

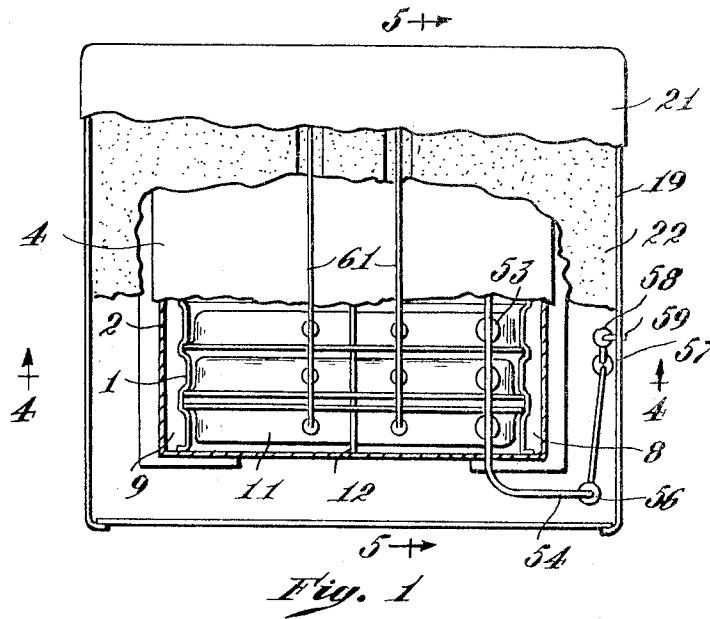
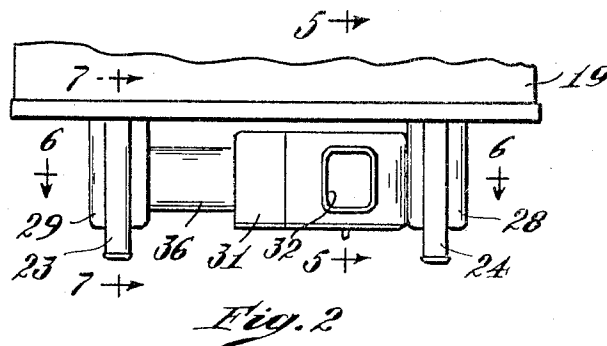
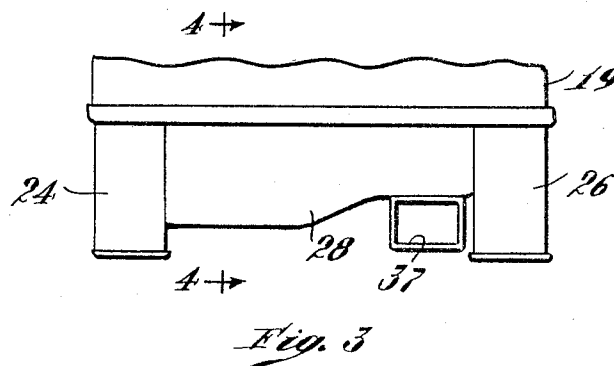
Jan. 24, 1967

