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(54) NOVEL METHOD FOR REPAIRING ANCIENT BOOK BY DEACIDIFICATION

(57) The present invention provides a novel method for deacidifying and repairing ancient books. Such treatment method comprises: first placing the ancient books to be treated in a closed deacidifying and repairing device; after sealing, performing dehumidification operation and vacuumizing operation on the system in sequence to maintain the system dry; and after the system is stable under negative pressure, turning on a fan set (4), directly delivering a nanoscale alkaline deacidifying powder to the deacidifying and repairing device via a gas pipe (15), or atomizing an alkaline deacidifying solution through a ultrasonic atomizer (14) and then delivering the atomized solution to the deacidifying and repairing device via the gas pipe (15), so that the ancient books to be treated absorb the alkaline deacidifying agent sufficiently and evenly; and meanwhile monitoring pH value and humidity of the ancient books, thereby implementing deacidification and repair of the ancient books.

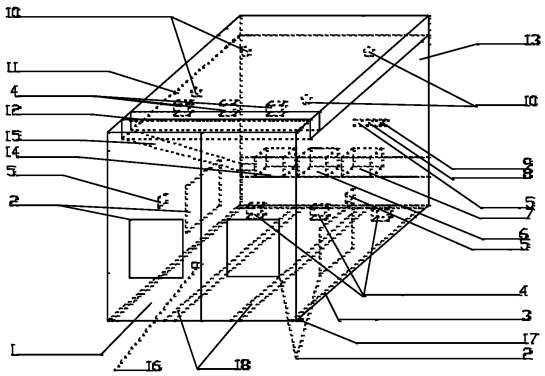

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of the deacidification and repair of ancient books, and specifically involves to a novel method for deacidifying and repairing ancient books.

BACKGROUND

[0002] Thousands of precious books, calligraphy and paintings, modern newspaper, files and other cultural relics are preserved in various libraries, museums and archives in China. Being the essence of the Chinese nation's excellent traditional culture and a significant constituent of the Chinese cultural heritage with important historic value, cultural value and information value, they possess an irreproducible historic significance. As a carrier of the literal essence, paper would suffer a critical situation by the increasing severe worm damage, acidification, mildew and breakage with the time flies. Paper is made from fibrous materials, and the stability of cellulose is one of the most important factors that maintain the physical performances of paper. Cellulose is relatively stable under neutral and alkalescent conditions and generally would not be hydrolyzed or oxidized. However, in an acidic condition, hydrolysis on the cellulose is enhanced due to the catalysis of acid. After the hydrolysis of cellulose, strength of ancient books will be reduced by the decreased degree of polymerization, resulting in pulverization of ancient books over time. Therefore, various factors such as acidic chemical residues during production, organic acid generated by aging and degradation, acidification resulted by the use and storage environment, may intensify the aging of paper. Thus, there's an urgent need of thorough deacidification and repair research on paper documents. Although various researches on deacidifying and repairing paper documents have been carried out by the domestic and foreign research institutes, practically applicable and mature deacidifying and repairing technology has not been achieved till now.

[0003] Current deacidifying and repairing technology mainly includes liquid phase deacidification and gaseous phase deacidification of which the principle is to neutralize the acid in ancient books by using an alkaline deacidifying agent so as to achieve deacidification and repair.

[0004] The liquid phase deacidifying and repairing method mainly includes organic solution deacidification and aqueous solution deacidification.

[0005] The deacidifying and repairing method by organic solvent mainly includes Weito method, FMC method, and barium hydroxide-methanol solution deacidification and repair. The deacidifying and repairing method by organic solution has advantages of high deacidifying and repairing efficiency, simple operation and low cost. Japan and western countries such as Germany, Italy, USA, and etc. mainly use organic solvent method, but the organic solvents are combustible wherein some have strong toxicity, and most of them are inappropriate for oil-soluble ink-printed print, causing dissolution of printing ink, thereby staining the ancient books. Additionally, a high level of safety requirement for operation is demanded when the toxicity is too strong.

[0006] The deacidification and repair by aqueous solution has advantages of environmental safety, easy operation, economy and good deacidifying and repairing effect, but deformation and crimping still exist in the treated paper documents, bringing influence on the handwriting and thereby against a large scale of deacidification and repair. There's no deacidifying and repairing technology to solve the problem of deacidifying an entire book by the aqueous solution so far. Paper would stick to each other if deacidification and repair are directly carried out on the entire book which results in severe secondary damage. The ancient book must be separated into single pages before the processing and then rebound after the processing. The ancient book has a rather low strength over a long time and it would be easily damaged when being separated. After the book is immersed into the solution, the strength of paper becomes lower which brings severe secondary damage to the ancient books though the deacidification and repair are carried out. Moreover, drying is required after the books are immersed into the solution. Aging and breakage of fiber are easily caused during the drying, thereby yellowing or even damaging the paper. Such method is complicated in process with long term, which is inappropriate for the ancient books.

