ABSTRACT: In an installation comprising a plurality of hermetically sealed multiple glazed window units, all of the window units are ducted to a common manifold. The manifold is ported to the atmosphere through pressure-compensating apparatus which vents air pressure built up within the system into the atmosphere, and admits filtered, dehumidified air drawn from the atmosphere into the system when ambient atmospheric air pressure exceeds the internal air pressure within the system.
PRESSURE-COMPENSATING SYSTEM FOR HERMETICALLY SEALED WINDOW UNITS

BACKGROUND OF THE INVENTION

The invention relates to hermetically sealed multiple glazed window units, and more particularly to means which automatically compensate for changes in the differential pressure within and without such units in a multiple unit installation. Additionally, construction techniques often call for the use of multiple glazed hermetically sealed window units for both thermal and acoustical insulation purposes. This is especially the case with large office, commercial and multiple-unit residential buildings in which temperature-regulated air conditioning and noise suppression are considered mandatory.

Typically the window units employed are constructed with two or more glass panels glazed in a framework which is integrated into the wall of the building. The hermetically sealed airspace between the glass panels serves to some extent to reduce the amount of heat transmitted through the window unit and, more importantly, substantially attenuates sounds passing through the unit from without. These window units pose two problems to their designers and manufacturers—moisture control and pressure compensation. If the air trapped within the sealed airspace between the glass panels contains even a small quantity of water vapor, changes in air temperature and pressure within the airspace and changes in the temperature of the glass panels themselves may cause condensation to form recurrently on the inner faces of the panels and frame. Repeated or extended exposure to moisture leads to the deposit of unsightly film or "scum" on the glass surfaces. In addition, such moisture tends to attack the frame material and may lead to the deterioration and eventual destruction of the vital glazing gaskets and sealant.

At the same time, changes in the air pressure within the sealed airspace an inside and outside of the building in which the unit is installed exert varying forces on the glass panels. With relatively small panels the effect of the variations is hardly noticeable, but with large units the resilient glass may be visibly distorted. In some cases the bending or bowing is so pronounced as to spoil the esthetic appearance of the installation. Under extremely adverse conditions the glass may actually be fractured by the stresses generated.

Since many new buildings are being built in which a large percentage of the outer walls are glass and since all glass will produce at least some reflection, the aesthetic appearance of a building, as seen from a distance, will be vastly enhanced if a person viewing it sees a nondistorted image on the windows. In buildings in which the outer pane of each multipaned windows undergoes some or all of the distortion which occurs due to pressure variations, a person looking at the building sees very unpleasant reflections which create the illusion that the building is somehow improperly constructed or located.

Distortion in window glass is created by variations in pressure on the opposite sides of the glass. Of course, the pressure on the outside of a window in a building wall is created and controlled only by atmospheric conditions. On the other hand, the pressure on the interior of the window is controlled by those same atmospheric conditions, to some extent, as well as by air conditioning units, elevators moving up and down within the building, stack pressures which are created by the height of the building, etc. Thus it becomes apparent, that if the outer pane of a multipaned window is to remain distortion-free, it is necessary that the pressure between the panes of glass and the pressure on the exterior of the wall in which the window is mounted remain substantially equal. This will allow any distortion which must be absorbed by the window to be absorbed by the inner pane. A person viewing the building from a distance cannot see any distortion on the inner pane and a person standing inside the building will not have his view of the outside distorted by the distortion of the inner pane since he will normally be standing close enough to it to prevent his eyes from observing the distortion. Thus, some means for accomplishing this result must be produced.

Commonly steps are taken in the manufacture of such units to avoid the introduction of moisture into the airspace before it is sealed. Any moisture inadvertently trapped within the sealed unit is removed by providing a desiccant material in the airspace. This desiccant serves, in addition, to absorb the minuscule amount of moisture that invariably manages to migrate into the airspace through the sealing gasket and sealant. If sufficient desiccant is used, as long as the unit remains hermetically sealed protection is afforded for many years against condensation and moisture-induced scum formation or deterioration. Eventually, however, even in the most effectively sealed units the desiccant becomes saturated and free moisture begins to accumulate.

Compounding this problem, changes in the pressure differential within and without the units cause even the smallest air leak to allow the passage of air between the atmosphere and the inside of the sealed unit. This process greatly reduces the time needed for a sufficient quantity of moisture to be drawn into the enclosed airspace to saturate the desiccant and cause condensation, scumming and corrosion.

