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Grossman

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[54] **CYCLIC TEST APPARATUS**

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[52] **U.S. Cl.** ..... **73/150 R;** 73/432 SD

[51] **Int. Cl.** **G01n 17/00**

[58] **Field of Search** ..... 73/150, 159, 432 SD

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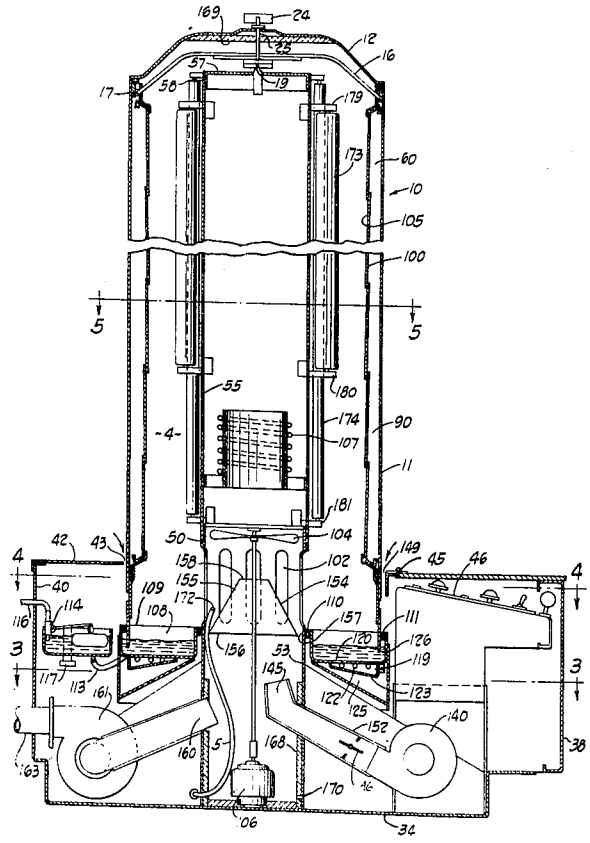
Primary Examiner—S. Clement Swisher

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[57] **ABSTRACT**

Apparatus for simulating the effects of extended outdoor weathering on paint, plastics, textiles and other surfaces and samples, including the effects of light, humidity, condensation, heat and/or atmospheric pollutants. The apparatus includes a closed chamber, panel or sample holders inside the chamber and around the outside wall and partially isolating the space between the sample and the outside wall to maintain the temperature therein below, but close to, the chamber interior temperature and above the ambient temperature outside the wall while having what is functionally the same moisture and pollutant content throughout the chamber, including the partially isolated space. The apparatus also includes a water vaporizer in the chamber to provide "humidity", a central stack, a fan for circulating the atmosphere within the chamber to keep it uniform, a rotor rotating the chamber to mitigate against the effect of variations in external conditions, a water seal at the bottom of the chamber to return condensate collecting on the samples and housing to the vaporizer, a heater to prevent condensation on the central stack, fans for forcing air into and drawing moisture-laden air out of the chamber, the latter to remove excess moisture from the chamber beyond the capacity of the condensation process, and insulation, heater and structure to prevent condensation about the chamber exteriorly thereof and at the atmospheric interface with ambient temperature and ambient atmosphere.