[0007] The gaseous phase deacidifying and repairing method mainly includes diethylzinc method and morpholine deacidification method.

[0008] The diethylzinc deacidification method: when meeting with the acidic hydrogen ion in paper, diethylzinc not only reacts with the acidic hydrogen ions in paper but also rapidly neutralizes the hydrogen in water to generate solid zinc oxide. Such solid zinc oxide remains on the surface of the paper and provides a certain deacidifying and repairing effect. However, diethylzinc is spontaneously combustible when meeting with air, and great danger exists, that is, a great threat of fire to the paper documents. In addition, residues of zinc oxide accelerate the photooxidation on paper fibers, yellowing and aging the paper to some extent. Therefore, such method is not a good one.

[0009] The morpholine deacidification method: under normal circumstance, morpholine is in liquid state, and turns into gas when mixing with water in vacuum, so as to react with the hydrogen ions in paper to achieve deacidification

and repair. This method changes the color of paper easily, yellows the newspaper and magazines, and does not exerts reinforcement during the process. A large scale of promotion of such method is limited due to the high cost for equipment and instruments. From the aspect of deacidification technology abroad, in 1970s and 1980s, gaseous deacidification and repair attracted people for its large scale of processing. However, its extensive application is limited by the high level requirement for technological conditions, potential safety hazard, great investment and uneven processing effect.

[0010] There are various similar gaseous phase and liquid phase deacidifying and repairing technologies at home and abroad currently, but each of these still has defects such as high cost, high difficulty of operation, strong toxicity of deacidifying agent, failure to develop in large-scale, potential safety hazard, environmental pollution, etc. A practically applicable method for deacidifying and repairing ancient books has not been found till now.

SUMMARY

[0011] Aiming at the above and in order to overcome the above-mentioned problems or at least partially overcome the above-mentioned problems, the present invention provides a novel method for deacidifying and repairing ancient books.

In the present invention, a gas phase deacidifying and repairing technology and a liquid phase deacidifying and repairing technology are combined together, and by using a gas phase/liquid phase and a gas phase/solid phase deacidifying and repairing technologies, not only secondary damage of paper adhesion caused by the liquid phase deacidification and repair is avoided, but also the present technology aims at that original temperature and humidity of the ancient books are kept without drying the ancient books, so that fibers would not age or break, and the ancient books would not be yellowed or damaged. Meanwhile, it also avoids the trouble that an alkaline gaseous deacidifying agent suitable for the gas phase deacidification and repair cannot be found. Most of the organic/inorganic alkaline liquid and the nanoscale alkaline deacidifying powder can be used for deacidifying and repairing the ancient books by using the present technology.

[0012] A novel method for deacidifying and repairing ancient books, comprises: first placing the ancient books to be treated in a closed deacidifying and repairing device; after sealing, performing dehumidification operation and vacuumizing operation on the system in sequence to maintain the system dry; and after the system is stable under negative pressure, turning on a fan set, directly delivering a deacidifying agent to the deacidifying and repairing device via a gas pipe, or atomizing an alkaline deacidifying solution through a ultrasonic atomizer and then delivering the atomized alkaline deacidifying solution to the deacidifying and repairing device via the gas pipe, so that the ancient books to be treated absorb the alkaline deacidifying agent sufficiently and evenly; and meanwhile monitoring a pH value of the ancient books, thereby implementing deacidification and repair of the ancient books;

wherein the ancient books comprises acidic ancient book, archived file, document, literature, journal, paper, calligraphy and painting, cotton and flax.

[0013] In the above-mentioned method, the closed device has good airtightness, and the system is kept at room temperature, so that a relatively high dryness and a relatively high vacuum degree therein can be reached. The closed device has a suitable volume. A relationship of a device volume and a total volume of the ancient books to be treated satisfies that a ratio of the device volume to the total volume of the ancient books to be treated is 1.1:1 - 50:1.

[0014] In the above-mentioned method, the dehumidification operation is as follows: dehumidifying the system to have air humidity of 10% - 90% through a dehumidifier and maintaining for 2 - 24 hours, when target duration is reached, turning off the dehumidifier. The duration of the dehumidification operation depends on an original humidity of the ancient books and the closed device volume; when the original humidity of the ancient books is 8% - 9% and the device volume is 1.5 - 2 times the total volume of the ancient books to be treated, the dehumidification operation lasts for 2 - 24 hours; when the original humidity is reduced by 10%, the duration of the dehumidification operation is reduced by 2 - 6 hours; when the device volume is doubled, the duration of the dehumidification operation is increased by 3 - 8 hours.

