

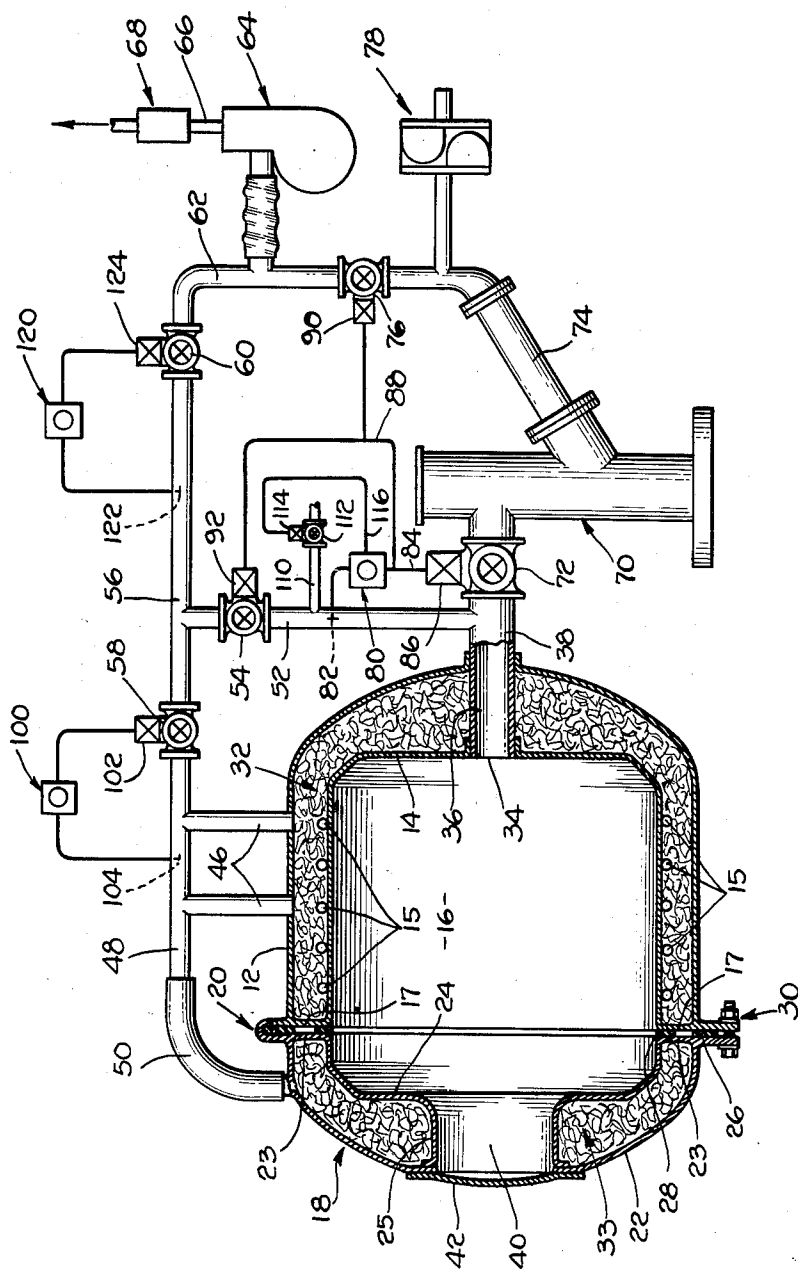
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HIGH VACUUM SYSTEM

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HIGH VACUUM SYSTEM

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The present invention is directed generally to a system for producing and maintaining a very high vacuum, more particularly relating to the operation of a double-walled environmental chamber for testing aircraft components or the like under controlled pressure and temperature conditions simulating high altitudes or outer space.

