Nov. 8, 1938. L. M. PERSONS 2,135,839

METHOD AND MEANS FOR EVACUATING THERMOSTAT ASSEMBLIES

Filed June 24, 1936

Fig. 1.

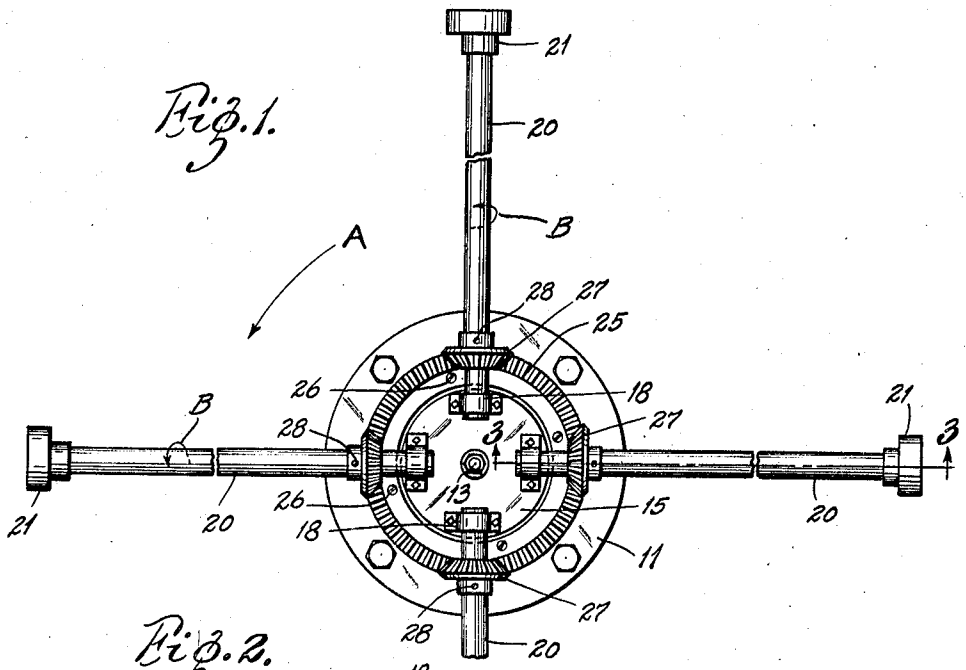


Fig. 2.

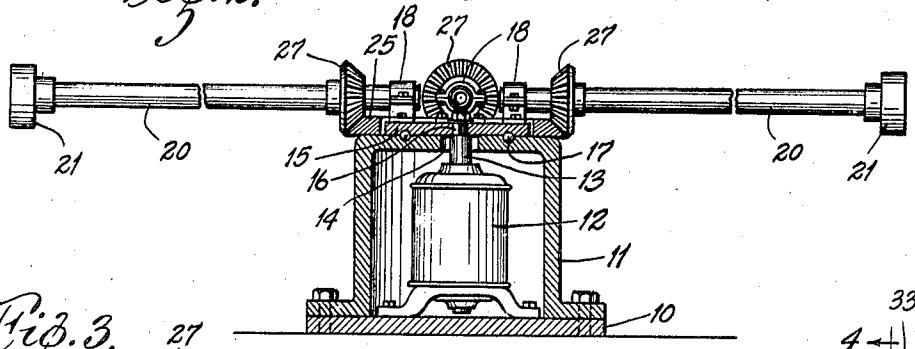


Fig. 3.