[0015] In the above-mentioned method, the vacuumizing operation is performed as follows after the dehumidification operation is completed, vacuumizing the system to have an inner pressure of 0 to -0.08 MPa through a vacuum pump, when target pressure is reached, turning off the vacuum pump, and maintaining the closed system under stable negative pressure until the deacidification and repair is completed.

[0016] In the above-mentioned method, the ultrasonic atomizer is an ultrasonic transducer, the ultrasonic transducer is placed in a container containing with the deacidifying agent and is powered on. The structure of the deacidifying agent is dispersed and atomized into small-molecular atomized gas by means of high-frequency resonance of a piezoelectric ceramic.

[0017] In the above-mentioned method, the deacidifying agent is a nanoscale alkaline deacidifying powder, an alkaline organic solution, or an alkaline inorganic solution; the pH value can be maintained stable for a relatively long term, being 7 to 13 and without toxicity; the deacidifying agent includes but is not limited to all alkaline materials such as NaOH solution, $Ca(OH)_2$ solution, $Cu(OH)_2$ solution, $Fe(OH)_3$ solution, KOH solution, Na_2CO_3 solution, $NaHCO_3$ solution, $NH_3 \cdot H_2O$ solution, ethylenediamine solution, phosphate solution, borate solution and the like. By means of a pressurizing or ultrasonic atomizer, the solution is dispersed into liquid drops in micronscale to nanoscale having an average particle

size of 1 nm - 2 μm, and is communicated with the closed deacidifying device via the gas pipe.

[0018] In the above-mentioned method, the deacidifying agent includes but is not limited to all alkaline powder materials such as nano NaOH powder, $Ca(OH)_2$ powder, $Cu(OH)_2$ powder, $Fe(OH)_3$ powder, KOH powder, Na_2CO_3 powder or $NaHCO_3$ powder, ethylenediamine powder and the like.

[0019] In the above-mentioned method, through the gas pipe, an air-blast system slowly introduces the nanoscale alkaline deacidifying powder or the deacidifying agent atomized by the ultrasonic transducer into the closed deacidifying and repairing device, and circulates the deacidifying agent inside the system for even distribution.

[0020] In the above-mentioned method, air humidity inside the system is maintained at 10% - 90%.

[0021] In the above-mentioned method, the deacidifying and repairing device has a pH value monitor for ancient book therein, after the pH value of ancient book monitored reaches approximately 7 - 8.5 and is maintained for 1- 48 hours, the system is turned off; the duration depends on a deacidifying degree of the ancient books and a closed device volume, when the original pH value of ancient book is 6 - 6.5 and the device volume is 1.5 - 2 times a total volume of the ancient books to be treated, the deacidification lasts for 2 - 5 hours; when the original pH value is increased by 0.2, the duration of deacidification is reduced by 1 - 6 hours; when the device volume is doubled, the duration of deacidification is increased by 3 - 8 hours.

[0022] Compared with the prior art, the advantages of the present invention lie in that:
A large-scale of acidified ancient books can be treated, without a great deal of equipment input, or affecting the original temperature and humidity of the ancient books, damage to paper structure, or secondary damage to the ancient books, so that acidic substances in the ancient book can be well neutralized with significant deacidifying effect. Meanwhile, a certain amount of the alkaline substances would left in the ancient books so as to further prolong lifetime of the ancient books better.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

FIG. 1 is a structural diagram of a deacidifying and repairing device of the present invention;
FIG. 2 is a structural diagram of a middle partition;
FIG. 3 is a structural diagram of a bookrack;
FIG. 4 is an air flow diagram of the present invention.

[0024] Each component in the figures is as follows:
double-open front door 1, visible window 2, water groove 3, fan set 4, hygrometer 5, dehumidifier 6, vacuum pump 7, piezometer 8, pH meter 9, light 10, middle partition 11, gas pipe hole 12, rear panel 13, ultrasonic atomizer 14, gas pipe 15, PLC-control system 16, drain valve 17, pulley track 18, bookrack 19, and air outlet 20.

DETAILED DESCRIPTION

[0025] The present invention is further described in detail by combining the following specific embodiment, but the implementation of the present invention is not limited thereto. Those technological parameters which are not described particularly can be carried out by referring to conventional technologies.