R. E. RICE ETAL
HEAT-STORAGE APPARATUS

3,299,945

Filed Aug. 24, 1964

3 Sheets-Sheet 1



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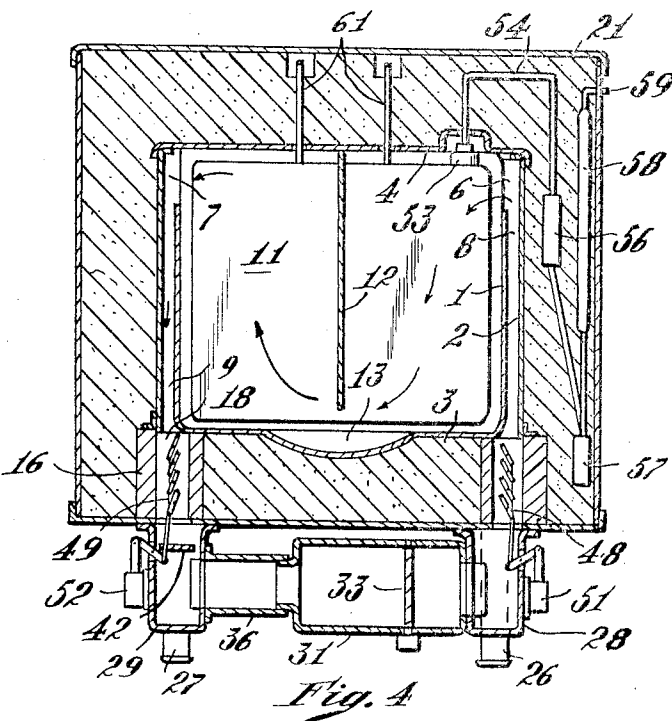
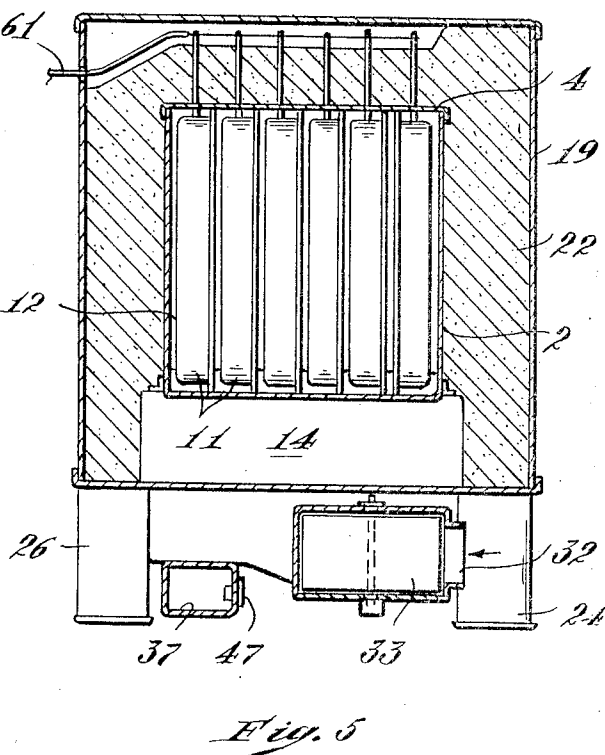
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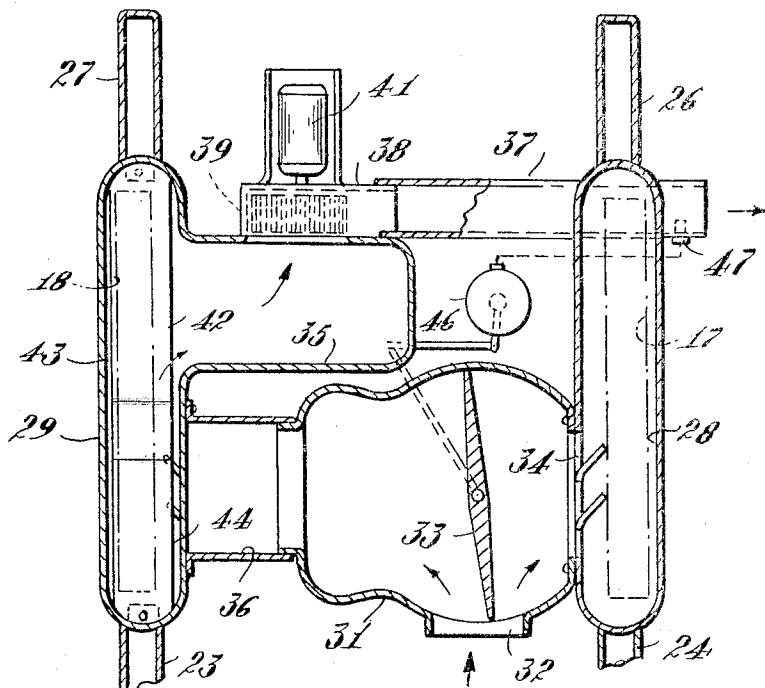