In accordance with a preferred form of the invention the double-walled structure defining an environmental chamber includes an outer shell and an inner liner, the two forming therebetween a jacket or insulating space. The insulating space may be filled with any conventional insulating material such as fiberglass, cork or the like for minimizing heat transfer into or out of the chamber. Means may be provided for maintaining the liner and thereby the chamber at a desired temperature, such means preferably including pipes in heat transfer relation with the liner for circulating heating or cooling liquid. A vacuum pump capable of providing a vacuum of one mm. Hg or thereabouts is connected to the insulating space and to the chamber. There is also provided a second vacuum pump for drawing the pressure within the chamber down to a very low value, of the order of 0.1 micron Hg, simulating altitudes of 300,000 feet or more. The conduits interconnecting the pumps with the chamber and with the insulating space are provided with valves, controlled by pressure regulators or controllers having pressure responsive elements for sensing the pressure in the insulating space and in the chamber. The regulators function to actuate the valves in accordance with the invention in a manner later described in detail by which to reach and maintain a predetermined intermediate pressure in the insulating space and the desired very low pressure within the chamber.

A particular problem heretofore existing in the construction and operation of environmental chambers where the pressure is to be reduced to one micron Hg or less is that gases such as air and water vapor are boiled off or otherwise released from the various components of the apparatus subject to such low pressure, thereby substantially delaying the attaining of the desired pressure. Fiberglass, cork or other material making up the thermal insulation customarily employed in the jacket of the environmental chamber is especially objectionable in providing such a source of undesired water vapor and air during the pull-down to very low pressures. Thus if the pressure surrounding the insulating material and other major components of the present system is prevented from falling below the vapor pressure of water at the temperature involved, considerable time will be saved in achieving the desired degree of vacuum within the chamber. At room temperature the vapor pressure or boiling point of water is approximately 22 mm. Hg, and under such conditions in accordance with the present invention the pressure in the insulating jacket is then held at about that figure in order to minimize the amount of water vapor to be handled by the vacuum pump.

A further advantage of the present invention results

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from the fact that the liner can be made of relatively thin material, since it must withstand only the comparatively small force created by the intermediate pressure in the insulating jacket. As a consequence, heating or cooling of the chamber by the fluid pipes on the outer surface of the liner is expedited.

Accordingly it is a principal object of the present invention to disclose a novel system for quickly achieving a high vacuum within an insulated enclosed chamber.

Another object of the invention is to disclose a high vacuum system including a double-walled container having means for producing and maintaining a higher vacuum within the chamber proper than that existing in the space between the walls of the container.

Another object of the invention is to disclose, in apparatus of the above character, means for quickly producing a vacuum within an enclosed chamber of the order of 1 micron Hg, including means for quickly changing the temperature within the chamber.

A further object is to disclose a high vacuum system permitting the use of a chamber-defining wall of very thin construction because of the low pressure exerted thereon.

These and other and additional objects and purposes of the invention will become clear from a study of the following description of a preferred embodiment thereof.

The figure in the drawing is a partially diagrammatic representation of a preferred system for the practice of the present invention.

Referring in detail to the drawing, there is indicated generally at 10 a double-walled apparatus including outer and inner walls 12 and 14 respectively. The inner wall defines an internal chamber 16 within which the present apparatus is designed to produce a desired temperature and pressure for conducting tests or other procedures as desired and means such as pipes 15 may be provided on the outer surface of inner wall 14 for circulation of cooling or heating liquid by which to control the temperature of the wall 14 and thereby of chamber 16. Access to chamber 16 is provided by suitable means such as a door indicated generally at 18, hinged at 20, so that the door can be swung leftwardly into open position when desired. The liner 14 may be extended outwardly in flanged portion 17 joining shell 12 so that opening of door 18 does not open the space between shell 12 and liner 14 to atmosphere. Door 18 itself includes outer and inner walls 22 and 24 respectively and flanged portions 23 and 25 extending between the walls. Annular gaskets 26 and 28 hermetically seal the door when closed and suitable means indicated generally at 30 serve to retain the parts in tightly closed relation. The spaces between the walls 12 and 14 and between the walls 22 and 24 of the door are filled with a suitable insulation material indicated generally at 32 and 33 respectively and consisting of, for example, cork, fiberglass or other material having a relatively low coefficient of heat transmission. The inner wall 14 of the apparatus is provided at one end with a port 34 communicating through a tubular portion 36 with an outlet pipe or conduit 38. There may desirably be provided at the other end of the apparatus, in the door 18, an observation opening 40 defined by the flange 25 including a glass or other transparent covering 42 extending across the opening.