[0026] A deacidifying and repairing device of the present invention has a structure as follows, shown as FIG. 1 to FIG. 4. The deacidifying and repairing device, includes a double-open front door 1, a fan set 4, a dehumidifier 6, a vacuum pump 7, a light 10, a middle partition 11, a gas pipe hole 12, a rear panel 13, an ultrasonic atomizer 14, a gas pipe 15 and a pulley track 18; the double-open front door 1 is provided on one side face of the device; the middle partition 11 divides the device into an upper part and a lower part, bottom faces of the upper and lower parts are each provided with the fan set 4; the dehumidifier 6, the vacuum pump 7 and the ultrasonic atomizer 14 are arranged at an external surface of the rear panel 13 opposite the double-open front door 1; lights 10 are provided all around a lower part of the middle partition; the gas pipe 15 locates at and runs through an upper part of the middle partition 11, and that section of the gas pipe is provided with the gas pipe hole 12, the gas pipe 15 is connected with the ultrasonic atomizer 14; and the pulley track 18 is provided on the bottom face of the device. The device further includes visible windows 2. Both sides of the double-open front door 1 and left and right sides of the device are provided with the visible windows 2. The device further includes a hygrometer 5, a piezometer 8 and a pH meter 9; the hygrometer 5, the piezometer 8 and the pH meter 9 are all provided in the interior of the device. A PLC-control system 16 is fixed on the double-open front door 1; the fan set 4, the dehumidifier 6, the vacuum pump 7, the ultrasonic atomizer 14, the lights 10 and a bookrack 19 are integrally controlled by the PLC-control system, by monitoring the hygrometer 5, the piezometer 8 and the pH meter 9, real-time control of on-off of the lights, on-off of the fan, wind speed, on-off of the dehumidifier, air volume of the dehumidifier, on-off of the vacuum pump, wind speed of vacuum pumping, on-off of the ultrasonic atomizer, atomization volume, on-off

of spinning of the bookrack and duration of spinning of the bookrack is performed. The device is made of an external material and an internal material, the external material is carbon steel, and the internal material is stainless steel; the device has a total width of 1 m - 2.5 m, a height of 1 m - 2.5 m, and a length of 3 m - 12 m. The device further includes a water groove 3 and a drain valve 17; the water groove is provided at the bottom face of the lower part of the device, locating at two sides of the device and the bottom face close to the rear panel; the water groove 3 has a depth of 1 - 10 cm below the bottom face and a width of 1 - 10 cm; the water groove 3 is connected to the drain valve 17; two pulley tracks 13 are provided, and a width between the two pulley tracks 13 is consistent with the width of the bookrack 19. The middle partition 11 is provided with an air outlet 20 thereon, since the closer to the fan, the higher the air velocity, an area of the air outlet increases with a distance from the fan set in a direction from the near to the distant. The bookrack 19 is made of stainless steel, with wheels at the bottom; the bookrack is provided with a link chain of stainless steel, a book basket is fixed on the link chain which is driven by a motor; after the motor is on, the book basket runs upward and downward so that more even absorption of atomized gas for the books is obtained; the book basket is designed as slightly wider at the top and slightly narrower at the bottom, the ancient books are opened laterally and placed with a lateral side facing upward, wind coming from the fan set 4 from top to bottom opens the ancient books slightly, allowing more even permeation of a deacidifying agent.

Embodiment 1

[0027] Five Ancient Medical Book (edition 1937, published by People's Medical Publishing House) having a volume of 0.004 m^3 were taken and tested to have a paper original humidity of 8.6%, and the books were placed in a 0.25 m $\times$ 0.25 m $\times$ 0.1 m deacidifying and repairing device having a volume of 0.00625 m^3. First, dehumidification was carried out to the system for 4 hours, and the dehumidifier was turned off when time's up. Then the vacuum pump was turned on to vacuumize the system until the pressure reached -0.05 MPa, and the vacuum pump was turned off. The ultrasonic atomizer was turned on, and a solution obtained by evenly mixing NaOH solid and water according to a mass ratio of 20:80 was selected as a deacidifying agent and added to a container. The prepared NaOH solution was atomized by the ultrasonic transducer and introduced into a sealed container via the gas pipe for deacidification and repair. By controlling a valve for the gas pipe, air humidity inside the system was controlled to be approximately 50%. Neutralization of acidic substances in the paper was performed simultaneously with monitoring the pH value of the ancient books. When the monitored pH value of the ancient books reached 7.2, the system was maintained stable for 2 hours, and then the system was turned off. Samples were taken to compare the paper performance average values before and after the deacidification and repair, shown as the following table:

Table 1

	pH	Water content%	Tensile strength (kN/m)	Burst	Tear (mN)	Folding strength (Times)
Before the deacidification and repair	5.98	8.6	1.460	1.568	28	3
After the deacidification and repair	7.21	9.1	1.540	1.590	32	4