Fig. 6

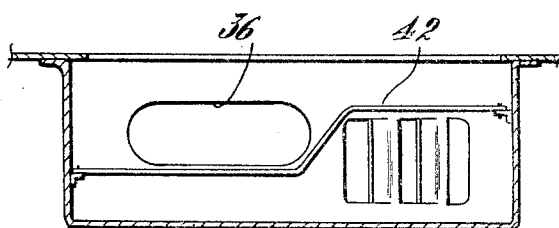


Fig. 7

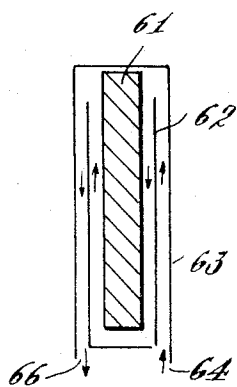


Fig. 8

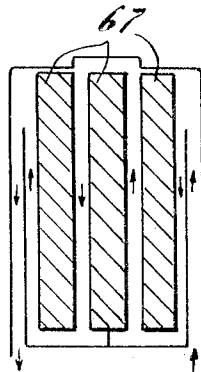


Fig. 9

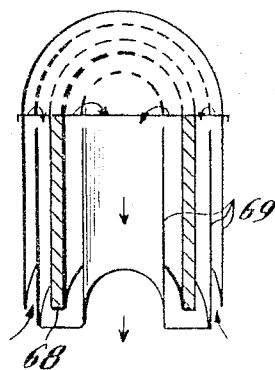


Fig. 10

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3,299,945

HEAT-STORAGE APPARATUS

Richard E. Rice, Arlington, and William E. Whitney,
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Cambridge, Mass., a corporation of Massachusetts
Filed Aug. 24, 1964, Ser. No. 391,676
4 Claims. (Cl. 165-4)

In many situations it is desirable to store heat for subsequent use. One example is heat derived from the sun. Another example is heat derived from electrical power at off-peak times when the rate is reduced.

Objects of the present invention are to provide heat-storage apparatus which is economical in production and use, which is simple to install, which stores a large amount of heat in a small space, which is readily adaptable to different requirements of climatic conditions, house sizes, etc., which is completely safe under all operating conditions, which is flameless and free from noxious by-products, and which is free from objectionable corrosive effects.

According to this invention the apparatus comprises an enclosure having top, bottom and side walls, a unit of heat-storage material in the enclosure, the enclosure containing a passageway past the unit for air or other fluid, the passageway having an inlet and an outlet at the aforesaid bottom, the passageway having a portion extending upwardly from the inlet to the aforesaid top, a second portion extending downwardly, a third portion extending upwardly, and a fourth portion extending downwardly from the top to the outlet, the top and side walls being closed to minimize heat loss. Preferably the enclosure contains a plurality of storage units and portions of the aforesaid passageway are disposed between the units, and the inlet and outlet are elongate and extend along opposite sides of the enclosure. The storage units may extend either lengthwise or crosswise of the aforesaid sides. When using air as the circulating fluid the blower is preferably located in the outlet duct so that the pressure in the heat-storage enclosure is less than atmospheric. Thus any leakage involves cold air into the enclosure instead of hot air out of the enclosure.

In a more specific aspect the aforesaid enclosure comprises inner and outer walls and the storage unit or units are disposed inside the inner walls, the first portion of the passageway is disposed between the inner and outer walls, the second and third portions are inside the inner walls, and the fourth portion is between the inner and outer walls. While the walls and units are preferably rectangular, they may comprise annular parts such as concentric cylindrical parts. The aforesaid enclosure should of course be surrounded with insulation.

In a still more specific aspect the apparatus comprises an enclosure having a top, bottom and sides, opposite sides comprising pairs of inner and outer walls, each pair of walls having a fluid passageway therebetween and the inner walls having a heat-storage chamber therebetween with top openings at the upper ends of the inner walls, units of heat-storage material disposed in said chamber transversely of said pairs of walls with spaces therebetween, a baffle extending downwardly from said top in said spaces with a bottom opening at the lower end thereof, one of said passageways having an inlet at the bottom thereof and the other passageway having an outlet at the bottom thereof, whereby fluid may flow upwardly through said one passageway, thence through one of said top openings, thence downwardly through said spaces on one side of the baffle, thence through said bottom opening, thence upwardly through said spaces on the other side of the baffle, thence through the other top opening, and thence downwardly through the other passageway. The afore-

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said chamber is preferably sealed at the bottom so as to catch any liquid which leaks from said unit.

The apparatus should have means in said inlet and outlet to obstruct downward radiation from said passageways. Preferably this means comprises shutters and means to close the shutter when heat is not being drawn from the apparatus.

In another aspect the apparatus comprises a storage chamber having a passageway therethrough for fluid to be heated, the passageway having an inlet and an outlet, a conduit for delivering heated fluid from said outlet, a duct for supplying fluid to be heated to said inlet, a duct to supply unheated fluid to said conduit at a predetermined location, valve means for controlling the proportion of fluid flowing through said ducts, and thermostatic means associated with the conduit beyond said location for controlling said valve means, said inlet and outlet being located at the bottom of the storage chamber and the chamber being closed at the top, thereby to minimize heat loss from the chamber. While said valve means may comprise a valve in each duct, preferably said ducts have a common entrance and a single valve is disposed in the common entrance to control the proportion of fluid flowing into the two ducts. In the preferred embodiment said inlet and outlet are elongate and extend along opposite sides of the bottom of the chamber, said ducts comprise elongate portions which extend lengthwise of the inlet and outlet under the inlet and outlet respectively, and said common entrance and valve are disposed between said elongate portions.

