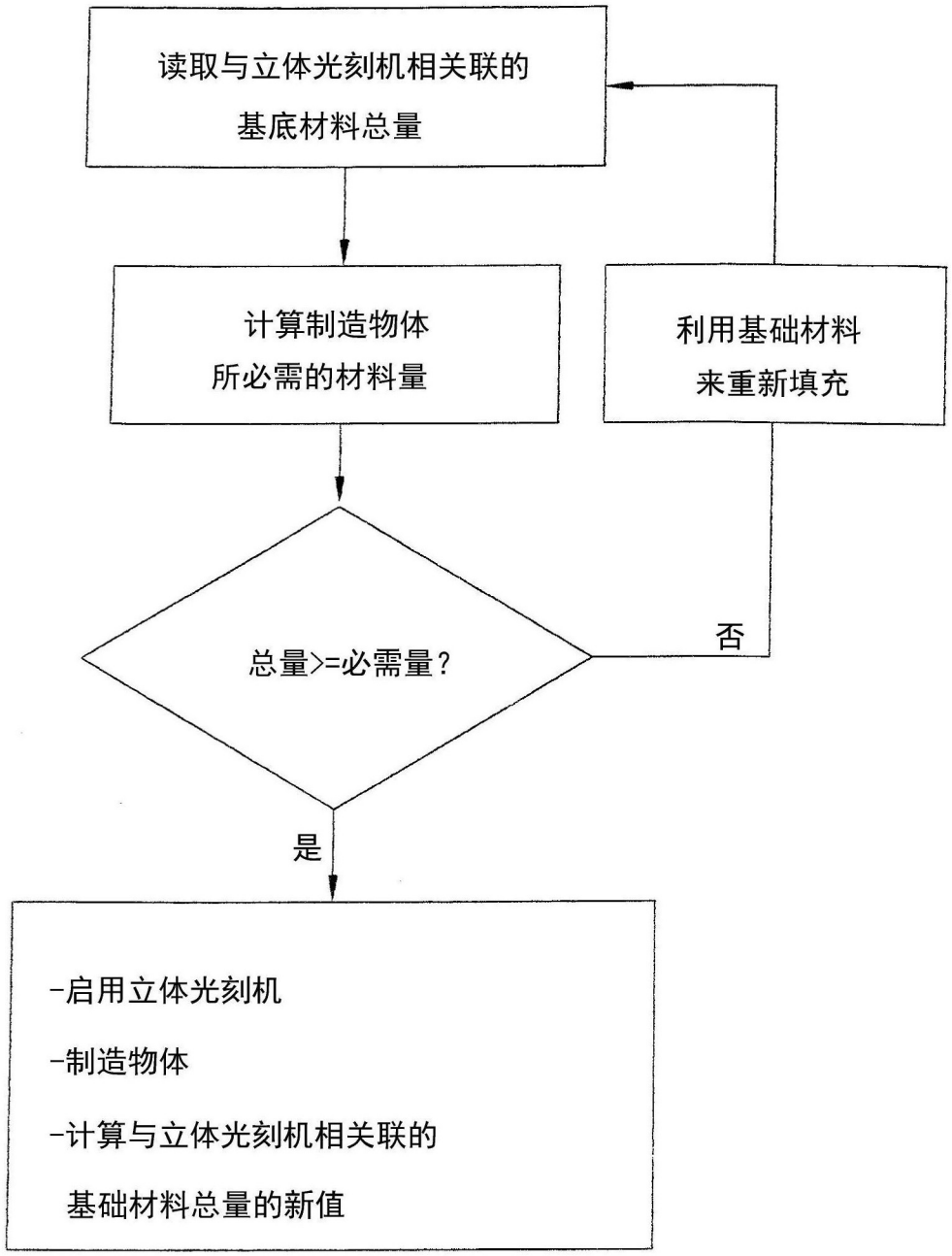

读取与立体光刻机相关联的
基底材料总量
计算制造物体
所必需的材料量
利用基础材料
来重新填充
总量>=必需量？
否
是
-启用立体光刻机
-制造物体
-计算与立体光刻机相关联的
基础材料总量的新值