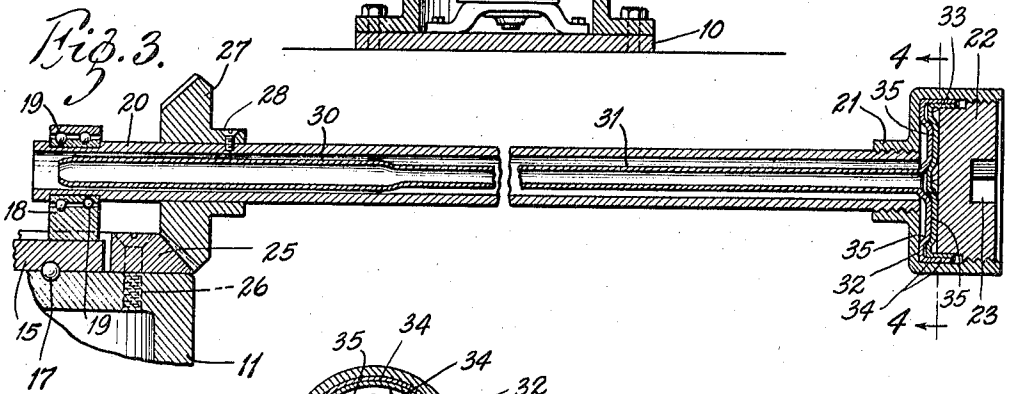
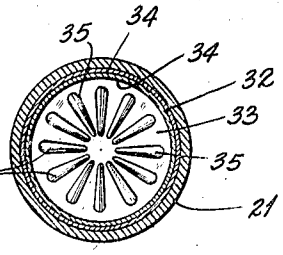


Fig. 4.



INVENTOR.
LAWRENCE M. PERSONS,
By Lawrence Le Tinqsland
ATTORNEY.

Patented Nov. 8, 1938 2,135,839

UNITED STATES PATENT OFFICE

2,135,839

METHOD AND MEANS FOR EVACUATING THERMOSTAT ASSEMBLIES

Lawrence M. Persons, St. Louis, Mo., assignor, by mesne assignments, to Automatic Control Corporation, St. Louis, Mo., a corporation of Delaware

Application June 24, 1936, Serial No. 87,016

26 Claims. (Cl. 226—82)

This invention relates to a method and means for evacuating air from thermostat assemblies or other like devices. It is particularly applicable to liquid-filled thermostat assemblies of the capillary type wherein there is a space or chamber extending laterally of the capillary tube.

For illustration, and it may be said that this illustration constitutes an especial application of the method and means, a thermostat comprising a bulb, a capillary tube, and a diaphragm member on the end of the capillary tube will be used. In this type device, the capillary tube ipso facto has a very small internal diameter, and the diaphragms, when the liquid is cold, are in contiguous relation one to the other. The movement of the movable diaphragm obtained by the expansion of the liquid is very small, such as .030 of an inch. Consequently, the effect of any air contained in the system is to destroy the accuracy of the instrument.

Great difficulty has heretofore been encountered in eliminating all traces of air from systems of this kind. With the very small space between the diaphragms and the very narrow diameter of the capillary tube, the former methods have been unsuccessful. Although a perfect vacuum may be drawn, small air bubbles are retained in the capillary because of the viscosity of the liquid, the capillary pressure, and the surface tension. Furthermore, the boiling point of the filling liquid may be reached within the range from atmospheric presure to a perfect vacuum, resulting in vaporizing the liquid and its being drawn off as a gas rather than in a perfect vacuum being created.

The present method overcomes these disadvantages and completely expels all air from these systems.

It is an object, therefore, of the invention to provide a method for completely eliminating air from liquid-filled systems, and in particular, liquid-filled systems of the capillary type.

It is a further object of the invention to provide a method for eliminating all air from capillary liquid-filled systems having pockets or chambers extending laterally of the capillary tube.

It is a further object of the invention to provide for the removal of air from such systems by the application of pressure to the liquid, the pressure being exerted both axially and transversely of the capillary tube and its annexed members.

It is a further object of the invention to provide means and mechanisms for performing the above method.

In particular, it is an object to provide means applying centrifugal force to the liquid axially of the capillary tube and to apply centrifugal force to the liquid radially of the capillary tube.

It is a further object of the invention to provide means preventing separation of the movable diaphragms under the influence of these centrifugal forces.

In the drawing—

Fig. 1 is a plan view, partly cut away, of a mechanism for supporting and rotating thermostat systems radially and axially relative to the capillary tube.

Fig. 2 is a vertical central section of the structure shown in Fig. 1.