For the purpose of illustration typical embodiments of the invention are shown in the accompanying drawings in which

FIG. 1 is a plan view with parts broken away;

FIG. 2 is a side view of the lower part of the apparatus viewed from the bottom of FIG. 1;

FIG. 3 is a similar view viewed from the right of FIG. 1;

FIG. 4 is a section on line 4-4 of FIG. 1;

FIG. 5 is a section on line 5-5 of FIG. 2;

FIG. 6 is a section on line 6-6 of FIG. 2;

FIG. 7 is a section on line 7-7 of FIG. 2; and

FIGS. 8 to 10 are diagrammatic vertical central sections of modifications.

The particular embodiment of the invention shown in FIGS. 1 to 7 comprises an enclosure having inner and outer walls 1 and 2, a bottom 3 and a removable top 4. As shown in FIG. 1 the inner walls 1 are disposed on only two opposite sides of the enclosure and as shown in FIG. 4 they terminate short of the top 4 to provide openings 6 and 7 interconnecting the passageways 8 and 9 between the inner and outer walls with the space between the inner walls containing the storage units 11. As shown in FIG. 1 the units 11 have peripheral flanges around one side which fit into grooves in the inner walls 1, the units slipping into the grooves from the top when the cover 4 is removed. The space between the inner walls is divided into two parts by means of a baffle 12 which is slotted from the bottom to fit over the units and divide the spaces between the units except for an opening 13 at the bottom of the enclosure to permit circulation of air from one side of the baffle to the other (FIG. 4). The enclosure 1-2 is supported on two elongate blocks 14 and 16 extending the full width of the enclosure (FIG. 5) and having longitudinal slots 17 and 18 therein which communicate with the passageways 8 and 9 respectively. The enclosure is entirely surrounded by a housing 19 having a removable cover 21 with insulation 22 filling the space between the enclosure and housing.

Supported on legs 23, 24, 26 and 27 is an air-mixing and delivery system comprising an elongate duct 28 com-

municating at the top with the slot 17 and an elongate duct 29 communicating at the top with the slot 18. Disposed between these two ducts is a chamber 31 having an inlet 32 and containing a valve 33, this chamber communicating with the duct 28 through an opening 34 and communicating with the duct 29 through a duct 36. Extending from the duct 29 is a conduit comprising two parts 35 and 37 interconnected by chamber 38 containing a blower 39 driven by motor 41. The duct 29 contains a baffle 42 which divides the duct into upper and lower parts except for narrow slits at the opposite longitudinal edges of the baffle (FIG. 6). The valve 33 is actuated by a motor 46 which is controlled by a thermostat 47 in the conduit 37. Disposed in the slots 17 and 18 are louvers 48 and 49 controlled by solenoids 51 and 52 which in turn are controlled by a thermostat in the space to which conduit 37 delivers heated air. When the thermostat calls for heat the louvers open and when circulation of air stops they close. This control system is described and claimed in the copending application of George Warren Webb, Ser. No. 391,562, filed herewith.

The storage units 11 may be filled with any suitable heat-storage material but they preferably contain sodium hydroxide mixed with a small percentage of rust inhibitor. The units are preferably filled with the material in liquid form before they are inserted in the enclosure. After the units are inserted the filling caps are removed and replaced with caps 53 connected to a tube 54 which leads through chambers 56, 57 and 58 to an outlet 59 to the atmosphere. The chamber 56 contains material to adsorb moisture, such as silica gel or activated alumina, or a molecular sieve. Chamber 57 serves to collect moisture removed by the material in chamber 56, and chamber 58 contains material to absorb carbon dioxide, e.g. sodium hydroxide or a caustic alkali such as lithium hydroxide, potassium hydroxide or barium hydroxide, preferably a mixture of sodium hydroxide, calcium hydroxide and a color indicator, such as SODASORB made by Dewey & Almy Chemical Co. This breather system is described and claimed in the copending application of Richard E. Rice, Ser. No. 391,564, filed herewith.

The storage units 11 may be stored with heat in any suitable way but as shown in the drawings they are equipped with internal heating rods which are supplied with current through leads 61.