48 Claims, 9 Drawing Figures



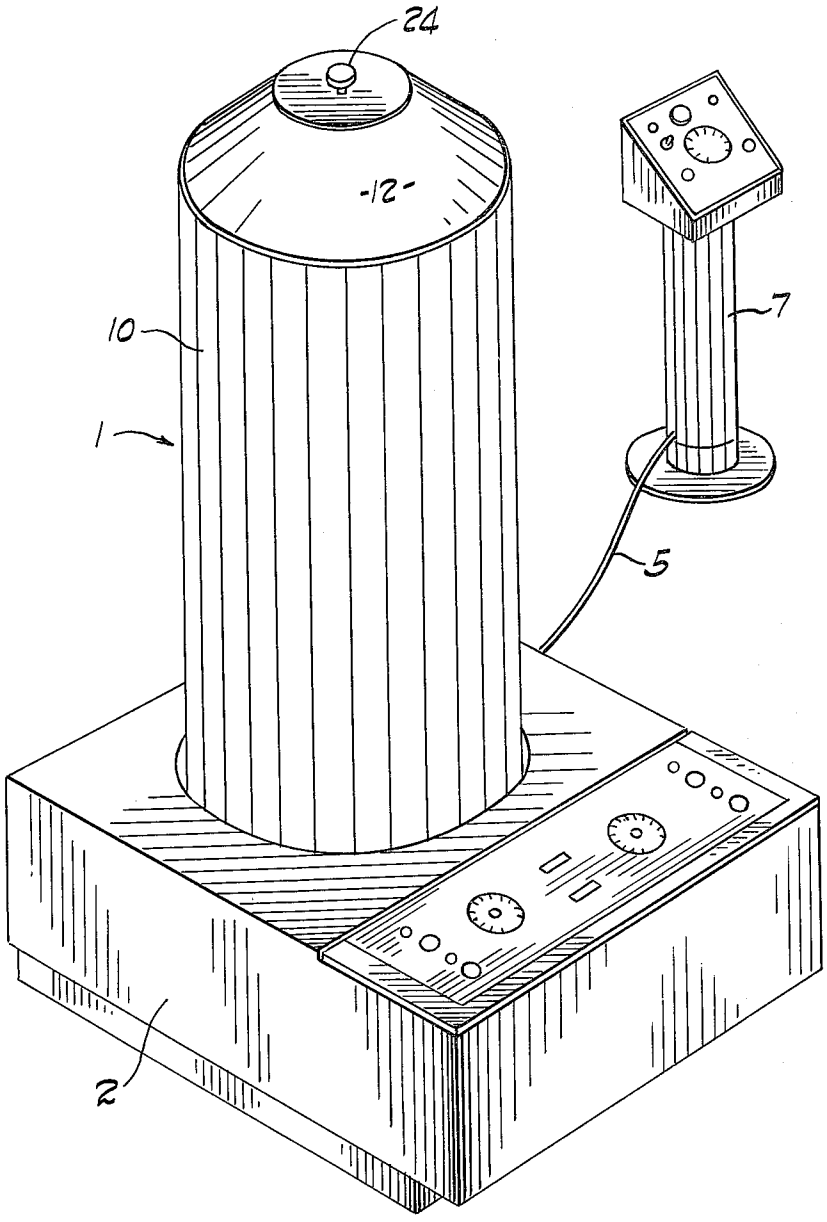


Fig. 1

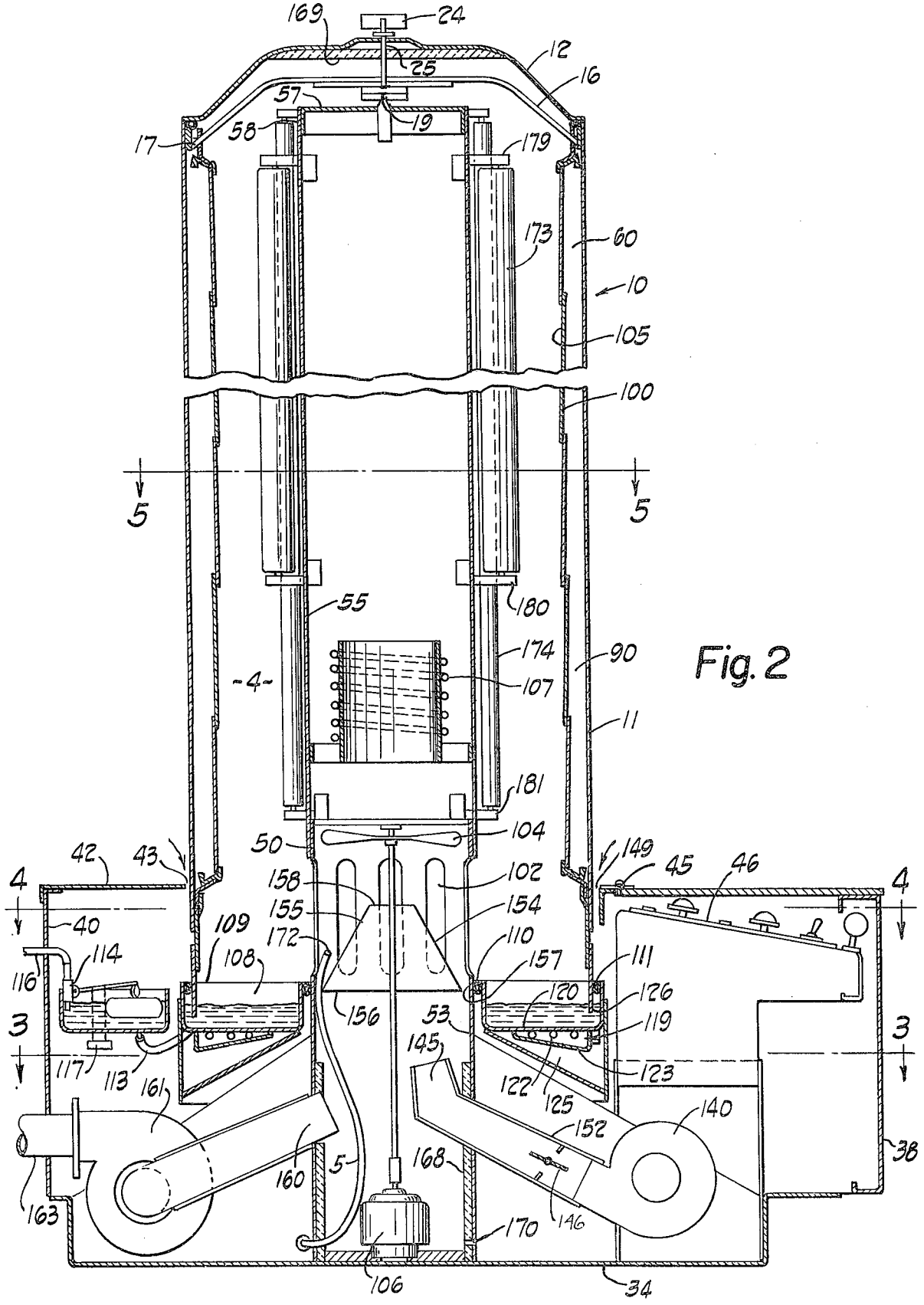

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Fig. 2

Fig. 3

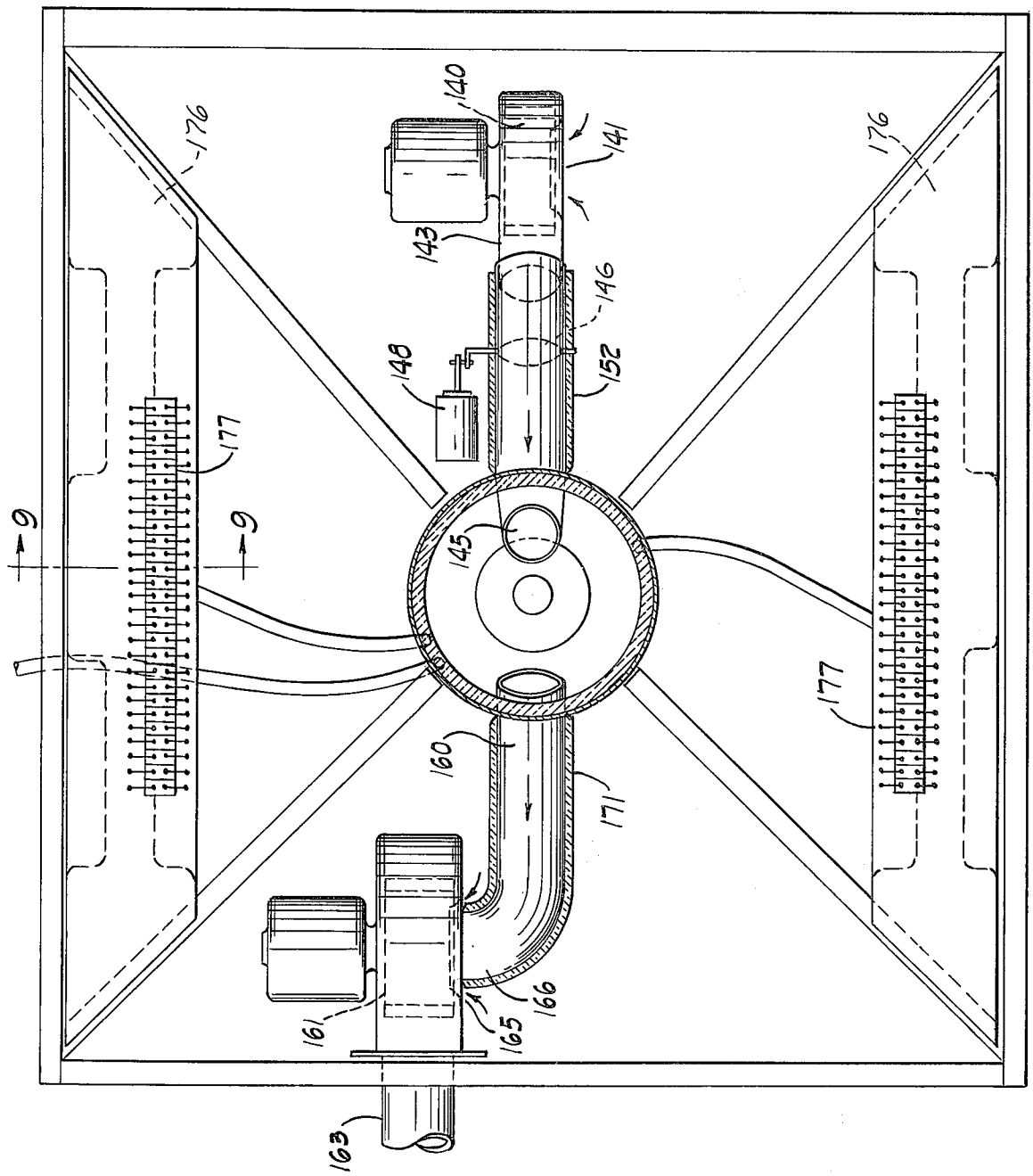
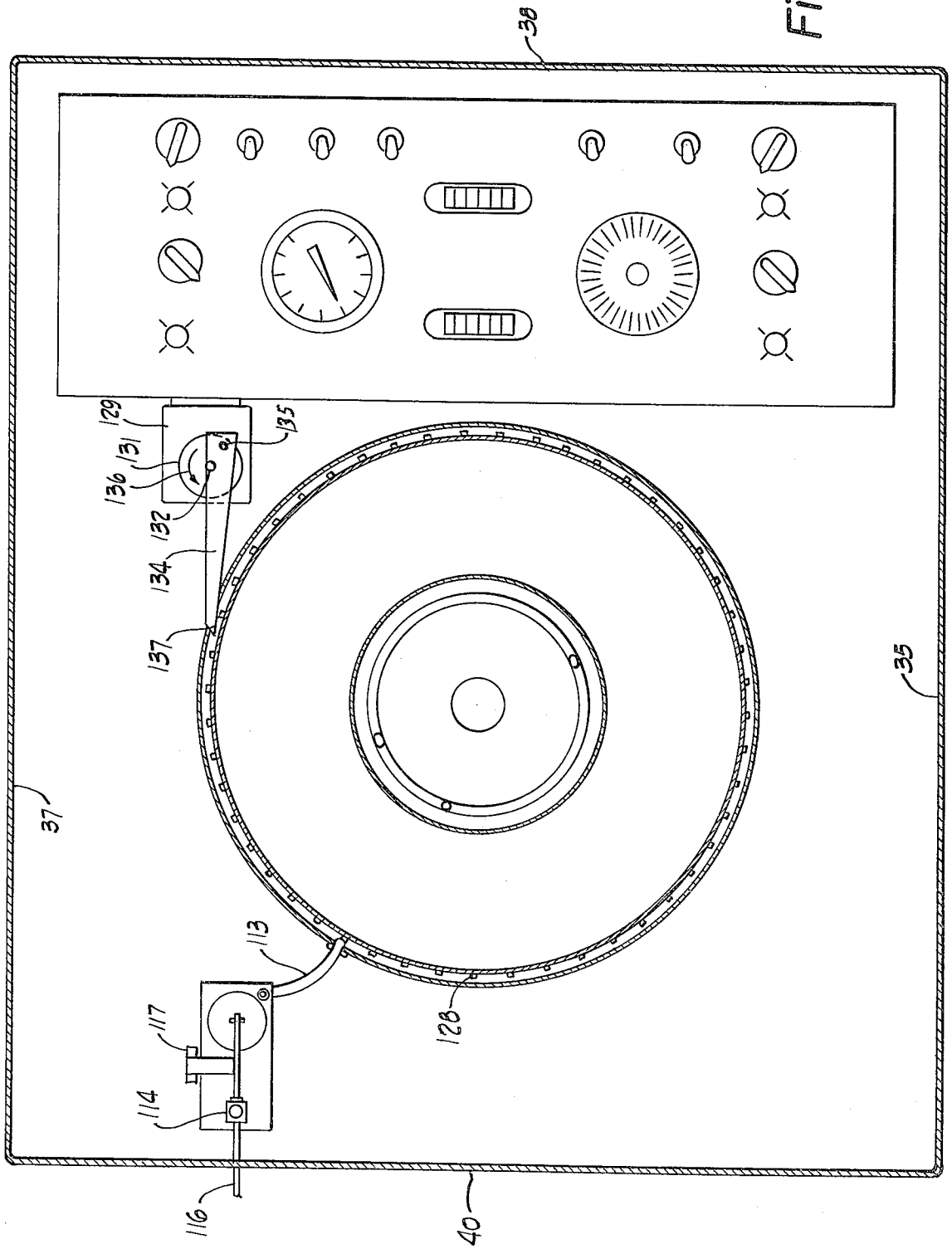