Fig. 3 is a section on the line 3—3 of Fig. 1.

Fig. 4 is a section on the line 4—4 of Fig. 3.

The machine for accomplishing the ends set out above comprises a base 10 that includes a standard 11. Within the standard is mounted a motor 12 having a shaft 13 vertically disposed and extending through an opening 14 in the top of the standard. A rotating disc 15 is fastened to the motor shaft 13 by means of a squared connection 16 whereby the disc rotates with the motor. Suitable bearings 17 may be inserted between the disc and the standard 11. The disc likewise supports journal brackets 18 that may be of the split type, as shown, to contain ball bearings 19 therein. A supporting tube 20 passes through the inner bearing race of the bracket 18 and is held against axial movement thereby. This supporting tube is adapted to receive the bulb and tube of the thermostat element, as will be described, it being of proper length therefor. Threaded to the outer end of the tube 20 is a cup element 21, the outer portion of which is internally threaded to receive the removable plug 22, suitable means such as the wrench-receiving cut-out 23 being provided for insertion or removal of the plug.

Fixed to the top of the standard 11 is a bevel gear 25 held in place by such means as the screws 26. A cooperating bevel gear 27 is secured to the supporting tube 20 by a set screw 28, the bevel gear 27 meshing with the gear 25. It will be understood that a plurality of these tube assemblies may be supported about the top of the disc 15, four being shown here for illustrative purposes.

The thermostat assembly may include a bulb 30 extending from which is a capillary tube 31. A pair of diaphragms 32 and 33 are secured to the end of the capillary tube 31 and are fastened together at their rims 34 which may be turned up for convenience. These diaphragms are adapted to be maintained in contiguous relation to each other when the fluid filling the system is cold,

and to be separated a slight distance in response to expansion of the fluid. Radial corrugations **35** are provided in both diaphragms in complementary relation.

In thermostats of this kind, the principal part of the fluid is contained within the bulb **30**, this bulb being located at a point, the heat of which is to be controlled. The capillary tube is of suitable length to connect the bulb **30** with the switch containing the diaphragms **32** and **33**. As will be understood, the internal diameter of the capillary tube **31** is very small, it being exaggerated in the drawing for purposes of clarity. Although the two diaphragms **32** and **33** are mounted in contiguous relation and even may be stamped out together or corrugated together, inevitably there will be certain spaces between them that will entrap air.

The method of making the assemblies is as follows: As has been noted, great difficulty has obtained in removing all of the air from systems of this kind. The smallness of the capillary tube coupled with the capillary action resists withdrawing of air from this tube by the application of a vacuum. Similarly, the pockets between the two diaphragms resist such removal of air. Also the amount of negative pressure that can be produced is definitely limited to the absolute pressure of the atmosphere. The liquids that may be employed generally have vapor points within the range of available vacuums, so that, when a certain negative pressure is applied, the liquid vaporizes so that, instead of drawing entrapped air, the liquid itself is drawn off in the form of a vapor.

The present method involves the use of two centrifugal forces, both of which may apply very high pressures that positively expel the air by forcing it centrifugally out of the system. To accomplish this, the bulb, capillary tube and diaphragms are assembled together. The capillary tube **31** extends through the diaphragm **32** so as to communicate with the space between the diaphragms. The outer end of the tube **30** is left open and the thermal liquid is charged into the system to fill it as completely as may be without especial operations. The thermostat assembly is then whirled about a first axis of rotation with the tube substantially radial thereof, and with the open end of the bulb **30** toward the center of rotation. This action forces the liquid out toward the diaphragms with a great pressure, this liquid, by the pressure, then expelling any air within the tube and bulb centripetally to the open end of the bulb. At the same time, the tube is rotated about its own axis, that is, about the axis that extends radially of the first axis of rotation, so that liquid is forced centrifugally of this second axis of rotation and radially of the two diaphragms. It, consequently, forces any air pocketed between the two diaphragms toward the center thereof, where the said air, by the first-named rotation, is carried axially inwardly along the capillary tube and bulb and expelled at the open end of the latter. Since the diaphragms might be distended by this centrifugal force, they are held together during the operation. After all of the air has been expelled by this double centrifugal action applied for a suitable time, the open end of the bulb **30** is sealed together.