图2

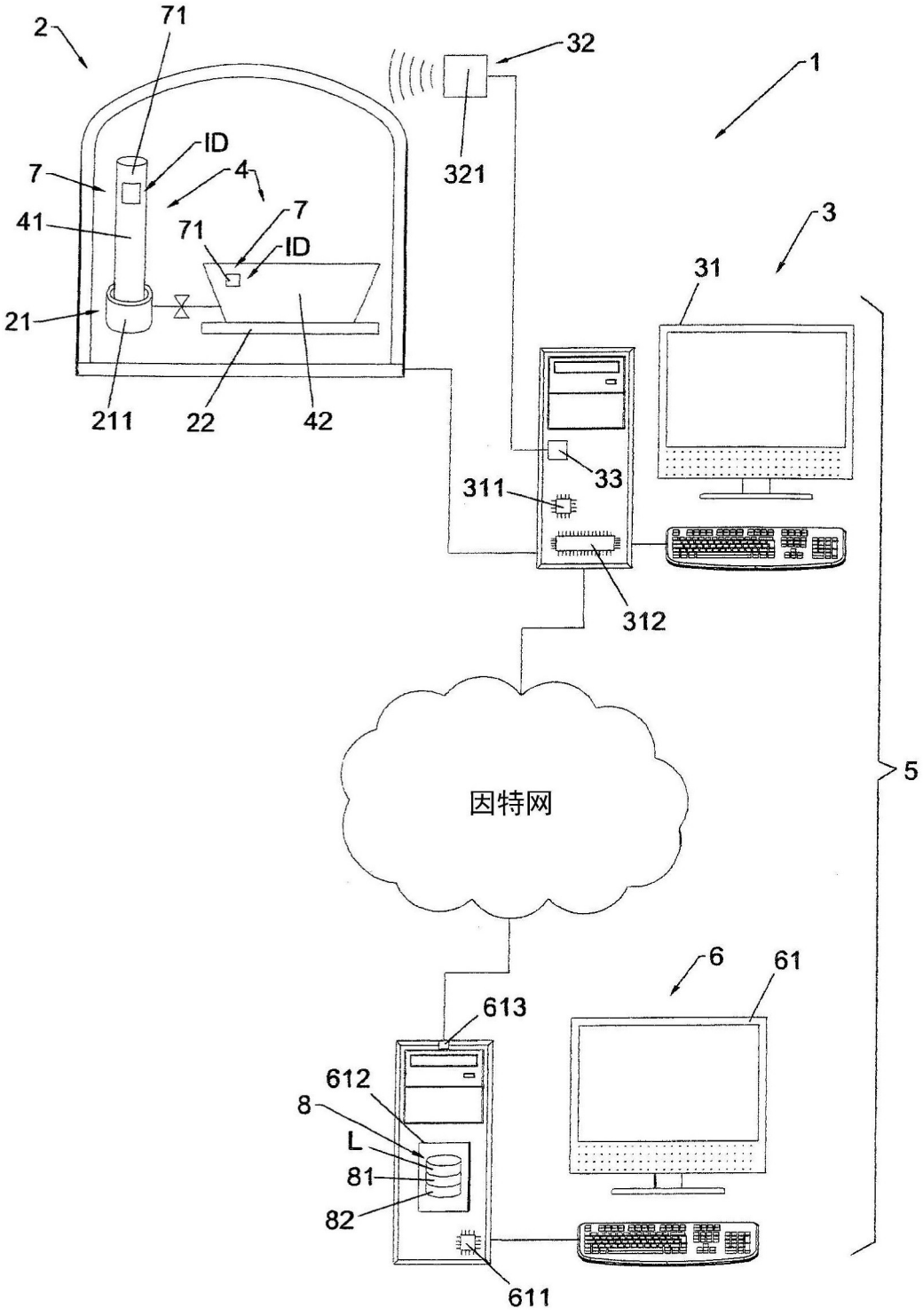

2
71
32
1
ID
7
4
321
41
7
71
ID
3
31
21
211
22
42
33
311
312
因特网
5
6
61
613
612
8
L
81
82
611