Fig. 4



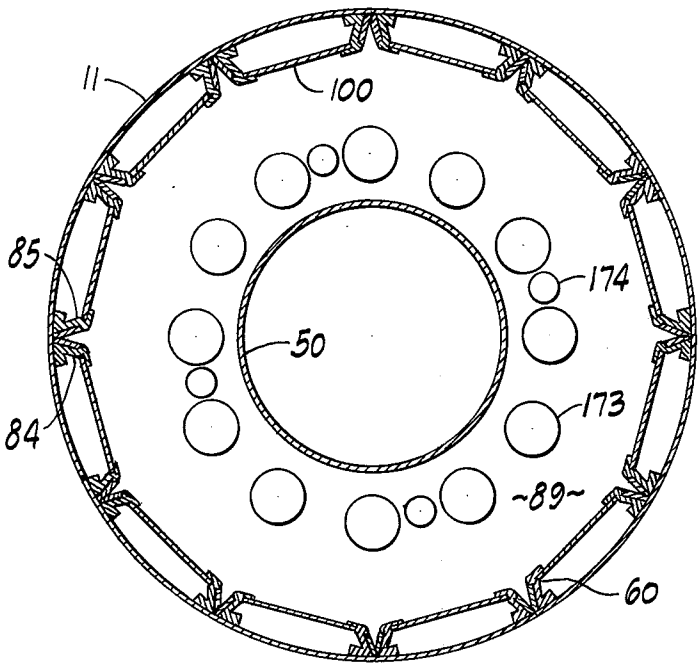


Fig. 5

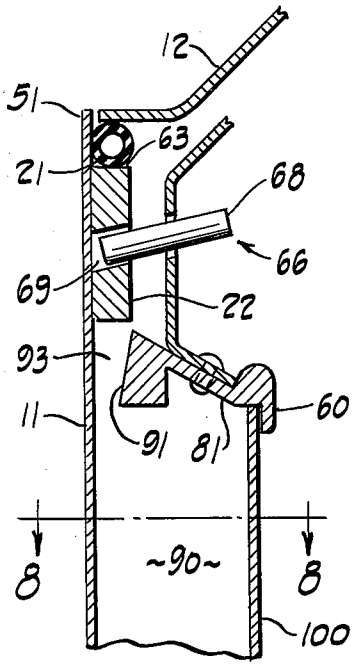


Fig. 6

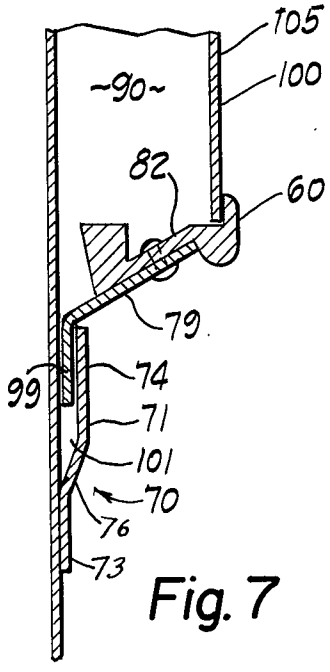


Fig. 7

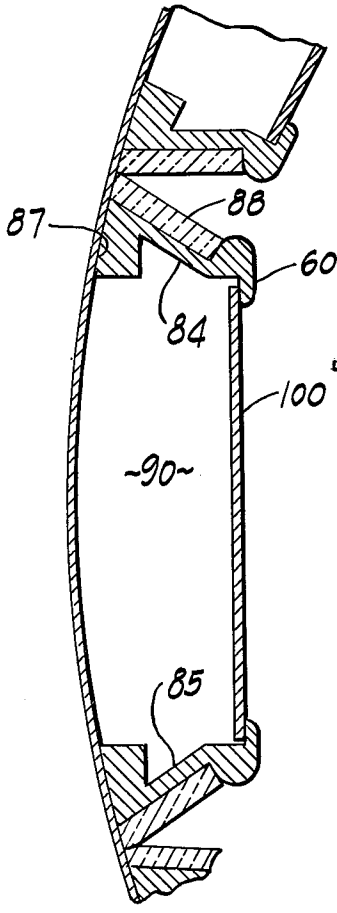


Fig. 8

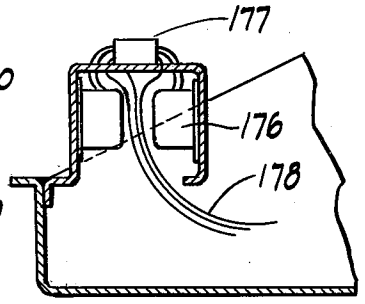


Fig. 9

CYCLIC TEST APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to testing apparatus or chambers for paints, plastics, textiles, and other coatings and materials and, more particularly, to such apparatus or chambers for simulating, cyclically, the effects of the natural or outdoor environment on the test subject matter including heat, sun, moisture, and/or noxious gases and other pollutants.

2. Description of the Prior Art

Throughout the years, there has been a continuing need for laboratory environmental test chambers or apparatus to simulate and accelerate the deteriorating forces of the weather on outdoor structures. This invention relates to the type of laboratory weathering apparatus wherein the deteriorating forces of sunlight, wetness, and gas contaminations in the atmosphere are simulated. The materials which are commonly evaluated in such apparatus include such items as paints, plastic materials, metals and textiles. The materials to be evaluated are usually made up as test panels or samples in such a manner that in-service conditions are simulated and full scale performance can be predicted.

There are many complex interactions of the many deteriorating forces which are present in the "weather", and the projections of "in-service" performance from the performance of laboratory test apparatus are frequently inaccurate and sometimes misleading. Sometimes the inaccurate projections of full scale "in-service" performance come about from the failure of the laboratory test apparatus itself to properly simulate the mechanisms of deterioration that are actually present in an outdoor environment.

Many devices have been suggested for use as laboratory environmental test chambers or apparatus, but none has proven entirely reliable. Typical of such prior art devices is the so-called Standard Oil Ultra-Violet or Golden Gate Cabinet, wherein the test panel or sample is mounted within a cabinet and exposed to ultraviolet rays from a suitable light source, such as a fluorescent or germicidal lamp, or the like, which is operated continuously during the test or cyclically on a predetermined cycle.

Another form of prior art environmental test apparatus is typified by the Cleveland Condensing Humidity Cabinet. In this apparatus the test panel or sample forms part of the wall of the test chamber. Condensation is caused to form on the interior or test side or surface of the test panel by heating a water source or supply within the cabinet to create a high humidity and elevated temperature within the cabinet. The condensation forms because of the temperture gradient between the elevated temperature within the cabinet and the ambient temperature without the cabinet, as it exists at the interface defined by the test surface. Again, the humidity and heat can be cycled with dry periods to cause alternate periods of condensate formation.

This type of apparatus in which the water is transported to the test surface by condensation provides a good simulation of the water transport mechanism occurring outdoors in nature. Also, a high temperature can be maintained on the test surface in such apparatus, thereby accelerating the deteriorating forces of wetness. However, since the back side of the panel in such apparatus is exposed to low moisture content

room air, there is usually a moisture gradient through the substrate that is often not representative of the conditions that prevail in nature relative to structures standing outdoors, such as automobiles, lawn furniture, utility buildings, and the like. This is a particular problem where the substrate is wood, where high moisture content through the entire thickness of wood provides high mechanical expansion forces on the wood which must be resisted by the coating on the wood.

Apparatus combining the effects of both ultraviolet and condensation exposure has also been proposed and made available commercially. In this type of apparatus, light and condensation exposure may be continuous or cycled and may be alternate, simultaneous, or part and part, as desired by the user. This permits simulation of the alternate periods of daylight, with heat and ultraviolet rays, and darkness, with cooling and condensation of moisture on the surface, found in nature.

In existing controlled condensation test apparatus, fans are frequently used to stir up the air to obtain uniformity of the temperatures at the test surface. However, the air currents and localized velocities at the test surface are frequently nonuniform, causing undesirable variations in the condensation rate which, in turn, give variations in the performance of the test surfaces.

Apparatus, in which the entire test panel or sample is mounted within the cabinet and the temperature gradient is obtained by cooling one side thereof, as with a water spray, to induce condensate from a high humidity atmosphere, are also known in the art.

This makes for a low rate of acceleration of the deteriorating forces of wetness due to the low temperature at the test surface. Such spray systems frequently cause abnormal spotting on the test surface, indicating some fault in the method used to simulate actual service conditions.

Other conventional test cabinets or apparatus, also, frequently provide sprays of cold water to simulate rainfall or dew. The water in such apparatus may be distilled or deionized and also is frequently treated to include entrapped air. All of this requires a complicated mechanical system, besides giving inaccurate results because spray and condensation do not have the same effect. Further, cold water sprays cool the test surface, excessively, relative to the cooling effect of condensation, thereby affecting test results.

Also known in the art is apparatus in which humidity or wetness is introduced on the test surface by cooling the sample, on one side, by pipes with coolant therein, but such apparatus also has proven deficient for many of the reasons noted above.