This method positively expels all air between the two diaphragms and within the capillary tube. The centrifugal pressures may be made high enough to do this regardless of the relative viscosity of the liquid and the smallness of the space. It will be understood that the two pressures are controlled by controlling the speeds of rotation in the two directions. Centrifugal forces of this kind are not applied solely to one end of the system, as is the vacuum, and so are not seriously influenced by friction, and so forth. Since the entire system is caused to rotate, the pressures produced in the liquid are applied incrementally.

The operation of the mechanism shown is as follows: With the plug **22** removed, the charged thermostat assembly is inserted so that the bulb **30** and the capillary tube **31** extend into the supporting tube **20** until the diaphragm **32** rests against the cup **21**, into which it fits snugly. The plug **22** is then inserted and turned down until it rests firmly against the diaphragm **33**. The motor **12** is then turned on so that it rotates the disc **15**. By virtue of the connection between the supporting tubes **20** and the disc **15**, these tubes are rotated in the direction of the arrow A in Fig. 1. By this rotation, centrifugal force is applied axially of the bulb **30** and the tube **31**. During this rotation, the gears **25** and **27** will mesh to cause rotation of the several tubes **20** in the direction of the arrow B in Fig. 1. This last rotation B applies centrifugal force to the liquid between the diaphragms. Hence, it will be clear that the two centrifugal forces above mentioned are obtained by this mechanism. Purely for illustrative purposes, it may be said that the rotation of the disc **15** may be approximately 1800 R. P. M. and the rotation of the tubes **20** about their own axes may be about 300 R. P. M.

It is preferable that the corrugations employed be radial, as shown, so that they will not provide pockets that do not communicate to the center of the diaphragms. As an illustration, annular corrugations present a greater obstruction to the centrifugal action of the liquid and the corresponding centripetal action of any air.

It will be seen that a method and a means have been provided to eliminate air from systems of this kind. It is, of course, understood that the method and means are highly valuable, whether the tube **31** be a capillary tube, or not, and whether the movable member be a diaphragm or some other similar means, such as a bellows. The method, however, finds particular advantage where a capillary tube is used or where the diaphragms are used. Since centrifugal forces are positive pressures, they are unlimited in value and may be controlled within wide ranges. They avoid any problem of vapor pressures of the liquid filler and may be made ample to overcome any viscosity effects of the liquid. Also the time required for expelling the air is greatly reduced.

What is claimed is:

1. In a method of expelling gases from liquid-charged assemblies, which assemblies include a space extending in one direction, and a second space extending laterally of and communicating with the first space, the steps of rotating the assembly about a first axis from which the first space extends radially, and simultaneously rotating the assembly about a second axis from which the second space extends laterally, whereby gas will be forced by cetripetal force inwardly from said second space toward said second axis to said first space, and gas in said first space will be forced by centripetal force toward said first axis.

2. In a method of expelling gases from liquid-charged assemblies, which assemblies include a tube open at one end, and an enclosed space ex-

tending laterally from the other end of the tube, the steps of rotating the tube about an axis at an angle to the axis of the tube with the open end of the tube toward said axis of rotation, simultaneously rotating the tube about its axis as a center until the gas is expelled from said space and said tube, and finally closing the open end of the tube.

3. In a method of expelling gases from liquid-charged systems that include a tube and a chamber at one end thereof, the chamber having one wall formed of a movable element, the steps of rotating the tube to produce centrifugal force in the liquid along the tube and toward said movable element, simultaneously rotating the movable element to produce centrifugal action of the liquid in the chamber, and holding the movable element against movement in response to said centrifugal forces.

4. In a method of expelling gases from liquid-charged assemblies that include a tube, a bulb at one end thereof and an expansible chamber at the other, the steps of supporting the assembly on a rotatable member, rotating said member about an axis at an angle to the axis of the tube, and simultaneously rotating said member about the axis of the tube.