Whatever the cause, when this occurs outside the entire unit is generally replaced because of the difficulty and expense of recharging the exhausted desiccant and rescaling the glass or frame. In those few prior art windows designed to provide means for recharging the exhausted desiccant without removing a glass panel, even if the air leak can be sealed conveniently, replacing the desiccant is at least a laborious and time-consuming undertaking.

SUMMARY OF THE INVENTION

In the subject invention the hermetically sealed airspaces within all of the window units in an installation are ducted to a common manifold so that pressure variations within the airspaces are transmitted to the manifold. The manifold in turn is ported to the ambient atmosphere, preferably outside of the building in which the window units are installed, through an air dehumidifying and filtering device. On the other hand, in many installations, it will be suitable to vent the manifold to a space within the same or another building which is located and designed so that it normally has substantially the same pressure as that on the exterior of the building in which the window units are mounted. When the pressure within the manifold is greater than the ambient outside pressure, this device permits air to escape to the atmosphere. When ambient outside pressure exceeds the manifold pressure, it permits air to enter the manifold for distribution to the individual window units. The air within the window units and the manifold is continuously exposed to a desiccating material contained in the dehumidifying device. Any moisture in this air migrates under the influence of its partial pressure to the desiccant, where it is absorbed. This desiccating material is positioned in the stream of all fresh atmospheric air drawn into the manifold, and effectively removes any moisture which might otherwise find its way to the individual window units. The dehumidifying and filtering device may be constructed with alternate airflow paths passing through two or more desiccant towers. Means may be provided for drying the exhausted desiccant in one of these towers while the others are in use.

It is an object of this invention to provide means for varying pressure differential within and without hermetically sealed window units, caused by variations in internal and external temperature and barometric pressure.

Another object of the invention is to overcome the incursion of moisture through a leak in an hermetically sealed window unit, or through migration across its sealing gasket.

Still another object is to eliminate the need for providing desiccant in each individual window unit in a multiple unit installation.

Yet another object is to provide an hermetically sealed window unit in which a leak may be repaired or a glass panel replaced without the need for renewing or recharging the exhausted desiccant. A still further object of the invention is to provide a system for venting multipaned windows so that the
external pane of each such window is not distorted by differences in the pressures on the inside and outside of the building, thereby producing an aesthetically appealing reflection in the building windows when viewed from a distance.

Other objects will become apparent on reading the following detailed description of several embodiments of the invention taken in connection with the attached drawings in which:

FIG. 1 is a fragmentary elevational view of the face of a building containing a typical installation of hermetically sealed window units employing the subject invention; FIG. 2 is a top plan view of a complex of buildings, some attached and some detached, employing the subject invention; FIG. 3 is a perspective view of two typical hermetically sealed window units, showing the individual and common ducts utilized in one embodiment of the invention to connect their sealed airspaces with the common manifold; and FIG. 4 is a diagrammatic view illustrating one construction of the dehumidifying and filtering unit of the subject invention and its relationship with the window unit installation of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 a typical multiistory building 11 is shown, having a number of hermetically sealed double-glazed window units 12, such as those illustrated in FIG. 3, integrated into its construction. The window units 12 comprise a frame 14, commonly of aluminum alloy, having hermetically glazed exterior and interior glass panels 15 and 16, respectively, enclosing an airtight airspace 17 therebetween.

It should be understood that while the subject invention is described herein as applied to an installation of hermetically sealed window units in a multiistory building, it is equally applicable to an installation in a single story or so-called split-level building as well. Likewise, as shown in FIG. 2, this system is not limited in its application to a single building structure, but may be employed in a building complex comprising a number of wings or semidetached building units 11a, 11b, 11c, 11d, completely separated buildings 11e, 11f, or both. In any case, each of the window units 14 is provided with an individual air duct 18 communicating between the airspace 17 entrapped within the unit 14 and a common air duct 19 linking similar units on the same floor level. Any conventional tubing or piping may be used to attach individual ducts 18 to the one or more common ducts 19 necessary to interconnect all of the window units 14 on each floor. In practice excellent results have been achieved utilizing flexible polyethylene tubing and easily applied slip fittings. For some installations it may be desirable to employ several common ducts 19 for the interconnection, but generally a single common duct 19 positioned in the wall above the window line, or in the crawl space above the windows adjacent to the wall of the building will suffice to interconnect the window units 14 on each floor.