Still other existing apparatus for simulating wetness deteriorating forces comprises structure by which test panels are hung in a high humidity room, which does not, however, include means to control condensation. For example, some such panels might "see" a cold wall, while others do not. Another example is the opening and closing of the access doors of the test chamber, whereby some panels located near the access door cool down and collect abnormal amounts of condensation and other panels in some other location, which are not so cooled, have little or no condensation. In other words, such rooms fail to provide a uniformity of test conditions.

As indicated above, existing test apparatus commonly uses elevated temperatures to accelerate the deteriorating forces of light and/or wetness exposure.

Such apparatus is inadequate and creates problems regarding its functioning and results because the temperatures therein are not uniform throughout the apparatus, especially at the various test surfaces and, thus, the results are not uniform and the tests are not accurate. For example, in high intensity arc sunlight simulators the radiant energy levels are quite high and test panels which are black operate at higher temperatures than lighter colored panels that have a lower radiation emmissivity.

All of the above described apparatus seeks to simulate, in a relatively short exposure, the effects on the test surface or sample of a long exposure outdoors in nature.

It is important to note that it is the effects of the weather for which simulation is sought, not the natural cyclic weather and weather conditions of nature.

But such correlation of effects has proven difficult to obtain. One reason for this is that nature, for all its order, varies infinitely and differently from place to place, time to time, and year to year, with "averages" being only that, and not determinative of a factual situation or indicative of the extremes. A second reason is the failure to adequately simulate or even to recognize the need to simulate the effect of gases and other pollutants. Still another reason is that the control of the conditions within the prior art test chambers has been inadequate relative to meaningful simulation and relative to providing uniform conditions within the entire test chamber and for each test panel or sample being tested therein at any given time.

This has frequently resulted in non-uniform exposure in a single test to effects of the dry and/or light exposure and the wet or humidity exposure where either or both such conditions are provided, whether such exposure is continuous or cyclic as available in the prior art devices and explained above.

Existing laboratory test chambers that add gas contaminants to the inside of the test chamber frequently have large throughputs of gas into and out of the chamber, requiring excessive flows of contaminant gas. Gas flow control is complex and expensive, costly sealing systems are required, and there are extensive requirements for safely venting the system. Therefore, such apparatus has not been widely accepted or found useful in a total effect system or testing apparatus of the type under consideration.

SUMMARY OF INVENTION

It is, therefore, a general object of this invention to provide a new and improved testing apparatus for paints, plastics, textiles and other coatings and materials which provides new, improved and better correlation between the effects of natural weathering and exposure in the test apparatus.

Another object of this invention is to provide a new and improved testing apparatus for paints, plastics, textiles and other coatings and materials which simulates the effects of natural environmental conditions, including moisture, dew, sunlight and/or atmosphere pollution factors, as predetermined by the desired test procedures on a cyclic basis.

Still another object of this invention is to provide a new and improved testing apparatus for paints, plastics, textiles and other coatings and materials which simulates the effects of natural environmental conditions, including moisture, dew, sunlight and/or atmosphere pollution factors, as predetermined by the desired test procedures on a cyclic basis, in which the test surface of the test panel or sample is contained entirely within a test chamber having a controlled atmosphere, so that both or all sides of the test panel or sample are subjected to the same "atmospheric conditions" of predetermined humidity and/or air/gas mixture, whereby the moisture and/or contaminants, pollutants or test gas permeate the test panel or sample in a manner closely simulating many factual situations obtained in natural exposure; in which there is a uniform and consistent flow of "atmosphere" air and contained gas, water vapor (humidity) through the test chamber so that conditions and concentration of gas and/or humidity are uniform throughout the chamber and on all test panels, surfaces and samples during both wet or humidity and dry or light cycles, in which the light energy, if any, has improved control and distribution to provide uniform exposure to all test surfaces to be so exposed within the chamber during the light, or ultraviolet cycle; and in which the "dew" effect is obtained at elevated temperature.

Still further objects of this invention include the provision of a new and improved testing apparatus for paints, plastics, textiles and other coatings and materials which simulates the effects of natural environmental conditions, including moisture, dew, sunlight and/or atmosphere pollution factors, as predetermined by the desired test procedures on a cyclic basis which is efficient in operation; which is economical to manufacture and use; which is easily operated; which has a "sealed" chamber whereby dripping and other moisture formation is prevented exteriorly of or from the test chamber because of the interface between the high humidity, high temperature atmosphere within the test chamber and the low temperature outside air, both from the test surface, per se, and from other surfaces within the chamber or necessary to its construction; which includes means to vent the high humidity, high temperature test atmosphere exteriorly of the test chamber without causing condensation or water formation on or about the outside of the test apparatus; which obtains all heat during the wet or condensation cycle from the water surface of the vaporizer; which includes a closed or sealed testing chamber having means whereby excess water vapor is or may be vented therefrom during the wet or condensation cycle; which can simulate the harsher or more deleterious effect of gases and pollutants dissolved in static water (dew) over such gases, per se, of in running or flowing water; which provides means for maintaining the temperature of the test surface during condensation, at an elevated temperature, within a few degrees (two or three) of the controlled temperature within the test chamber, while utilizing the ambient room temperature to provide the temperature gradient necessary for condensation; which includes means, medial of the test apparatus, facilitating recycling and uniform distribution of the heat, moisture (humidity) and gaseous content of the atmosphere within the test chamber over and in functional contact with the surfaces and/or panels or samples being tested; and which includes means for minimizing or mitigating against the effects of external conditions on the test samples and test programs by ensuring equal "exposure" thereto.

Other objects of this invention include the provision of a new and improved testing apparatus for paints,

plastics, textiles and other coatings and materials which has a closed testing chamber, water vaporizing means for creating a high temperature 100 percent humidity condition in the test chamber and means to cool the test surfaces or samples within the test chamber to cause condensation thereon and which includes means whereby excess humidity or moisture beyond the condensation capacity of the system may be exhausted or removed, during the wet cycle, from the system without reducing moisture content below that necessary for humidity saturation and condensation on the interior surfaces, including test surfaces, representing the effective interface(s) with the outside ambient temperatures; to provide such a test apparatus which exhausts such excess moisture from the apparatus without condensing it at the ambient temperature interface at the point of exhaust; and to provide such a test apparatus which has a thermal seal, but not a moisture or atmosphere seal.

Still another object of this invention is to provide a new and improved testing apparatus for paints, plastics, textiles and other coatings and materials obtaining one or more of the objects and advantages set forth herein.

These and other objects and advantages of this invention will become apparent from the following description of preferred forms thereof, reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a testing apparatus embodying a preferred form of this invention;

FIG. **2** is a broken, vertical sectional view of the apparatus shown in FIG. **1** taken along the fore and aft centerline thereof;

FIG. **3** is a horizontal sectional view, on an enlarged scale, of the apparatus shown in FIG. **1** taken along the line **3—3** of FIG. **2**;

FIG. **4** is a horizontal sectional view, on an enlarged scale, of the apparatus shown in FIG. **1** taken along the line **4—4** of FIG. **2**;

FIG. **5** is a horizontal sectional view, on an enlarged scale, of the apparatus shown in FIG. **1** taken along the line **5—5** of FIG. **2**;

FIG. **6** is a broken vertical sectional view, on an even larger scale than FIG. **2**, showing the panel-holding and top structure of the apparatus of FIG. **1**;

FIG. **7** is a broken vertical, sectional view, on the same scale as FIG. **6**, of the bottom structure of the panel-holder of the apparatus shown in FIG. **1**;

FIG. **8** is a horizontal sectional view of the apparatus shown in FIG. **1**, taken along the line **8—8** of FIG. **6**; and

FIG. **9** is a broken sectional view taken along the line **9—9** of FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Briefly, this invention comprises a chamber in which test panels, samples, and the like, are mounted for exposure to predetermined conditions of light, heat, moisture and atmosphere, including gaseous pollutants, in predetermined cycles to determine, on an accelerated basis, the effect that natural weathering conditions will have on the material being tested.

The apparatus may also be used for testing the effects of predetermined conditions, such as gases or other pollutants, and the like, per se, on the test material.

The apparatus comprises a test chamber sealed against uncontrolled entry or leakage of "atmosphere", a central light source, supports for test panels, means to introduce and circulate moisture, as water vapor (humidity), and test gases into the chamber, means to control the temperature within the chamber and means whereby the test panels are subjected to the same or substantially the same atmospheric conditions relative to humidity and gas exposure on both sides, and means to provide a temperature differential at the test surface whereby condensation is induced thereon. The chamber is rotatable and the panels are so mounted and held relative to the chamber, the light source and outside conditions that the exposure will be uniform for all test surfaces.

More particularly, apparatus embodying a preferred form of this invention is indicated generally at **1**, FIG. **1**, and includes a base member **2**, a test chamber **4**, FIG. **2**, and preferably, a tube or conduit **5** by which a source of test gas, such as apparatus **7**, may be interconnected therewith.

In order to obtain the objects and advantages of this invention, test chamber **4** is defined by an enclosure, or housing, indicated generally at **10**, FIG. **1**, which is adapted to be sealed against all but controlled communication with the atmosphere, room or space surrounding the test apparatus, including, particularly, the time during which the apparatus is used for testing purposes.