5. In a method of making liquid-filled assemblies having a diaphragm element with radial corrugations, and a closure element annexed to said diaphragm to form a chamber therewith, and a tube attached to communicate into the center of said chamber, the steps of charging the space in said tube and said chamber with liquid, supporting the assembly on a rotatable member, rotating said member about the axis of said tube to cause centrifugal force in said chamber to expel gas centripetally along said corrugations, and simultaneously rotating said member about an axis at an angle to the axis of said tube to expel gas axially of the tube.

6. In a method of making liquid-filled assemblies having a chamber member, one wall of which comprises a diaphragm, attached to a capillary tube, the connection being on a middle line of the chamber and the tube communicating inside the chamber, and a bulb at the other end of the tube, the steps of charging the tube, the bulb and the space in the chamber with liquid, supporting the assembly thus produced on a rotatable member, and rotating said member simultaneously about the axis of the tube and an axis at right angles thereto, to apply centrifugal forces to the liquid to expel the air from the chamber into the tube, and to expel the air in the tube to the remote end of the bulb.

7. In a method of expelling air from liquid-filled assemblies that include a tube and a hollow expansible member on the end of the tube, the tube communicating within the expansible member, the steps of supporting the assembly on a rotatable member, supporting said expansible member to prevent expansion thereof in any direction, and simultaneously rotating said movable member about the axis of the tube and about an axis at right angles to the tube to apply centrifugal forces to the liquid therein whereby said liquid expels the air in said expansible member and said tube.

8. In a method of expelling gas from liquid-filled systems having a space extending in one direction and a second space extending transversely to the first, the steps of applying a gas expelling force to a plurality of points in said first space, and simultaneously applying a gas expelling force to a plurality of points in said second space.

9. In a mechanism for expelling gas from liquid-charged assemblies, a base, a rotatable member, said rotatable member being adapted to receive the assembly, means mounting said rotatable member on said base, and means for rotating said rotatable member about two axes whereby to apply centrifugal forces to said assembly to expel gas therefrom.

10. In a mechanism for expelling gas from liquid-charged assemblies, a rotatable member adapted to receive and support the assembly, a base, means mounting the rotatable member for rotation about the base, and interengaging means between the member and the base to cause rotation of the member about its own axis upon rotation thereof about the base.

11. In a mechanism for expelling gas from liquid-charged assemblies, an elongated member for receiving and holding the assembly, means for causing the member to rotate about an axis at an angle to its axis to produce centrifugal force in the liquid axially of the elongated member, and means causing the member to rotate about its axis to produce centrifugal force in the liquid radially thereof.

12. In a mechanism for expelling gas from liquid-filled assemblies including a tube and an expansible chamber extending radially of the tube, an elongated member to receive the tube, an enlarged portion on the elongated member to receive the expansible chamber, said enlarged portion including means to prevent expansion of the expansible member, and means to rotate the elongated member about its own axis and about an axis at an angle thereto, to apply centrifugal forces to the liquid in the tube and chamber and expel air therefrom.

13. In a mechanism for expelling gas from liquid-filled assemblies, a base, a rotatable support mounted on said base, a plurality of assembly-holding members mounted on the support and extending radially therefrom, means to rotate said support and thereby to rotate said holding members, and means to cause said holding members to rotate about their own axes.

14. In a mechanism for expelling gas from liquid-filled assemblies, a base, means on said base to hold an assembly, means to rotate the assembly about a first axis, and means to cause rotation of the assembly about a second axis at an angle to the first whereby to cause the gas to travel inward toward the first axis, and then inward along said first axis to an extremity of said assembly.

15. In a mechanism for expelling gas from liquid-filled assemblies, a base, a member mounted for rotation on the base, assembly-receiving members, means mounting said assembly-receiving members on the rotatable member to rotate therewith, said mounting means also permitting rotation of the assembly-receiving members relative to said rotatable member, means for rotating said rotatable member, and means for causing said receiving members to rotate relative to said rotatable member, whereby to cause centripetal travel of said liquid inwardly toward the first axis, and along said axis to one extremity of said assembly.