图3

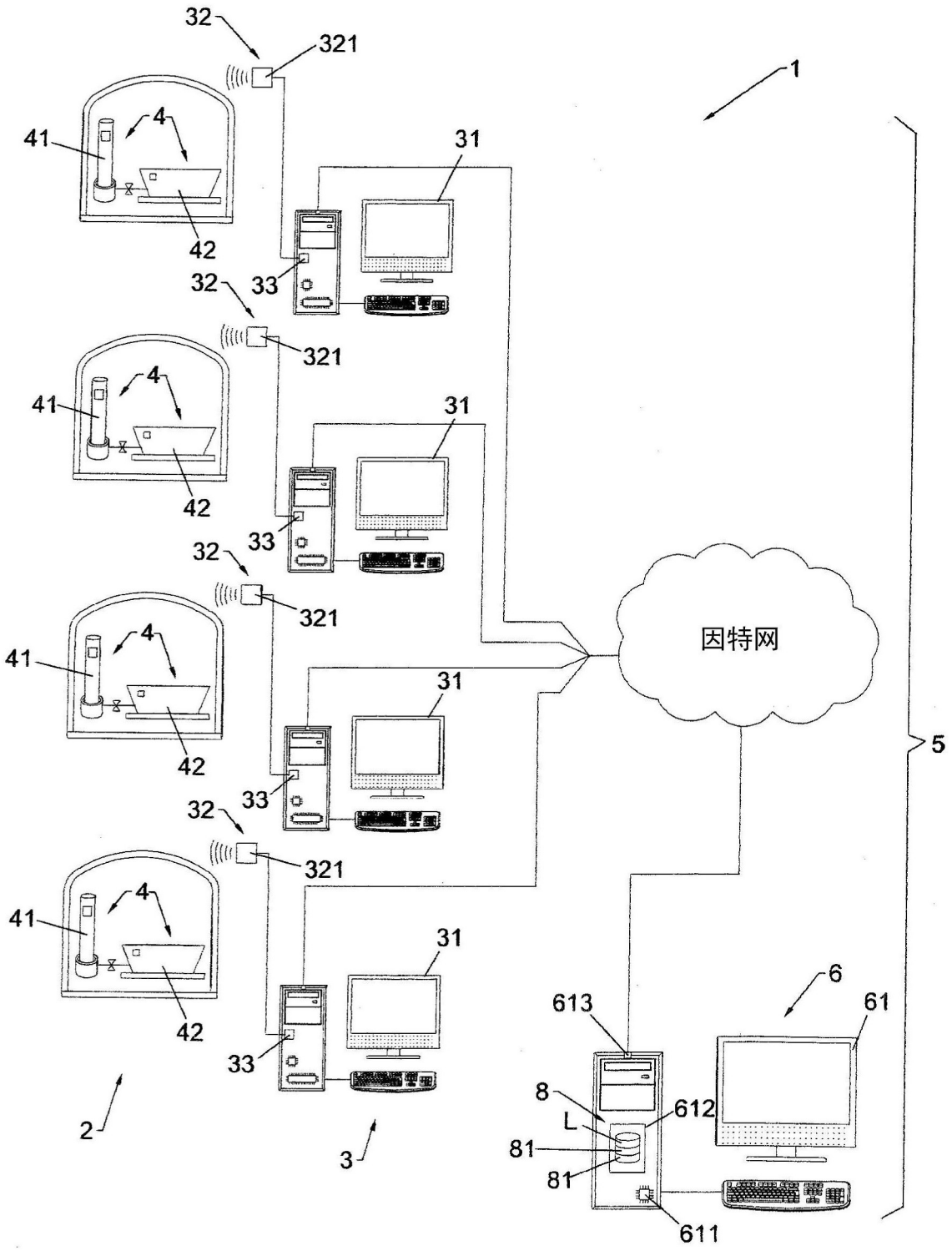