To this end, housing **10** includes an exterior, lateral wall **11** which is imperforate and preferably circular in configuration, but may take other desired shapes, such as, for example, polygonal, consistent with the objects and advantages of this invention.

Housing **10** also includes a top or cover **12** which is supported in detachable sealing engagement with the housing wall **11**, by means to be hereinafter more fully described.

Enclosure **10** is supported on and for rotation relative to the base **2** by means of spiderlike support structure **16**, FIG. **2**, having its respective ends **17** secured, as by welding, at spaced intervals to the side **11** and its center rotatably supported on a fixed pivot point **19** carried on and by the base **2**, so that the enclosure **10** can be rotated by means to be more fully described below.

The cover **12** is held in position against a gasket **21** carried on a support **22** secured on the wall **11**, when the test chamber is in use, by means of a knob **24** coacting with the threaded post **25** carried on spider **16**. The cover **12** is easily removed to provide access to the test chamber **4** by unscrewing knob **24**.

Base **2** is adapted to support the test chamber, for rotation about the central axis thereof, to house the components by which the environmental conditions are produced and to support a control panel by which the test conditions can be determined, programed and controlled.

To this end, base **2** is conveniently rectilinear in shape and comprises a base or base plate **34**, FIGS. **2** and **4**, sides **35** and **37**, respectively, front **38**, back **40** and a top member **42** having an aperture **43**. Aperture **43** is complementary in shape to the side **11** of enclosure **10**, and has a free fit therewith so as to permit relative rotation and, preferably, of sufficient size to permit free flow of air past the side **11** and into the interior of the base **2** and for the purposes to be hereinafter more fully described.

The top 42 also preferably includes a hinged portion 45, which is preferably transparent, i.e., glass or clear plastic, forwardly of the aperture 43, to provide access to a control panel 46 mounted within the base 2, which access may be selectively locked or secured by conventional means, not shown, to prevent tampering with the controls during operation of the test chamber. Alternatively, the top 42 can be so apertured and constructed that the control console is mounted therein or thereon, and is directly accessible to the user.

In order to support the enclosure 10, and provide means by which the desired test conditions can be introduced and maintained, as programmed, within the test chamber 4, base 2 includes a central support member, column, conduit or stack 50, FIG. 2, mounted on the base or bottom plate 34 and extending upwardly therefrom through and centrally of aperture 43 and terminating at a height substantially equal, within the precepts of this invention as discussed herein, with the top 51 of chamber side 11.

Stack 50 may be of unitary construction or, preferably, as shown, includes a lower member or portion 53 of any desired shape and an upper member portion 55, carried on member 53, and of cylindrical shape complementary to and centrally located within the side 11 of housing 10.

To facilitate manufacture, maintenance and repair, column members 53 and 55 may have a male and female or bayonet joint, as shown.

A spider, rod, or bracket, 57 mounted on the upper end 58 of stack 50 carries and supports the pivot point 19 on the axis of the enclosure 10 without blocking flow of gases upward and out of the stack 50.

Stack 50 is of sufficient strength and rigidity to ensure a proper alignment of the pivot point 19 on the axis of the housing 10 during rotation of the housing 10, both to prevent binding between the parts, and, more important, to ensure uniform distribution of the test conditions relative to the test panels during operation of the apparatus.

The chamber 4 also includes means to ensure that the panels, samples or test surfaces are disposed so as to have "equal" exposure to the test conditions within chamber while providing means whereby a temperature gradient is preserved across the sample with an interface at the test surface while ensuring substantially uniform humidity and "atmosphere" or gas conditions on both the back and front (all sides) of the test sample.

To this end, the interior of the wall 11 of housing 10 is provided with a plurality of panel holders 60, see FIGS. 2, 5, 6 and 7, preferably disposed in vertical rows and entirely covering the inside of wall 11 so as to provide a uniform distribution of holders within the chamber 4. The holders 60 are so mounted and so constructed that the samples or test panels are disposed evenly about the interior of wall 11 and equidistant from the axis of the chamber 4 and the stack 50 so that the test conditions are and can be made uniform with respect thereto in accordance with the precepts of this invention.

Further, the holders preferably are removable so that the samples can be mounted thereon and then the holder can be inserted and positioned within the chamber easily, through the top thereof.

In addition, the panel mounting means, or holders, includes structure whereby the panels or samples are spaced a predetermined distance from the interior of the wall 11 and the space between the panels or samples and the housing or wall is radially isolated, temperaturewise, from the chamber interiorly of the panels or samples. This is to effect the purposes to be explained more fully hereinafter, while permitting flow of the chamber atmosphere within the space so as to provide substantially equal, within the concepts of this invention, conditions of humidity, pollution or gas contamination, and the like, on both sides of the test panel or sample. Further, the isolation of temperature is only partial, thereby ensuring, on the one hand, that the sample is at an elevated temperature during the wet or condensation cycle and the test surface is subjected to condensation while at a high temperature, within only a very few, two or three or so, degress of the air or vapor temperature within the chamber 4 intermediate the stack 50 and the test panels or samples, and, on the other hand, that there is a sufficient temperature gradient, due to ambient temperature or factors only, to provide condensation.

To this end, the upper end 51 of wall 11 is provided with interior means for supporting the panel holders 60 which means also conveniently supports or provides means for ensuring a sealing engagement between the cover 12 and wall 11. More particularly, a flange, ledge, circumferential band, ring, or the like, 22 is mounted within the wall 11 near the top thereof. The flange 22 includes a seat 63 upon which a gasket or O-ring, 21 is carried and the seat and gasket are so positioned that the cover 12 will bear down upon the gasket when the knob 24 is tightened onto the post 25.

Flange 22 also includes means, hooks or hangers 66, equally spaced circumferentially about the interior of wall 11 upon which holders 60 may be hung. More particularly, each such hook or hanger 66 preferably comprises a pin or rod 68, held, as by insertion, in an aperture 69 in flange 22.

Pin 68 preferably extends in a slightly upwardly direction from its point of support so that devices, such as holders 60, supported thereon will be urged by gravity against and into contact with the wall 11 to effect the structure, function and result necessary to obtain the objects and advantages of this invention.

The chamber 4 also preferably includes means 70, FIG. 7, remote from the top 51 of wall 11, for coaction with the panel holders 60 to maintain or help maintain the same in position against the interior side of wall 11.

More particularly, such last-named means conveniently and preferably comprises a plurality of clips or brackets 71 equal in number to the number of pins 68 and spaced correspondingly about the interior of wall 11. Brackets 71 are adapted to receive and/or hold a coacting portion of the holder 60 to be retained thereby.

Brackets 71 conveniently comprise a base or lower portion 73, which is secured, as by welding or other means, to the interior of wall 11, an upper or gripping portion 74 and an intermediate angled portion 76 which holds portion 74 in spaced relationship with wall 11 so that a cooperating flange or bayonet 79 on the holder 60 may be received slidably therein with portion 74 functioning, in part, as a spring so that the flange 79 is pressed against wall 11.

Holder 60 comprises an open frame with "solid" sides for holding the test panels or samples on "chords" of wall 11 of the chamber 4, while screening and pro-

tecting the remote or outer side (i.e., side adjacent or nearer the wall **11**) of the sample from the chamber temperature interior of the panels.

To this end, each holder **60** conveniently and preferably includes a top member **81**, a bottom member **82** and two vertically extending side members **84** and **85**, respectively, FIGS. **6**, **7** and **8**.

Each side member **84** and **85** includes a seat portion **87** for engagement, in a relatively sealing manner, with the interior of wall **11** to which end seat **87** conveniently is curved complementary to the side **11** to bear thereagainst, albeit, a seat member providing a line contact can be used, if desired.

Also, side members **84** and **85** preferably have insulation, such as rubber or foam **88**, attached thereto to facilitate and aid in maintaining a temperature differential between the major interior portion **89** of the chamber **4** intermediate the stack **50** and panel holders **60** and the space **90** intermediate the panel or sample and the wall **11**.

The top and bottom members **81** and **82** of holder **60** are adapted to permit gas or atmosphere to flow vertically behind the panels and within the space **90** in the manner and for the purposes to be hereinafter more full explained. This may be accomplished by providing the top and bottom members with a straight, outer, relative to the stack, edge **91** which lies on a chord of the wall **11**, thereby leaving a space **93** between the edge **91** and wall **11** through which flow can occur or by perforating the top and bottom members. Preferably and conveniently, the holders **60** may be formed from a single length of rolled or extruded stock which is cut, mitered and bent, to form a frame comprising the top, bottom and sides of the holder **60**.

In such instance the top, bottom and sides of the holder all have the same cross section and the top and bottom edges **91** are spaced from the wall **11** along a chord thereof as explained above.

The holders **60** also include means **79**, as noted above for coacting with the means **70** at the lower end of the wall **11**. When such means **70** takes the form and structure described above, each holder includes a downwardly extending flange or projection **99** which is of the size to fit within the space **101** between the grip portion **74** of clip **71** and the wall **11**, bayonet fashion.

The panels or samples **100** are held in position on or in the holders **60** by adhesive tape, clips or any other desired means known in the art.