16. In a mechanism for expelling gas from liquid-filled assemblies, a base, a rotatable plate mounted on the base, a plurality of assembly-receiving tubes mounted on said rotatable plate for additional rotation relative thereto, said

tubes extending radially from said plate, a power means connected to said plate to rotate the same, a gear fixed to the base, and gears fixed to said tubes to mesh with the fixed gear, whereby upon rotation of the plate, the tubes will be rotated relative thereto.

17. In a method of separating a lighter substance from a heavier one in an assembly containing both, the steps of rotating the assembly about one axis to cause centripetal movement of the lighter substance toward said axis, and rotating the assembly about an axis at an angle to said first axis to cause said lighter substance to travel centripetally toward said second axis.

18. In a method of separating a lighter substance from a heavier one in an open ended assembly containing both, the steps of rotating the assembly about an axis passing through said open end to cause the lighter substance to travel centripetally toward said axis, and rotating the assembly about an axis at an angle to and intersecting said first axis and with the open end toward said second axis, to cause said lighter substance to travel centripetally toward said second axis and out said opening.

19. In a method of separating a lighter substance from a heavier one in an assembly containing both, the steps of rotating said assembly about a horizontal axis to cause centripetal travel of said lighter substance toward said axis, and rotating the assembly about a vertical axis to cause centripetal movement of said lighter substance along said horizontal axis and toward said vertical axis.

20. In a method of expelling a lighter fluid from a heavier fluid in systems containing both and having two communicating fluid-containing spaces, a second one of which extends transversely from the first, the steps of applying an expelling force simultaneously throughout the transverse space to cause the lighter fluid, but not the heavier, to be directed toward the first space, and applying an expelling force in the first space to expel the lighter fluid, but not the heavier, therefrom.

21. In a method of expelling a lighter fluid from an assembly containing said lighter fluid and a heavier substance, and which assembly comprises an elongated member and a member extending laterally from said elongated member, said laterally extending member including two normally contiguous walls at least one of which is flexible, the steps of simultaneously rotating said assembly about two axes one of which is at an angle to the axis of said elongated member, and at the same time holding said walls of said laterally extending member together to prevent flexing of said inflexible wall away from said other wall.

22. In a mechanism for expelling a lighter substance from an assembly containing both the lighter substance and a heavier one, a base, a rotatable member adapted to receive the assembly, means mounting the rotatable member on the base, and means for rotating the rotatable member simultaneously about two axes whereby to cause the lighter substance to travel centripetally toward both axes.

23. In a mechanism for expelling by centripetal force a substance from an assembly including a tube and an expansible member extending outwardly from the tube, a base, a plate mounted for rotation on said base, a plurality of tubes mounted on and extending outwardly from said plate, each tube having at the end thereof a cup to receive the radially extending member, removable means in said cup adapted to abut said expansible member to control the expansion thereof, and means to rotate said plate and said tubes.

24. In a mechanism for expelling by centripetal force from an assembly including an expansible member, a base, a support for said assembly rotatably mounted on said base, and adapted to receive said assembly, and means on said support to restrain relative movement between said expansible member and the remainder of the assembly.

25. In a mechanism for expelling a relatively light fluid from an assembly comprising a hollow, longitudinal member and a chamber extending laterally therefrom, said chamber comprising two walls at least one of which is flexible, a base, a support for said assembly mounted for rotation on said base, a laterally extending member on said support, said laterally extending member having a wall against which one wall of said laterally extending chamber may abut, and means adapted to abut said laterally extending chamber to hold said flexible wall thereof against the other wall.

26. In a centrifuge, a base, a rotary power means, an axle rotated by said power means, a circular gear supported on the base concentrically of said axle, a plurality of assembly receiving arms extending radially from said axle, means supporting said arms for rotation with said axle, said means permitting rotation of said arms about their own radii, a gear on each arm and fixed thereto, said gears meshing with the circular gear, whereby upon rotation of the axle relative displacement between said gears and said circular gear will cause said arms to be rotated about their axes as they are rotated about said axle.

LAWRENCE M. PERSONS.