Means are provided for evacuating the internal chamber 16 and the insulating space or jacket 32 down to a predetermined, fairly low intermediate pressure of from

about one to about thirty mm. Hg. In the present embodiment of the invention, the insulating space 32 is connected through one or more conduits 46 to a main pipe 48, the latter being also connected through a flexible hose member 50 to the insulating space 33 of the door 18. The internal chamber 16 is connected through the conduit 38 previously mentioned and conduit 52 and valve 54 to the pipe 56, the latter forming a continuation of the pipe 48 downstream of valve 58. Pipe 56 communicates downstream through valve 60 with pipe 62 leading to a suitable exhaust pump indicated generally at 64. The pump 64 is provided with an outlet pipe 66 and an oil filter or vapor trap of conventional type indicated generally at 68 may be included in pipe 66 in order to prevent excessive discharge of oil vapor or droplets during operation, as is well known in the art.

Additional pump means are provided for evacuating the internal chamber 16 to a very low pressure, of the order of one micron Hg or less. In the present illustrative embodiment of the invention, such means are exemplarily shown as including an oil diffusion pump indicated generally at 70 of known construction adapted to draw air from the chamber 16 through the conduit 38 and valve 72 when the latter valve is in open position. The diffusion pump 70 discharges through conduit 74 and valve 76 to the pipe 62 and thence through the mechanical evacuating pump 64. For reasons later appearing, it may be desirable to provide an auxiliary holding pump indicated generally at 78 communicating with the conduit 74 in order to maintain the diffusion pump in condition ready for effective functioning during the operating cycle of the present system.

The operating cycle just referred to contemplates, in general, that the internal chamber 16 and the insulating spaces 32 and 33 are first reduced in pressure to an intermediate pressure level by the pump 64. The insulating space pressure may then be drawn down further and maintained at a desired value. By means of the diffusion pump 70, the pressure in the internal chamber is drawn further down to the very low pressure desired therein for testing or other purposes. To accomplish this, there is provided a pressure controller or regulator indicated generally at 80 having a pressure-sensing element 82 disposed in the conduit 52 and being thus responsive to the pressure in the internal chamber 16. The pressure controller 80 in turn is connected through the line 84 with the actuator 86 of valve 72 and through line 88 with actuator 90 of valve 76 and actuator 92 of valve 54. The three valves, 54, 72 and 76 thus controlled by the regulator 80, serve effectively, with valve 54 open and valves 72 and 76 closed, to isolate the diffusion pump 70 and to permit the mechanical pump 64 to evacuate the internal chamber 16. When pressure controller 80 causes the closing of valve 54 and the simultaneous opening of valves 72 and 76, the diffusion pump 70 is placed in effective evacuating communication with the internal chamber 16, the latter being now isolated from the insulating jacket 32 and the main pipe 56 by reason of the closing of valve 54. The controller 80 is desirably of the adjustable type whereby the operator may select any desired pressure at which the above actions are caused to take place.

Thus, the mechanical pump 64 is first put into operation in order to draw down the pressure within both the chamber 16 and the insulating spaces or jackets 32 and 33. When the pressure at element 82 falls to the value for which controller 80 is set, the latter acts to close valve 54 and open valves 72 and 76. Thereafter, the insulating jackets 32 and 33 are pneumatically isolated from the chamber 16 and the pressure maintained within the jackets by pump 64 will be determined by the setting of a pressure controller 100 connected to an actuator 102 of valve 58, the controller 100 having a pressure-sensing element 104 which may be located in the pipe 48 or other suitable location to be responsive to the pressure exist-

ing within the jackets. It will be understood that the controller 100 serves to throttle the valve 58 so as to maintain the desired pressure within the jackets in a manner well known in the art, the mechanical pump 64 continuing to operate in conventional fashion.