In addition to the means described above for controlling condensation by utilizing the heat flow from the back side of the test panel, it has been found that the heat transfer control to the front side of the panel is also very important.

It is also desirable to overcome any tendencies toward temperature stratification and to provide a "uniform" atmosphere in terms of humidity and pollutant percentage throughout the test chamber **4**, including substantially uniform conditions in the spaces **90**, respectively. To this end, stack **50** is provided with a plurality of apertures **102**, FIG. **2**, adjacent the lowermost, as viewed, end of the chamber **4**. In addition, a fan **104** or other means to move air or gas positively preferably is positioned within the stack and adapted to blow or circulate the air or atmosphere through the stack **50** in a direction away from apertures **102**, upwardly, as viewed. The fan draws air and atmosphere in through the apertures and expelling it at the top end where, in the apparatus depicted, it flows outwardly and then downwardly through the space on intermediate the stack and test surface **105** of the test panels or samples **100** and to a lesser degree through the space **90**.

Fan **104** is driven by any suitable means such as a motor **106** carried on base **34**. If desired, means **107** can also be positioned within the stack **50** to heat the air if the normal process of providing "humidity" and "light" do not provide the desired "atmospheric" temperature within the test chamber. Such means conveniently comprises a conventional resistance heater mounted by suitable means within the stack **50** and above the fan **104** and controlled, if desired, by a suitable thermostat, not shown, responsive to the temperature within the chamber as well as by a suitable on-off switch.

The recirculation volume flow is regulated by the selection of fan speed and fan blade arrangement, so that only sufficient volume flow is maintained to obtain uniformity of temperatures at the test surface. It has been found that with panel configuration shown, very low velocity of vapor-laden gases can be maintained so that the film coefficient of heat transfer is low, thereby permitting the test surface **105** of test panels **100** to operate with a measurable temperature difference below the vapors in the space **89**. This temperature difference is sufficient to let the panel surface drop below the dew point of the gases and condensation of water vapor will be accelerated at the test surface.

If, on the other hand, high recirculation gas or atmosphere velocities are maintained across the test panel surfaces **105**, the total overall heat exchange might be increased to a degree, but the heat transfer mode at the test panel will tend toward convection transfer rather than condensation film transfer, and collection of condensate or dew at the test surface will be nonuniform, and some particular spots where turbulence is higher than the average might get no condensation at all.

When a number of test panels are located in the test chamber **4**, it is important that all panels start to collect dew at the same time after a wet cycle period is started. In other words, all test panels should be subjected to equal deteriorating forces of wetness.

The apparatus **1** also includes means to seal the lower end of the chamber **4**, especially thermally, and to provide water vapor within the chamber. Apparatus **1** also includes means to rotate the housing **10** about its central axis and stack **50** to ensure uniform distribution or exposure of the panels or samples, relative both to any variation in conditions, particularly light sources, which may exist within the chamber, and, more particularly, to ensure that any condition outside the test apparatus, particularly with relation to uneven temperature, or the like, because of a heat source, sun shining on the apparatus, or the like, has its effect on the test mitigated by the constantly changing position of the respective portions of the chamber relative thereto.

To these ends, a pan, container or water reservoir **108** is supported in or on the base **2** at the lower extremity of the housing **10**. Pan **108** is of greater diameter than the outside of diameter of the wall **11** and the top **109** of reservoir **108** is positioned below the apertures **102**. The reservoir **108** is toroid-shaped so as to fit about the lower portion of the stack **50**. Gaskets **110** and **111** provide a seal between the reservoir **108** and the stack **50** and the exterior of wall **11**, respectively, so that the water vapor enters into the chamber **4** and

not into the room or space in which the apparatus is being used. The gaskets **110** and **111** also so serve to center the housing **10** about the axis of the apparatus.

Reservoir **108** is watertight and is in communication via tube **113** with a float-controlled valve **114,** situated at the same level and then via tube or hose **116** with a water source so that a predetermined water level is maintained within the reservoir at all times. Valve **114** also conveniently includes a safety switch **117,** of the mercury or other type, for shutting off the water heater, to be described below, in case the water supply fails.

Means is also provided to heat the water within the reservoir **108** to vaporize the same. Preferably and conveniently such means comprises a resistance heater, indicated generally at **119,** mounted against the bottom **120** of reservoir **108** with the heater strips **122** in direct contact therewith. The heater **119** is shielded against heat loss to the exterior of the apparatus by a housing **123** which is secured to reservoir **108** by suitable means, such as welding, and which may be filled with an insulating material **125,** as shown, if desired.

The water level maintained in the reservoir **108** is sufficient to cover or submerge the lower extremity **126** of wall **11** so that "gases", and the like, within the chamber **4** are sealed against escape around the edge of the wall **11.**

As noted above, apparatus **1** preferably also includes means to rotate the housing **10.**

Such rotation serves to provide a uniformity of heat transfer from all the test panels **100** located around the inside surface of the wall **11.** For example, one side of the housing **10** might be "looking at" a cold window and transmitting heat outwardly at a higher rate than the opposite side of the housing that does not "see" the window or looking at a heater or concentration of heat, such as sunlight, with the opposite effect relative to the rest of the housing. Also, room air convection currents might be more pronounced on one side of housing **10** than the other.

The collection of dew at a steady controlled rate necessarily requires the heat flow, which causes condensation, to be held at a controlled and consistent condition. The rotation of housing **10** ensures that all test panels have a similar heat transfer condition and will, therefore, have a similar temperature condition and a similar dew collection condition.

Such means preferably and conveniently includes a gear ring, rachet, or series of equally spaced projections **128,** FIG. **4,** on the exterior of the wall **11** adjacent the lower end **126** thereof within the base **2,** but above the reservoir **108.** The rotating means also includes a motor **129** mounted within the base **2** in operative relation with the gear ring or projections **128.** A lever arm, disc or wheel **131** is mounted on the shaft **132** of motor **129** and is adapted to be rotated thereby. A rachet arm or lever **134** is pivotally mounted, as at **135,** on the disc or wheel **131** eccentric of the shaft **132** and is adapted to be rotated with wheel **131.** Arm **134** extends from the disc **131** and is in sliding contact with the exterior of wall **11** and is urged against the wall **11** by the rotation of the wheel **131,** which, in the example shown, is counterclockwise, as indicated by the arrow **136.**

The end **137** of rachet arm **134** remote from pivot **135** is adapted to engage a projection on the housing and move the same in a predetermined direction, counterclockwise as shown, as the pivot **135** moves through the arc of the circle toward the housing **10** and to withdraw to be in position for another engagement as the pivot **135** moves in an arc away from the housing **10.** In other words, the movement of the housing **10** is a step-by-step process with the housing advancing during the time the rotation of the disc **131** advances the pivot **135** in the direction in which housing is to move and standing still at other times.

Apparatus **1** also includes means for controlling the volume and nature of the atmosphere including the quantity of water vapor within the chamber **4** while preventing uncontrolled leakage of air therein or atmosphere therefrom and for drying the panels or samples after the wet or dew cycle, especially when the wet cycle is alternated with a light or ultra-violet cycle.

In a laboratory test exposure, all panels in the test chamber **4** should dry off uniformly, so that time of wetness and time of dryness are closely controlled because these are important variables in evaluating one type of material against another type of material. Such drying is conveniently and preferably accomplished by introducing low moisture content room air into the chamber **4.**

To this end, the apparatus **1** is provided with a motor-driven fan **140,** FIGS. **2** and **3,** having an intake **141** exposed to the air surrounding the apparatus and an exhaust or outflow duct **143** opening as at **145** within the lower end **53** of stack **50** and, preferably, directed toward the opposite end, upwardly, as viewed, of said stack whereby fresh or outside air may be selectively directed into the test chamber **4** to change the "nature" composition of the atmosphere therein, as, for example, to replace the humid air after the wet cycle is terminated and the light and/or dry cycle is to begin. Duct **143** preferably includes a vane **146,** controlled by a solonoid **148,** to prevent air entering the chamber **4,** except when the fan **140** is operating so as to preclude condensation in the duct or about the fan because of an interface between the atmosphere within the test chamber and conduit and without the apparatus.

Also, during the drying cycle, the moisture generating capability of the vaporizing water in reservoir **108** is reduced by turning off water heater **119,** heat is added to the recycled air and fresh air stream and heater **107** and by the lights, as described below, if in use.

Further, in order to ensure that the wall **11** is cooled at its lower extremities to counteract the effect of end **126** being in the heated water in reservoir **107,** the intake of fan **140** may be simply open into the interior of base **2** and the air may be drawn by the fan **140** thereunto through a space **149** provided by making the diameter of the aperture or opening **43** in the top **42** of base **2** slightly greater than the outside diameter of the wall **11,** so that the air flows as indicated by the arrows in FIG. **2.** Further, the opening **145** of duct **143** is preferably narrowed a bit to create a jet effect so as to ensure that air being blown or forced into the apparatus by the fan **140** is directed into and enters the test chamber recirculation system described above and powered by fan **104.**

Also, in order to further obviate the possibility of condensation at an undesired interface between the ambient and chamber atmosphere, means, such as electrical conventional resistance heaters **152,** controlled by suitable controls and switches, not shown, may be provided, as by wrapping around the duct **143.**

The means for controlling the atmosphere within the test chamber also includes means as noted above for removing or exhausting excess humidity of water vapor from the test chamber which is produced by the water evaporation, but is beyond the condensation capacity of the system.