Embodiment 2

[0028] Five Ancient Medical Book (edition 1937, published by People's Medical Publishing House) having a volume of 0.004 m^3 were taken and tested to have a paper original humidity of 9.2%, and the books were placed in a 0.25 m $\times$ 0.25 m $\times$ 0.1 m deacidifying and repairing device having a volume of 0.00625 m^3. First, dehumidification was carried out to the system for 3 hours, and the dehumidifier was turned off when time's up. Then the vacuum pump was turned on to vacuumize the system until the pressure reached -0.07 MPa, and the vacuum pump was turned off. The ultrasonic atomizer was turned on, and a solution obtained by evenly mixing NaOH solid and water according to a mass ratio of 20:80 was selected as a deacidifying agent and added to a container. The prepared NaOH solution was atomized by the ultrasonic transducer and introduced into a sealed container via the gas pipe for deacidification and repair. By controlling a valve for the gas pipe, air humidity inside the system was controlled to be approximately 50%. Neutralization of acidic substances in the paper was performed simultaneously with monitoring the pH value of the ancient books. When the monitored pH value of the ancient books reached 7.2, the system was maintained stable for 2 hours, and then the system was turned off. Samples were taken to compare the paper performance average values before and after the deacidification and repair, shown as the following table:

Table 2

	pH	Water content%	Tensile strength (kN/m)	Burst	Tear (mN)	Folding strength (Times)
Before the deacidification and repair	5.86	9.2	1.488	1.572	28	3
After the deacidification and repair	7.10	8.7	1.556	1.598	33	4

Embodiment 3

[0029] Five Ancient Medical Book (edition 1937, published by People's Medical Publishing House) having a volume of 0.004 m^3 were taken and tested to have a paper original humidity of 7.3%, and the books were placed in a 0.25 m $\times$ 0.25 m $\times$ 0.1 m deacidifying and repairing device having a volume of 0.00625 m^3. First, dehumidification was carried out to the system for 4 hours, and the dehumidifier was turned off when time's up. Then the vacuum pump was turned on to vacuumize the system until the pressure reached -0.05 MPa, and the vacuum pump was turned off. The ultrasonic atomizer was turned on, and a solution obtained by evenly mixing NaOH solid and water according to a mass ratio of 30:70 was selected as a deacidifying agent and added to a container. The prepared NaOH solution was atomized by the ultrasonic transducer and introduced into a sealed container via the gas pipe for deacidification and repair. By controlling a valve for the gas pipe, air humidity inside the system was controlled to be approximately 50%. Neutralization of acidic substances in the paper was performed simultaneously with monitoring the pH value of the ancient books. When the monitored pH value of the ancient books reached 7.2, the system was maintained stable for 2 hours, and then the system was turned off. Samples were taken to compare the paper performance average values before and after the deacidification and repair, shown as the following table:

Table 3

	pH	Water content%	Tensile strength (kN/m)	Burst	Tear (mN)	Folding strength (Times)
Before the deacidification and repair	5.89	7.3	1.451	1.578	27	3
After the deacidification and repair	7.38	8.9	1.535	1.598	31	4

[0030] The above embodiments of the present invention are merely illustrative examples for the present invention, but implementations of the present invention are not limited thereto. For those skilled in the art, various variation or alteration can be made based on the above description. However, there is no need and cannot be exhaustive for all implementations. Any modification, equivalent substitution and improvement made within the spirit and principle of the present invention shall be included in the scope of protection of the present invention.

Claims

1. A novel method for deacidifying and repairing ancient books, **characterized in that**, the method comprises:

first placing the ancient books to be treated in a closed deacidifying and repairing device;
after sealing, performing dehumidification operation and vacuumizing operation on the system in sequence to maintain the system dry;
after the system is stable under negative pressure, turning on a fan set, directly delivering a deacidifying agent to the deacidifying and repairing device via a gas pipe, or atomizing an alkaline deacidifying solution through a ultrasonic atomizer and then delivering the atomized alkaline deacidifying solution to the deacidifying and repairing device via the gas pipe, so that the ancient books to be treated absorb the alkaline deacidifying agent sufficiently and evenly; and
meanwhile monitoring pH value of the ancient books, thereby implementing deacidification and repair of the ancient books;

wherein the ancient books comprises acidic ancient book, archived file, document, literature, journal, paper, calligraphy and painting, cotton and flax.

2. The novel method for deacidifying and repairing ancient books according to claim 1, wherein a relationship of a device volume and a total volume of the ancient books to be treated satisfies that a ratio of the device volume to the total volume of the ancient books to be treated is 1.1:1 - 50:1.

3. The novel method for deacidifying and repairing ancient books according to claim 1, wherein the dehumidification operation is as follows: dehumidifying the system to have air humidity of 10% - 90% through a dehumidifier and maintaining for 2 - 24 hours; duration of the dehumidification operation depends on an original humidity of the ancient books and the closed device volume; when the original humidity of the ancient books is 8% - 9% and the device volume is 1.5 - 2 times the total volume of the ancient books to be treated, the duration of the dehumidification operation is 2 - 24 hours; when the original humidity is reduced by 10%, the duration of the dehumidification operation is reduced by 2 - 6 hours; when the device volume is doubled, the duration of the dehumidification operation is increased by 3 - 8 hours.