The auxiliary holding pump 78 on the exhaust side of the oil diffusion pump 70 is desirably provided in order to permit the oil diffusion pump to work into a partial vacuum before valve 76 is opened and thus to maintain the pump 70 in condition for immediate operation in the manner referred to hereinabove. It will be seen that when the diffusion pump 70 is switched into the system by the opening of valve 72, the valve 76 is open so that the pump 70 discharges effectively into the mechanical pump 64, and the holding pump 78 thereafter is not needed. However, it may continue operation without adversely affecting the present system.

The pressure controller 80, in addition to controlling the actuation of valves 54, 72 and 76 as described above, serves also to maintain a predetermined pressure in chamber 16. A pipe 110 is connected to pipe 52 and is provided with a valve 112 having an actuator 114. Valve 112 is a bleed valve, serving to admit outside air into chamber 16. Its actuator 114 is connected by line 116 to controller 80. Thus, controller 80 effectively throttles valve 112 in order to maintain within the chamber 16 any pressure within the range of the pump used.

Means may be provided for maintaining in the chamber 16 and jackets 32 and 33 a pressure attainable by the mechanical pump 64 alone, not necessitating operation of the oil diffusion pump 70. Such means are here shown as including a selectively adjustable pressure controller 120 in communication with a pressure-sensing element 122 in the pipe 56, the controller 120 being adapted to control the actuator 124 and thus throttle valve 60. The result so achieved could likewise be achieved by bleeding air into the system through the bleed valve 112, but it is desirable to minimize the amount of air actually handled by the mechanical pump 64 when it is working at substantially less than capacity in order to avoid excessive discharge of oil vapor and droplets to the atmosphere.

It will accordingly be seen that the present invention permits the attainment of a desired high vacuum, in the range of a few microns Hg or less, very rapidly by minimizing the outgassing of a great many of the structural components of the system and by virtually eliminating the boiling out of water vapor from moisture in the system. The present invention moreover permits, by reason of the relatively low intermediate pressure existing in the insulating jackets, the use of a relatively thin inner wall or liner so that the temperature of the liner and within the chamber may be readily changed as desired, with a minimum of lag resulting from heat transfer through the liner wall.

It will be understood that the pressure regulators or controllers, together with the pressure-sensing elements, valves and actuators associated therewith have not been shown or described herein in detail since such components are well known in the art and their details form no part of the present invention. Modifications and changes from the specific components exemplarily shown herein are within the contemplation of the present invention and are intended to be embraced within the scope of the appended claims.

I claim:

1. A high vacuum system comprising: a double walled structure, the walls being spaced apart to form an insulating space therebetween and the inner wall defining a chamber; thermal insulating material in said space; first and second exhaust pumps, each having intake and discharge sides, said second pump being capable of maintaining a working pressure below that at which said insulating material releases substantial quantities of gas; a first conduit connecting the intake side of the first pump with the space, a second conduit including a first valve, normally open, connecting the intake side of the first pump with the cham-

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ber, a third conduit including a second valve, normally closed, connecting the intake side of the second pump with the chamber and a fourth conduit including a third valve, normally closed, connecting the discharge side of the second pump with the intake side of the first pump; sensing means responsive to pressure within the chamber; and means controlled by the sensing means for closing said first valve and opening said second and third valves when the pressure in the chamber is drawn down by the first pump to a predetermined value whereby the first and second pumps in series draw the pressure in the chamber down to a working pressure substantially below that in the space.

2. The invention as stated in claim 1 wherein said predetermined value is substantially at least the vapor pressure of water at the working temperature in the space.

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3. The invention as stated in claim 1 including a bleed valve throttably controlled by said last named means and connected between said chamber and atmosphere for maintaining the pressure in the chamber at a desired value.

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