More particularly, during the wet cycle, moisture is evaporated from the surface of the water in reservoir **108** due to heat applied to the water by heater **119.** The test panel **100** and all of the inside walls of the test chamber become wet with condensate (or dew). Additional water vapor is generated, beyond the capacity of these surfaces to condense water vapor, and this must be vented from the chamber. Water vapor is lighter than the air it eventually mixes with, and, therefore, it tends to have higher concentrations in the top of the chamber. Conversely, water vapor content tends to be lowest in the bottom of the chamber. Placement of the vent discharge at the lowermost point in the chamber will confine the losses to only those which are in excess of the vapor condensation capability of the entire chamber. Since the test chamber is essentially at 100 percent relative humidity during the wet cycle, there is a specific concentration of water vapor and air for each temperature level. For example, at 100°F., the saturated mixture of air and water vapor contains 0.043 lb. of water vapor for each pound of dry air. At 130°F., the saturated mixture of air and water vapor contains 0.110 lb. of water vapor for each pound of dry air. The water vapor which vents from the unit, because it is in excess of the condensation capability of the test chamber, always carries with it the corresponding ratio of air. This air then must be replaced by an incoming flow of new air.

For example, at 100°F., the venting rate was measured and found to be as low as one chamber volume every 1.6 minutes. At 130°F., in spite of the fact that the vent stream has an appreciably higher moisture content, the venting rate was still in the same range of a chamber volume every 1.6 minutes. This low volume of venting flow, together with the uniformity in the amount as temperature is varied, provides for ease of gas control of gas additions to the test chamber. Such gas additions are frequently made by apparatus to be hereafter more fully described in the test chamber to simulate the deteriorating forces of industrial atmospheres on test surfaces.

In order to exhaust the excess water vapor during the wet (or dew) cycle and to provide means for safely exhausting any test atmosphere containing noxious gases or pollutants, in accordance with these purposes and objects, the apparatus **1** includes diffusion means disposed in the stack **50** below the lowermost portions of chamber **4,** and, more important, below or more remote from the panels **100** than the apertures **102.**

Preferably and conveniently, such means includes a baffle or similar structure **154** mounted or carried within the stack **50.** Baffle **154** is disposed so as to substantially, but not entirely, block the passageway within stack **50** and immediately below apertures **102** so that only a slight flow can occur through the apertures and down the stack.

In addition, baffle **154** is preferably adapted to facilitate and aid recirculation of the test atmosphere within the chamber by directing gas flow passing through the apertures to the intake side of fan **104,** and also aids drying of the test panels or surfaces when the wet cycle is off by directing air drawn in through duct **143** into the recirculating system, by directing the same into the intake side of fan **104.**

To this end, baffle **154** preferably comprises a truncated, hollow conical member having a side wall **155** disposed laterally inwardly of the apertures, with the bottom **156** thereof being in close, but spaced, proximity with the wall **157** of stack **50** just below the apertures **102** and the top having a central aperture **158** through which incoming gas is directed toward and can reach the intake side of fan **104** with minimal admixture with the test atmosphere prior to so doing.

The exhaust means also includes an exhaust duct **160,** leading from the lower end **53** of stack **50,** an exhaust fan **161** having its intake side connected with the exhaust duct and its exhaust side connected to a further duct **163** which leads to any convenient location external of the apparatus, care being taken, when noxious test gases are being used, to ensure that duct **163** does not lead to a confined space or other area where injury may be caused to workers or others.

All of the venting flow from the test chamber passes into the lower end **53** of stack **50,** then passes into duct **160,** to the inlet of vent fan **161,** and then is discharged through conduit **163.** During the wetness-simulating cycle, fan **140** is not in service and damper or vane **146** is closed. The entire test chamber is thereby maintained at sub-atmospheric pressure, so that none of the contained gases and vapors will get out into the room, even if there is a malfunction of some of the seals. During the dry cycle, when fan **140** is operating and damper **146** is open, the test chamber is also held at sub-atmospheric pressure by the proper sizing of opening or nozzle **145,** as compared to the capacity of vent or exhaust fan **161.**

The exhaust means also includes means whereby the hot moisture-laden gases within the test apparatus may be exhausted to the outside atmosphere without causing moisture formation at the outlet of the exhaust duct **163** or adjacent the test apparatus. To this end, the inlet of fan **161** is also arranged with an annular flow inlet **165,** FIG. **3,** around the discharge end **166** of duct **160.** Into this annular fan inlet, there is a flow of air from inside the base **2.** This air comes into the base through the space or opening **149** and thus the exhaust action, even more than the intake action, helps to lower the temperature of the wall **11** adjacent the reservoir during the wet cycle when the water is being heated. This also holds the interior of base **2** at sub-atmospheric pressure to further ensure against any losses of vapors or gases to the surrounding room.

To further protect against unwanted condensation, the interior of lower end **53** of stack **50** is preferably covered with insulating material **168,** FIG. **2,** as preferably is, also, the under or inner side of cover **12** as at **169.**

Further, a vent **170** is preferably provided in lower end of **53** so that air may be drawn from base **2** into the lower end during the operation of exhaust fan. Such air would be room air and "dry", thereby helping reduce the relative humidity so as to aid in preventing unwanted condensation in this area.

Stack **50,** where it passes through reservoir **108,** is in contact with the highest temperature point in the system. Water vapors issuing from the higher temperature water surface, mix with recirculated air at a lower temperature. Therefore, the surface of stack or conduit **50**

in the immediate vicinity of reservoir **108** is always above the dew point and condensation does not occur. To further enhance this situation, the insulation **125** under reservoir **108** is reduced on its inside circle to provide additional heating of the central space below the reservoir to further ensure against undesirable condensation.

Further, like the intake duct **143,** exhaust duct **160** can be provided with heating means, such as electrical resistance heater **171,** FIG. **3,** to ensure that the temperature of the gases being educted are above the dew point.

Pollutants and other test gas and contaminates are also added to test atmosphere by being introduced into the apparatus just upstream of the circulating fan **104.**

Conveniently, this is done by means of tube **5** being disposed with an open end **172** in the stack **50** above the bottom **156** of baffle wall **155.**

Finally, a plurality of lights or bulbs **173** is mounted within chamber **4** upon the exterior side of stack or conduit **50** to provide a source of ultra-violet, or other rays, as desired. Lights **173** are equi-angularly spaced about the stack or conduit **50** to ensure equal distribution, relative to the test panels **100.** Lights **173** may all be the same or, as shown, alternate or equally spaced bulbs **174** may be of a different type to improve or vary the effect of the light exposure or ultra-violet cycle.

When bulbs or tubes **173** and **174** are of the fluorescent or arc type, the necessary ballasts **176** are conveniently disposed within the base **2,** FIGS. **3** and **9,** together with terminal boards **177** from which wires **178** head up the stack **50** to the sockets **179, 180** and **181,** as the case may be, FIG. **2.**

In addition, by correlating heater **107** and heater **119** the humidity can be controlled, if desired. For example, a humidistat could be used to actuate heater **119** when more humidity was called for and to deactuate **119** and actuate **107** to raise the temperature if a lower humidity is desired.

Modifications, changes and improvements to the preferred forms of the invention herein disclosed, described and illustrated may occur to those skilled in the art who come to understand the principles and precepts thereof. Accordingly, the scope of the patent to be issued hereon should not be limited to the particular embodiments of the invention set forth herein, but rather should be limited by the advance by which the invention has promoted the art.

I claim:

1. A testing apparatus for simulating the effects of natural weathering comprising a housing adapted to have a test atmosphere or gas therein, a central axis, conduit means disposed in said housing and extending along said axis, means for mounting test panels or samples in equidistant relationship with and radially, outwardly of said conduit means, and means for circulating the atmosphere in said housing in one direction across and in functional engagement with said test panels or samples and the same atmosphere and in the opposite direction through said conduit means.

2. The apparatus according to claim **1** in which said housing has an exterior wall, said test panels are arranged symmetrically about and in spaced relationship with said wall, and said apparatus includes means at least partially isolating the space between said panels and wall from the interior of said housing surrounding said conduit whereby the test atmosphere in said space can be controlled to have different characteristics from that in the said interior of said housing surrounding said conduit.

3. The apparatus according to claim **2** wherein the atmosphere in said housing circulates into said space between said panels and wall and is controlled to have a lower temperature than the atmosphere intermediate said conduit means and test panels.

4. The apparatus according to claim **2** with means to control the temperature and content of the test gas or atmosphere.