4. The novel method for deacidifying and repairing ancient books according to claim 1, wherein the vacuumizing operation is performed as follows after the dehumidification operation is completed, vacuumizing the system to have an inner pressure of 0 to -0.08 MPa through a vacuum pump, and maintaining the closed system under stable negative pressure until the deacidification and repair is completed.

5. The novel method for deacidifying and repairing ancient books according to claim 1, wherein the ultrasonic atomizer is an ultrasonic transducer, the ultrasonic transducer is placed in a container containing with the deacidifying agent and is powered on, wherein the structure of the deacidifying agent is dispersed and atomized into small-molecular atomized gas by means of high-frequency resonance of a piezoelectric ceramic.

6. The nanoscale deacidifying agent according to claim 1, wherein the deacidifying agent is a nanoscale alkaline deacidifying powder, an alkaline organic solution, or an alkaline inorganic solution; the pH value is 7 to 13; the alkaline deacidifying solution comprises NaOH solution, $Ca(OH)_2$ solution, $Cu(OH)_2$ solution, $Fe(OH)_3$ solution, KOH solution, Na_2CO_3 solution, $NaHCO_3$ solution, $NH_3 \cdot H_2O$ solution, ethylenediamine solution, phosphate solution or borate solution; by means of a pressurizing or ultrasonic atomizer, the alkaline deacidifying solution is dispersed into liquid drops in micronscale to nanoscale having an average particle size of 1 nm - 2 μm.

7. The nanoscale deacidifying agent according to claim 1, wherein the deacidifying agent comprises nano NaOH powder, $Ca(OH)_2$ powder, $Cu(OH)_2$ powder, $Fe(OH)_3$ powder, KOH powder, Na_2CO_3 powder or $NaHCO_3$ powder, or ethylenediamine powder.

8. The novel method for deacidifying and repairing ancient books according to claim 1, through the gas pipe, the fan set slowly introduces the nanoscale alkaline deacidifying powder or the deacidifying agent atomized by the ultrasonic transducer into the closed deacidifying and repairing device, and circulates the deacidifying agent inside the system for even distribution.

9. The novel method for deacidifying and repairing ancient books according to claim 1, wherein air humidity inside the system is maintained at 10% - 90%.

10. The novel method for deacidifying and repairing ancient books according to claim 1, wherein the deacidifying and repairing device has a pH value monitor for ancient book therein, after the pH value of ancient book monitored reaches approximately 7 - 8.5 and is maintained for 1- 48 hours, the system is turned off; the duration depends on a deacidifying degree of the ancient books and a closed device volume, when the original pH value of ancient book is 6 - 6.5 and the device volume is 1.5 - 2 times a total volume of the ancient books to be treated, the deacidification lasts for 2 - 5 hours; when the original pH value is increased by 0.2, the duration of deacidification is reduced by 1 - 6 hours; when the device volume is doubled, the duration of deacidification is increased by 3 - 8 hours.