The operation of the apparatus is as follows. When no heat is being drawn from the apparatus the louvers 48 and 49 are closed to minimize radiation through the slots 17 and 18. When the thermostat in the room, water heater or the like to which conduit 37 delivers heat calls for heat, the louvers 48 and 49 open and the blower 39 is started to produce circulation of air as follows. The air entering through inlet 32 is divided by the valve 33. The air entering to the right of the valve (FIGS. 4 and 6) passes through the duct 28, slot 17, passageway 8, opening 6, downwardly between the units 11 on the right of the baffle 12 (FIG. 4), through the opening 13, upwardly through the space between the units on the left of the baffle 12, through the opening 7, passageway 9, slot 18, duct 29 and thence to the conduits 35 and 37. Air entering to the left of the valve 33 passes through the duct 36, the lower part of duct 29, upwardly through the slits 43 and 44 to the upper part of duct 29 and thence mixes with the hot air in conduit 35, thereby reducing the temperature of the hot air to the desired value. The thermostat 47 may be set to deliver air at any desired temperature. When the temperature tends to rise above the value to which the thermostat is set, valve 33 moves counterclockwise to deliver a larger proportion of cool air to duct 29 and when the temperature of the air in conduit 37 tends to fall below the set value the valve 33 moves clockwise so that a larger proportion of the entering air passes through the enclosure 1-2. When the space to be heated reaches the desired temperature the motor 41 stops and the louvers 48 and 49 close.

From the foregoing it will be understood that by locating the inlet 17 and outlet 18 at the bottom of the storage housing, heat loss is minimized because there can be no chimney effect. The automatic louvers 48 and 49 further reduce heat loss. The baffle 42 causes the cool air entering through duct 29 to flow upwardly along the sides of the duct through the slits 43 and 44, thereby keeping the sides of the duct cool and reducing radiation.

The modification illustrated diagrammatically in FIG. 8 comprises a single storage unit 61 like unit 11 of the preceding figures and inner and outer walls 62 and 63 corresponding to 1 and 2 of the preceding figures with an inlet 64 at one side and an outlet 66 at the other side. Thus the unit 61 extends along the inlet and outlet sides instead of crosswise of the sides as in the preceding figures.

FIG. 9 is like FIG. 8 except in that it has a plurality of heat storage units 67 instead of a single unit as in FIG. 8.

The modification shown in FIG. 10 is like FIG. 8 in that it has a single storage unit 68 but it differs in that the unit and the enclosure walls 69 are cylindrical instead of rectangular, the air entering between the outer walls and leaving through the inner cylindrical wall. In each of these modifications the inlet and outlet are located at the bottom so as to minimize heat loss.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

We claim:

1. Apparatus comprising an enclosure containing heat-storage means and a passageway through the enclosure, characterized in that the enclosure comprises walls parallel to each other and said means comprises a thin heat-storage unit having opposite faces of greater area than its edges, said faces being approximately parallel to said walls, means for holding the unit with spaces between it and said side walls, two inner walls extending upwardly from the bottom of the enclosure and terminating below the top of the enclosure, one of said inner walls located between the heat-storage unit and one side wall and the other of said inner walls located between the unit and the other side wall, a central baffle extending downwardly from the top of the enclosure and terminating above the bottom of the enclosure, said inner walls, baffle, and side walls forming in the enclosure a passageway extending from an opening at the bottom of one end of the enclosure upwardly along said end to the top of the enclosure, thence downwardly over the heat-storage unit to the bottom of the enclosure, thence around the baffle and upwardly over the heat-storage unit to the top of the enclosure, and thence downwardly along the opposite end of the enclosure to an opening at the bottom of said opposite end of the enclosure.

2. Heat-storage apparatus according to claim 1 wherein in the bottom of the enclosure between the two inner walls comprises a container to catch any liquid which may leak out of said unit.

3. Heat-storage apparatus according to claim 1 wherein said outer walls are enclosed in insulation.

4. Apparatus comprising an enclosure containing heat-storage means with a passageway through the enclosure, characterized in that the enclosure comprises four concentric cylinders, namely, a first outer cylinder extending to the top of the enclosure, a second cylinder spaced inwardly of the first cylinder and extending from the bottom of the enclosure, a third cylinder formed of heat-storage material spaced inwardly of the second cylinder and extending from the top of the enclosure to a point above the bottom of the enclosure, and a fourth cylinder spaced inwardly from the third cylinder and extending from the bottom of the enclosure to a point below the top of the enclosure, said cylinders together with the bottom and top of the enclosure forming a passage leading from an opening at the bottom of the first cylinder through a path upwardly between the first and second cylinders,

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thence downwardly between the second and third cylinders, thence upwardly between the third and fourth cylinders and then downwardly in the fourth cylinder to an opening at the bottom of the fourth cylinder.

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