图4

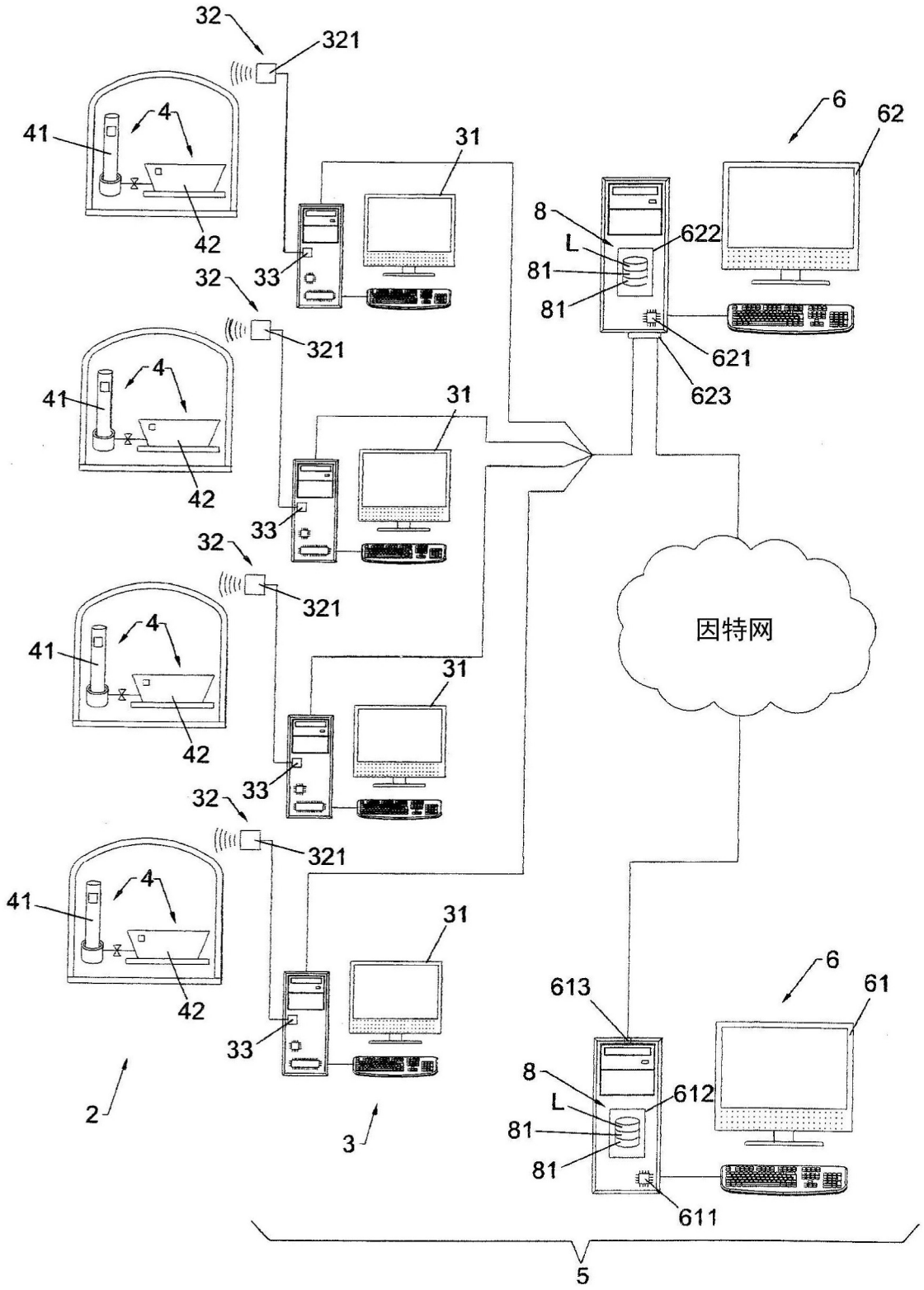