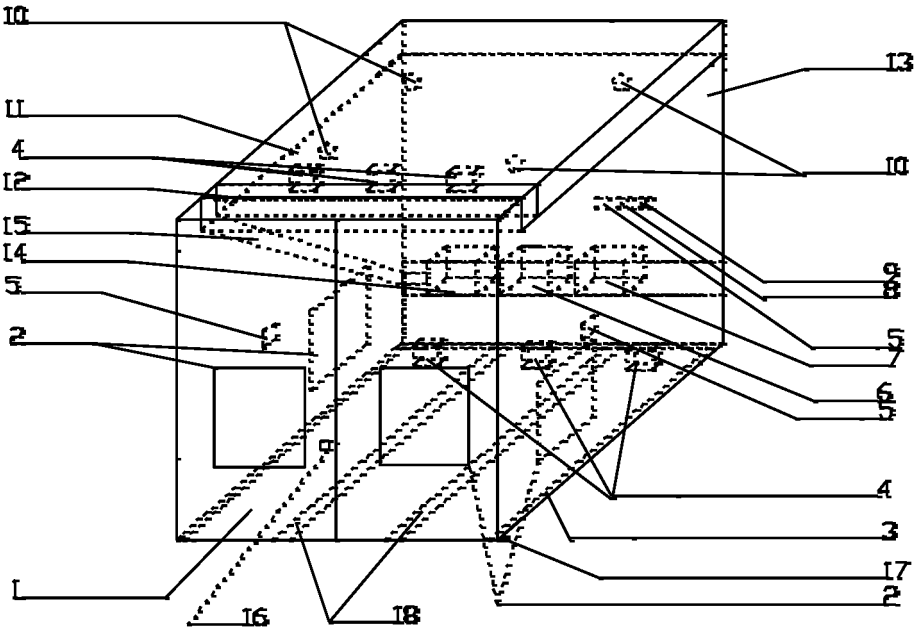

FIG. 1

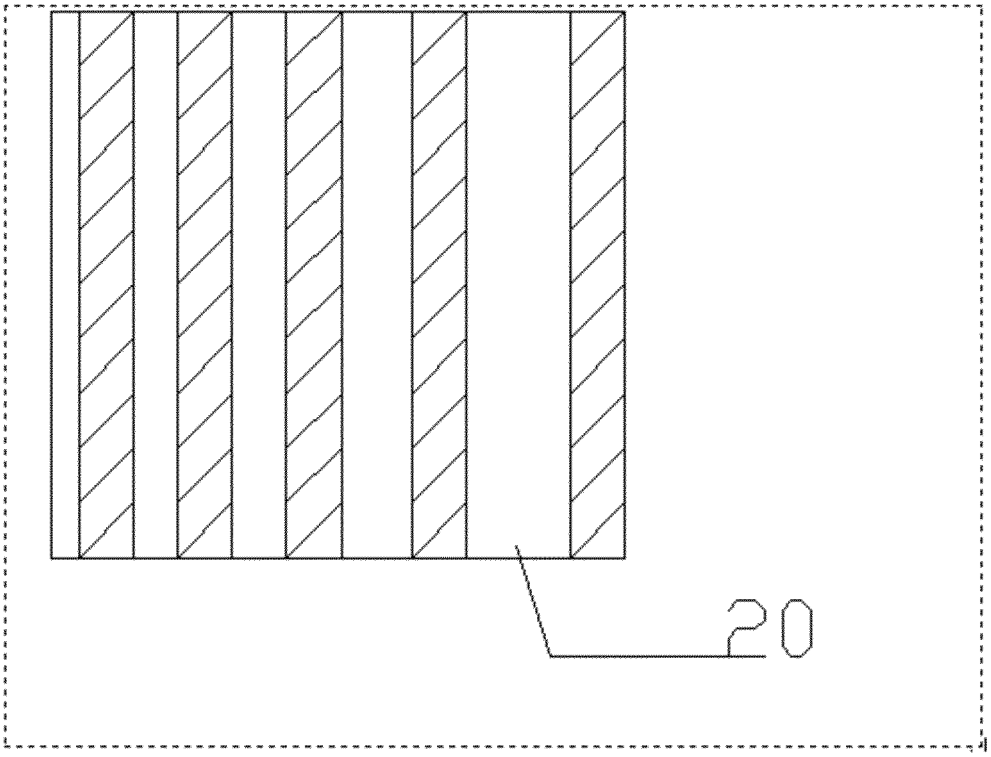

FIG. 2

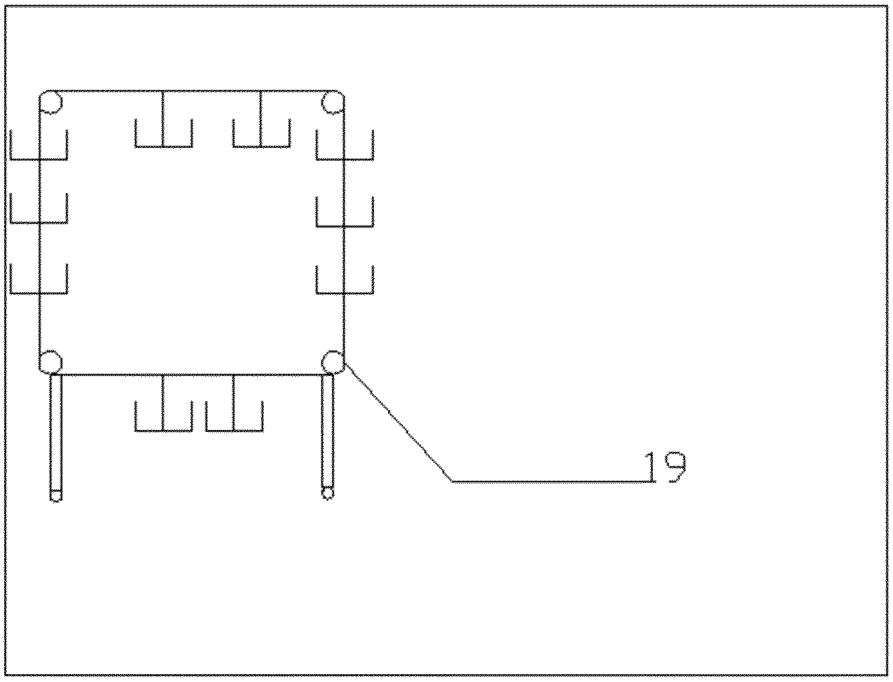

FIG. 3

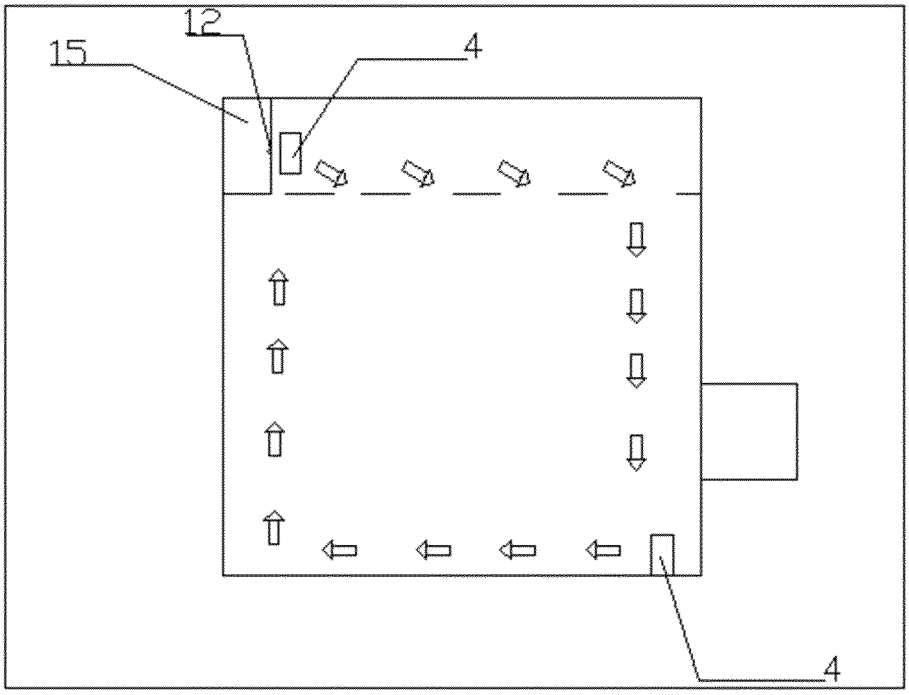

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/113229

A. CLASSIFICATION OF SUBJECT MATTER

D21H 25/18(2006.01)i; D06M 11/38(2006.01)i; D06M 11/44(2006.01)i; D06M 11/49(2006.01)i; D06M 11/76(2006.01)i; D06M 13/332(2006.01)i; D06M 101/06(2006.01)i

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)

D21H D06M

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)

CNABS, CNTXT, CNKI, VEN: 脱酸, 修复, 真空, 湿度, 雾化, 古籍, 文物, 字画, 纳米, 密闭, 密封, 负压, 气体, 干燥, deacidification, deacidifying, repair, vacuum, humidity, atomization, ancient books, cultural relics, calligraphy, nano, seal, negative pressure, gas, dry

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 108004847 A (SOUTH CHINA UNIVERSITY OF TECHNOLOGY) 08 May 2018 (2018-05-08) claims 1-10	1-10
Y	CN 105239460 A (SHAANXI NORMAL UNIVERSITY) 13 January 2016 (2016-01-13) description, paragraphs 8-16, and embodiments	1-10
Y	CN 102242529 A (GUANGDONG UNIVERSITY OF TECHNOLOGY ET AL.) 16 November 2011 (2011-11-16) description, paragraphs 19 and 20	1-10
Y	JP 06316897 A (OE, R. ET AL.) 15 November 1994 (1994-11-15) description, paragraphs 10-16, embodiment 1	1-10
A	US 6645298 B1 (RUAG MUNITION) 11 November 2003 (2003-11-11) entire document	1-10