All of the common ducts 19 are in turn connected to a common manifold 21. In a single building installation such as that shown in FIG. 1 the common manifold 21 would merely connect the common ducts 19 of each of the floors. In a building complex, as shown in FIG. 2, the common manifold would connect the ducts from the several floors of each of the building units 11a-d, 11e and 11f. Like ducts 18 and 19, manifold 21 may be of any convenient material, but is preferably formed of polyethylene tubing or a similarly durable, corrosion-resistant material. Manifold 21 may be run through the building or buildings 11, 11a-f at any convenient level. If desired, it may be run across the roof of the building, or buried underground, as where it crosses the ground spaces between buildings 11a and 11e.f.

At some convenient point along its length, manifold 21 is connected to the dehumidifying and filtering unit 22. Unit 22 is illustrated in detail in FIG. 4. In some very large installations several of these units 22 may be utilized; however, normally only one is required.

Unit 22 may be a conventional dehumidifying and filtering device such as Air-Dry Corporation of America "Air Dryer"

Model A2-5 E comprising a pair of desiccant towers 23, 24 containing a common desiccant 25, 4-way inlet and outlet valves 26, 27, respectively, particle filter 28, color change dew point indicator 29, purge blower 31, dust filter 32 and cam timer 33. The operation of this and similar units is well known and need not be described in greater detail here. The arrows in FIG. 4 indicate the direction of airflow through unit 22 when the ambient atmospheric pressure is greater than the air pressure within common manifold 21.

In this condition, which may be the result of an increase in ambient barometric pressure or a lowering of the temperature of the air in airspaces 17 of window units 14, or both, atmospheric air enters the system through point 34 and passes through dust filter 32 which removes the larger solid impurities it may be carrying. Timer 23 has previously actuated valves 26 and 27 to direct the incoming air through desiccant tower 23 and thence, through dew point indicator 29 and particle filter 28 into common manifold 21. The desiccant 25 in tower 23 effectively removes all traces of moisture from the incoming air and insures that none will be introduced into manifold 21 or window units 14. Simultaneously, timer 33 has activated purge blower 31 which directs a stream of air, which may be preheated, through the desiccant 25 in desiccant tower 24 to remove the moisture which has been accumulated in the prior use of that tower. The moisture laden air coming from tower 24 passes through valve 27 and thence through board into the atmosphere through indicator 35. Indicator 29 provides means for continuously monitoring the condition of the air present in manifold 21 for an accumulation of moisture. Should indicator 29 sense that moisture is present in the system the unit 22 may be adapted automatically to shut down until the problem has been corrected or to place an alternate fresh desiccant tower on line. Filter 28 removes fine particles which may remain in the air after it has passed through the unit 22, and serves to maintain the cleanliness of airspaces 17 in window units 14.

According to the theory of partial pressures, each of the various elements, etc., which combine to form what is commonly referred to as air, tend to be equally distributed throughout any given volume. It has been shown that this theory is particularly applicable to moisture. Consequently, assuming that there is no flow of air through the dehumidifying and filtering unit 22 in either direction, as the moisture in the manifold adjacent the desiccant is absorbed, that moisture which is present in the manifold farther away from the desiccant, and that within the window units themselves, will tend to migrate toward the desiccant to maintain an equal distribution. Thus, even if air did not pass through the unit 22, the migration of the moisture in accordance with the principle of partial pressures would achieve substantially the same dehydrating result, causing air within the system to become more and more dry, as time goes on, so long as the desiccant is properly conditioned to accept moisture. Therefore, with this system, moisture which naturally migrates through glass, metal, rubber, etc., over a long period of time, will also be removed from the air due to partial pressures.

Timer 33 is set to reverse varies 26, 27 before the desiccant 25 in towers 23, 24 has been exhausted, so that the air present in manifold 21 is always moisture free. Should the temperature within airspaces 17 increase, or atmospheric barometric pressure decrease, or both, to the point where the pressure within manifold 21 is greater than that of the ambient atmosphere, the flow of air through the system is reversed automatically.