图5

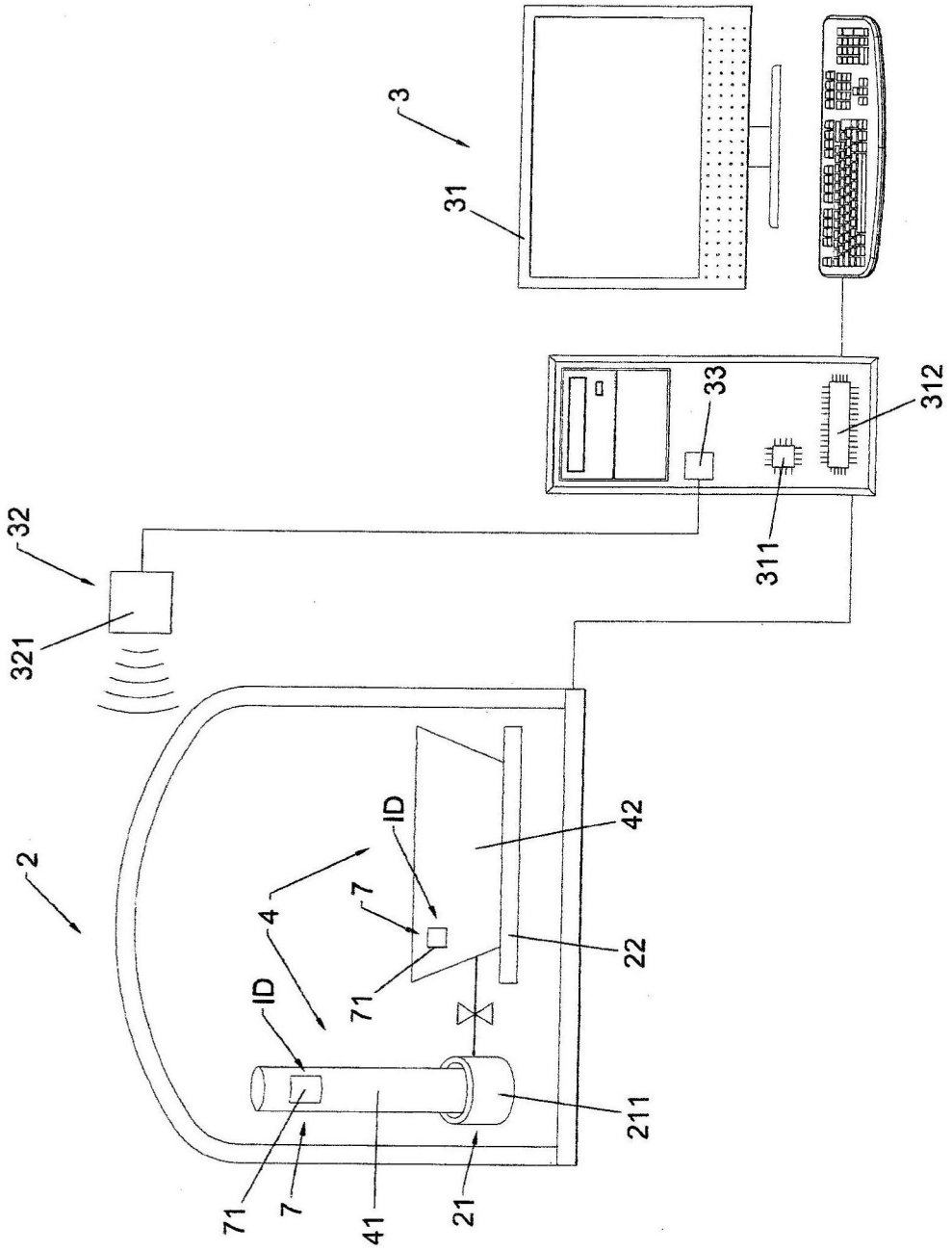


图6