A	US 5219524 A (EVERSEAL PRESERVATION LABS INC.) 15 June 1993 (1993-06-15) entire document	1-10

☐ Further documents are listed in the continuation of Box C. ☑ 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
11 January 2019	**18 January 2019**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/113229

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	108004847	A	08 May 2018	None			
CN	105239460	A	13 January 2016	CN	105239460	B	08 March 2017
CN	102242529	A	16 November 2011	CN	102242529	B	12 March 2014
JP	06316897	A	15 November 1994	JP	2502449	B2	29 May 1996
				JP	H06316897	A	15 November 1994
				US	5679308	A	21 October 1997
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				EA	004082	B1	25 December 2003
				CA	2327786	A1	14 October 1999
				US	2004056235	A1	25 March 2004
				EP	1084299	B1	06 November 2002
				WO	9951818	A1	14 October 1999
				AU	1478599	A	25 October 1999
				EP	1217125	A3	14 April 2004
				EP	1217125	A2	26 June 2002
				DE	59806223	D1	12 December 2002
				EA	200200347	A1	26 June 2003
				AT	227379	T	15 November 2002
				EP	1084299	A1	21 March 2001
				EA	200000940	A1	23 April 2001
US	5219524	A	15 June 1993	US	5260023	A	09 November 1993

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REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- Ancient Medical Book. People's Medical Publishing House, 1937 **[0027] [0028] [0029]**