5. A testing apparatus for simulating the effects of natural weathering comprising a housing having an exterior wall and adapted to have a test atmosphere or gas therein, a central axis, conduit means disposed in said housing and extending along said axis, means for mounting test panels or samples arranged symmetrically about and in spaced relationship with said wall, outwardly of said conduit means, said apparatus includes means at least partially isolating the space between said panels and wall from the interior of said housing surrounding said conduit, means for circulating the atmosphere in said housing in one direction across and in functional engagement with said test panels or samples and in the opposite direction through said conduit means, and means to control the temperature and content of the test gas or atmosphere to cause said test gas or atmosphere to be at 100 percent relative humidity and the gas or atmosphere in said space to be at a temperature lower than that of the test gas or atmosphere surrounding said conduit means sufficient to reduce the temperature of the test sample adjacent said test gas or atmosphere below the dew point of said test gas or atmosphere.

6. The apparatus according to claim **5,** in which said space is maintained at said lower temperature by action and effect of the ambient temperatures without and adjacent said wall.

7. The apparatus according to claim **6** with means for rotating said housing about said axis.

8. The apparatus according to claim **5** with reservoir means containing water opening into said housing without said space, and means to heat said water to evaporate the same.

9. The apparatus according to claim **8** in which said reservoir comprises an open pan, said housing has an open end defined by said wall and said wall terminates within said pan and below the level of the water contained therein.

10. The apparatus according to claim **9** in which said conduit extends below said reservoir and said apparatus includes an aperture in said conduit means above said reservoir and below the lowermost of said panels, and said aperture provides communication between said interior of said housing, intermediate said panels and said conduit means.

11. The apparatus according to claim **10** in which said conduit extends below said reservoir and including means in communication with said conduit means below said aperture for educting test atmosphere, including excess water vapor, exteriorly of said test apparatus.

12. The apparatus according to claim **11** in which said last-named means educts said water vapor without condensation of water vapor because of such eduction.

13. The apparatus according to claim **11** in which said last-named means comprises a baffle means in said

conduit means more remote from said panels than said aperture and substantially, but not entirely closing said conduit, an exhaust duct leading from said conduit means more remote from said aperture than said baffle and, and exhaust fan exhausting atmosphere including water vapor from said conduit means through said exhaust duct.

14. The apparatus according to claim **13** in which said last-named means educts said water vapor without condensation of water vapor because of such eduction.

15. The apparatus according to claim **14** including an auxiliary inlet to said exhaust fan in communication with ambient air, said exhaust fan mixing said exhaust atmosphere and ambient air before expelling the mixture thereof from the apparatus.

16. The apparatus according to claim **15** with means to insulate said conduit means more remote from said panels than said baffle means, and means to admit ambient air to said conduit means more remote from said baffle means than said exhaust duct.

17. The apparatus according to claim **13** including an intake duct leading from the ambient atmosphere without said housing to said conduit means more remote from said panels than said aperture, and an intake fan to force air through said intake duct and into said recirculation system.

18. The apparatus according to claim **17** with means intermediate said conduit means and intake fan to control flow through said intake duct.

19. The apparatus according to claim **17** with means to heat the air within said intake and exhaust ducts.

20. The apparatus according to claim **19** in which said heating means comprises electrical resistance heating wire wrapped around said ducts, respectively.

21. The apparatus according to claim **17** in which said baffle means is disposed to direct the flow of test gas and atmosphere through said aperture toward said circulating fan, said baffle means has a central opening, and said intake duct directs said air through said central opening toward said circulating fan.

22. The apparatus according to claim **21** in which said baffle means comprises a truncated hollow cone with its base opening toward said intake duct and its top opening toward said circulating fan.

23. The apparatus according to claim **10** with means to heat said conduit means above said pan and adjacent said aperture to a temperature above the heated water temperature.

24. The apparatus according to claim **23** in which said last-named means comprises the means for heating the water and insulation so positioned that heat is directed against and toward said conduit means.

25. The apparatus according to claim **10** with baffle means in said conduit means adjacent said aperture and disposed to direct the flow of gas or atmosphere through said aperture along said conduit means.

26. The apparatus according to claim **10** in which said circulating means includes a fan disposed in said conduit means above said aperture and moving atmosphere through said aperture and along said conduit means to the other end of said housing to form a recirculating system.

27. The apparatus according to claim **26** with baffle means in said conduit adjacent said aperture directing test gas or atmosphere flowing through said aperture toward said fan.

28. The apparatus according to claim **5** with means to introduce water vapor into said atmosphere.

29. The apparatus according to claim **28** including means for educting test atmosphere, including excess water vapor, exteriorly of said test apparatus.

30. The apparatus according to claim **5** with means to introduce a test gas into said housing.

31. A testing apparatus for simulating the effects of natural weathering comprising a housing having an exterior wall, means for mounting test panels in said housing in spaced relationship with said exterior wall, said test panels dividing said housing into first and second portions whereby the test atmosphere in said first portion can be controlled to have different characteristics from that in the said second portion.

32. The apparatus according to claim **31** wherein the test atmosphere in the said housing circulates into said first and second portions and said test atmosphere is controlled to have a lower temperature in said first portion than in said second portion.

33. The apparatus according to claim **32** with means to control the temperature and content of the test gas or atmosphere.

34. The apparatus according to claim **33** with reservoir means containing water opening into said housing without said space, and means to heat said water to evaporate the same.

35. A testing apparatus for simulating the effects of natural weathering comprising a housing having an exterior wall, a test atmosphere or gas in said housing, means for mounting test panels in said housing and arranged about and in spaced relationship with said wall, means at least partially isolating the space between said panels and wall from the interior of said housing interiorly of said panels, said atmosphere circulating into said space between said panels and wall, and means to control the temperature and content of the test gas or atmosphere to cause said test gas or atmosphere to be at 100 percent relative humidity and the gas or atmosphere in said space to be at a temperature lower than that of the test gas or atmosphere interior of said panels sufficient to reduce the temperature of the test sample adjacent said test gas or atmosphere below the dew point of said test gas or atmosphere.

36. The apparatus according to claim **35** in which said space is maintained at said lower temperature by action and effect of the ambient temperatures without and adjacent said wall.

37. The apparatus according to claim **35** with reservoir means comprising an open pan containing water opening into said housing without said space, said housing has an open end defined by said wall and said wall terminates within said pan and below the level of the water contained therein, and means to heat said water to evaporate the same.

38. The apparatus according to claim **37** including means in communication with said housing interiorly of said panels for educting test atmosphere, including excess water vapor, exteriorly of said test apparatus.

39. The apparatus according to claim **38** in which said last-named means educts said water vapor without condensation of water vapor because of such eduction.

40. A testing apparatus for simulating the effects of natural weather comprising a housing adapted to have a test atmosphere or gas therein, means to control the nature of said test atmosphere, means for mounting test panels or samples within said housing, said test panels

dividing said housing into first and second portions, means in communication with said housing for eductting the test atmosphere exteriorly of said apparatus, and said first and second portions each adapted to contain part of said test atmosphere individually.

41. The test apparatus according to claim **36** in which said means to control the nature of said test atmosphere includes means to introduce water vapor therein and said eduction means includes means to educt excess water vapor.

42. The apparatus according to claim **41** in which said educting means educts said water vapor without condensation of water vapor because of such eduction.

43. The apparatus according to claim **41** including reservoir means having an upper open end in said housing for providing water vapor.

44. The apparatus according to claim **41** in which said apparatus includes conduit means, said panels are disposed about said conduit means, and said test gas or atmosphere circulates in one direction in said conduit means and in the opposite direction without said conduit means.

45. The apparatus according to claim **44** in which said eduction means is in communication with said conduit means.

46. A testing apparatus for simulating the effects of natural weather comprising a housing adapted to have a test atmosphere or gas therein, means for mounting test panels or samples within said housing, means to control the nature of said test atmosphere including means to introduce water vapor therein, conduit means, said panels disposed about said conduit means, reservoir means having an upper open end in said housing for providing water vapor, said conduit means extending below said reservoir means, an aperture in said conduit means above said open end of said reservoir means, baffle means in said conduit means nearer said open end of said reservoir means than said aperture, an exhaust duct leading from said conduit means more remote from said aperture than said baffle means, an exhaust fan exhausting atmosphere including water vapor from said conduit means through said exhaust duct, said test gas or atmosphere circulates in one direction in said conduit means and in the opposite direction without said conduit means, and means in communication with said housing for eductting test atmosphere exteriorly of said apparatus, said eduction means including means to educt excess water vapor, and said eduction means being in communication with said conduit means.

47. A testing apparatus for simulating the effects of natural weathering comprising a housing having an exterior wall adapted to have a test atmosphere or gas therein, a central axis, conduit means disposed in said housing and extending along said axis, means for mounting test panels or samples arranged symmetrically about and in spaced relationship with said wall, outwardly of said conduit means, said apparatus includes said panels and wall from the interior of said housing surrounding said conduit means for circulating the atmosphere in said housing in one direction across and in functional engagement with said test panels or samples and in the opposite direction through said conduit means, means to control the temperature and content of the test gas or atmosphere, and reservoir means containing water opening into said housing without said space, and means to heat said water to evaporate the same.

48. The testing apparatus according to claim **31** wherein said first portion comprises the space between the exterior wall and said test panels and said second portion comprises the space interior to said test panels.

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