Since the air in common manifold 21 is continuously in contact with desiccant 25 in towers 23, 24, regardless of the direction of airflow through the system, any moisture which might find its way into one or more of the window units 14 will be drawn by the strongly hygroscopic desiccant 25 out of airspace 17 and absorbed by the desiccant 25. Should one or more of the window units 14 develop a minor leak, this characteristic of the system would prevent the accumulation.
of moisture either in that window unit or in any of the other window units in the installation. In the event a glass panel 15, 16 were broken or had to be removed, the remainder of the installation would likewise be maintained moisture free since the amount of moisture entering the total system through the exposed duct 18 over a short period of time would be relatively small. When the broken panel is replaced, the system immediately commences to dehumidify the rescaled airspace 17 of that window unit 14 and to return it to its moisture-free condition. Thus, even without the continuous ebb and flow of air with in the system resulting from variations in internal and external pressure, the moisture trapped in each individual window unit 14 will be drawn to the dehumidifier and removed from the system.

Since the pressure within airspaces 17 in all of the window units 14 is maintained constantly at ambient atmospheric pressure, the distorting effect associated with variations in the pressure differential between airspaces 17 and the ambient atmosphere referred to earlier is entirely eliminated. Thus one of the chief causes of leakage associated with hermetically sealed window units is effectively removed, and the life of such units substantially extended.

With the foregoing description in mind, what is claimed is:

1. In a window installation of a type including at least one window unit mounted in a wall of a building defining a substantially enclosed volume, the interior atmosphere of said enclosed volume being substantially controlled to remain within a predetermined range of temperatures, the pressure within said enclosed volume often being affected by factors additional to the atmospheric pressure exterior of said enclosed volume and therefore normally being different therefrom, and the atmospheric exterior of said enclosed volume being substantially uncontrolled and therefore variable in temperature and pressure in correspondence with prevailing outdoor temperature and pressure, each said window unit comprising a window frame sealingly mounting a plurality of laterally spaced window panes defining a sealed interior window volume therebetween, a surface of one of said plurality of panes being exposed to said atmosphere exterior of said enclosed volume and a surface of another of said plurality of panes being exposed to said atmosphere interior of said enclosed volume, a system for removing moisture from within said interior window volume and for maintaining each said window unit substantially free from visual distortion as viewed from the exterior of said enclosed volume, said system comprising:

   a hygroscopic material

   first air passage means providing communication between said otherwise sealed interior window volume and said hygroscopic material, and

   second air passage means providing continuous communication between said hygroscopic material and a relatively unconfined volume, as compared to said interior window volume, in which the atmospheric pressure substantially corresponds with the atmospheric pressure prevailing exteriorly of said enclosed volume.

2. The system of claim 1 further comprising

   a plurality of means containing said hygroscopic material, and

   means for providing constant communication between said first air passage means and one of said plurality of containing means.

3. The system of claim 1 wherein said system further comprises

   means for selectively purging moisture from a first portion of said hygroscopic material while providing continuous communication between said first air passage means and a second portion of said hygroscopic material.

4. The system of claim 3 including

   a plurality of windows as described therein, and

   manifold means providing continuous communication between each said otherwise sealed space in each of said plurality of windows with each said otherwise sealed space in every other of said plurality of windows and with said relatively unconfined volume through said air drying and cleaning means.

5. An air breathing system for use with multipaneled windows mounted in a building enclosure wall with the exterior surface of a first pane exposed to the building exterior whereat atmospheric temperature and pressure are substantially uncontrolled and therefore vary in correspondence with the prevailing outdoor temperature and pressure, and with the exterior surface of a second pane exposed to the building interior whereat atmospheric temperature is controlled to remain within a predetermined range and the atmospheric pressure is often affected by factors additional to the atmospheric pressure at the exterior of the building enclosure wall and is therefore normally different therefrom, said system comprising:

   air drying and cleaning means, at least one multipaneled window mounted otherwise in the building exterior wall and having

   a sealed space intermediate the panes thereof,

   a relatively unconfined volume, compared to said sealed space, having a pressure which varies in correspondence with that prevailing on the exterior of the building wall in which said window is mounted, and

   means providing continuous communication between said other wise sealed space and said relatively unconfined volume through said air drying and cleaning means.

6. The system of claim 5 including

   means for selectively purging moisture from said air drying and cleaning means while maintaining communication between said otherwise sealed space and said relatively unconfined volume through said air drying and cleaning means.