Chapter XIV

The Heating and Ventilating of the Capitol

MANY members of Congress, as might be expected of so many men of different temperaments and in such different physical conditions, found the warming and ventilating apparatus as first devised unsatisfactory.

As early as 1854, because of complaints of overheating in some portions of the building and drafts in other portions, Captain Meigs made an effort to rectify the trouble in this respect.[1] With this purpose in view the register under each desk was supplied with diffusing boxes and valves so that each member could regulate the heat according to his personal feeling. Deflectors were put in front of all wall registers in the Senate, openings in the risers of steps were removed, and a small circular register was put under each Senator's desk. Mr. Walter, after his duties ceased as Architect, made a report, May 6, 1866, upon the heating of the building.[2] In this report a brief account of the heating apparatus is given, with a clear description of the method adopted in heating and ventilating the Capitol wings. The fresh air was drawn in by large fans and forced into chambers and through steam coils, whence it was carried by ducts to the Halls of Congress, passageways, and committee rooms. Four fans were used, one for each Hall of Congress and one for the committee rooms and hallways in each wing. The supply was drawn from the side wings on the west of the corridors connecting with the old building and at the level of the terraces; this entrance, being shut out from the street, was supposed to be free from dust. The registers in the Halls of Congress were located in the floor and distributed over the surface.

The objections raised to the effectiveness of the ventilating system were first put in concrete form by a joint committee of the two Houses on ventilation, February 20, 1865.[3] Mr. Buckalew, who was chairman of this committee, stated that under the appropriation act of July 2, 1864, plans had been obtained for proposed changes in heating and ventilation. These plans were made by Charles F. Anderson, who has been mentioned before as one of the competitors for the extension of the Capitol.[4] His report named as defects in the existing arrangements the location of the air inlets near the ground and street level, where dust and dirt were taken into the circulation, the overheating of the air by the steam, the deficiency of moisture, the registers in floors and dust rising from them, the inequality of temperature, the imperfect removal of air because of the method of outlet in the roofs, and the presence of unnecessary quantities of gas in the Chambers. The committee approved of the suggestions and made the report a part of the committee report. The changes suggested were as follows: The air should be brought in through vertical stacks with inlets at a high elevation, from which it was to be conducted, after being warmed, to air spaces in the

[1] In 1853 scientists A. D. Bache and Joseph Henry were commissioned to study the heating, ventilating, and acoustics of the Capitol. Meigs accompanied Bache and Henry on their study of major public buildings in northeastern cities and collaborated in the development of modifications to the Capitol. *DHC,* 587–588.

[2] Secretary James Harlan, *Report on Warming and Ventilating the Capitol* (Washington: Government Printing Office, 1866).

[3] *Report of the Joint Select Committee on Warming and Ventilating the Capitol,* S. report 128 (38–2), Serial 1211.

[4] Charles F. Anderson, *Architect's Report and Plans for the Improvement of the Lighting, Heating, Ventilation, and Acoustics of the Senate Chamber and Hall of the House of Representatives* (Washington: Government Printing Office, 1864).

roof. Anderson's idea was to force the air into the roof chamber and exhaust it at the floor level. The coils were to be heated by hot water instead of steam, so as to prevent overheating, and the air was to be hydrated by jets of water located in the ducts. To accomplish this proposed modification it was necessary to elevate the ceilings about 15 feet, make the roof double, and insert windows around the upper part of the Halls, making a clerestory. Anderson calls attention to the fact that Meigs adopted the down-draft system in 1853 and then abandoned the measure. Anderson accompanied his report with twenty drawings and estimates for the proposed changes.

Thomas U. Walter, in the above-mentioned report to James Harlan, Secretary of the Interior, includes reports from Prof. Joseph Henry and Dr. Charles M. Wetherell, of the Smithsonian Institution. The latter gives an exhaustive review of the chemical condition of air, temperature, hygrometric condition, air currents, and a bibliography, with extracts bearing upon the subject of ventilation. Mr. Walter describes the plan of heating as given previously in these pages. The examination of the scientists led them to report that the means provided for a supply of warm and pure air were ample, and they agreed that the principal cause of complaint was a deficiency of moisture.[5]

After a careful investigation Mr. Buckalew's committee reported everything in a satisfactory condition, with the exception of the absence of any method of charging the air with moisture, which Professor Henry considered of great importance and probably the cause of the disagreeable effects of which the members complained. He recommended steps to be taken to rectify this fault. The dissatisfaction of the Congressmen continued, and various schemes and plans have been submitted from that period to the present time, some for simple devices to overcome special defects, as well as plans for a complete revision of the system.

June 20, 1868, Mr. Covode, chairman of the Committee on Public Buildings and Grounds, made a report under the following resolution of Congress:

"Whereas the confined and poisonous air of the Hall and corridors of the Representatives' wing of the Capitol has caused much sickness and even deaths among the members of the House, and under present arrangements must continue to remain in a poisonous condition:

"*Resolved,* That the Committee on Public Buildings and Grounds be directed to examine at once and report to the House by what means a sufficient supply of pure air may be obtained for said Hall, and that the committee be empowered to use the present means of ventilation to the best advantage at present, and that they report by bill or otherwise."[6]

This committee authorized an investigation by Gen. Hermann Haupt, chief engineer of the Pennsylvania Railroad, and Lewis W. Leeds, a specialist in heating and ventilating, and ended with a recommendation that someone of ability and experience be employed to further examine and report upon the subject. General Haupt proposed an inlet for fresh air at the level of the gallery, with a forced ventilation, and no outlets at the ceiling, but outlets in the floor, thus making a plenum chamber of the Hall, with the necessary exit of foul air at the floor level. He contended that the heated air which was let into the Chamber at the floor simply passed through the Hall and out at the ceiling without carrying the carbonic-acid gas with it, but leaving this product at or near the floor level or point of breathing. Mr. Leeds agreed with the idea of having the outlet for vitiated air at the floor, but thought a certain amount of radiant heat was necessary, and proposed open fires in connection with the apparatus for supplying heated air. He called attention to the fact that the inlets in the floor were more or less contaminated by the refuse tobacco and spittle which had accumulated in them, and the

[5] Harlan, *Report on Warming and Ventilating the Capitol.*

[6] Committee on Public Buildings and Grounds, H. report 65 (39–3), Serial 1358.

air which came into the room was offensive from that cause; therefore he made this a plea for abolishing the inlets in the floor.[7]

Among suggested changes may be mentioned one of A. J. Marshall, July 28, 1868, who proposed to take the air in through high towers, keep it under compression in an air chamber in the roof, and this pressure was to force it out of the Hall at registers in the floors. He commends this system as being part of the scheme which was advocated by C. F. Anderson.[8]

William Loughbridge, June 23, 1870, proposed to have a plenum chamber under the Speaker's desk, and from this point by radial ducts to conduct the heated air to each desk, and have registers in the faces of the desks, with open glass panels in the ceiling for hot air. Each desk was to be provided with deflectors, so that the members could deflect the hot air along the floor or on their person at will.

March 3, 1871, Mr. Jenckes, chairman of a select committee, made a report stating that several committees had investigated the subject and that many reports had been made, "but their investigations and the elaborate reports which followed them have led to nothing substantial in the way of improving the condition of the two Halls. The evils were felt and admitted, but the plans which were proposed for removing them did not meet the approbation of either House."[9] This report makes a careful review of the whole subject. Chairman Jenckes expresses his surprise at the conflicting views of the many engineers, experts, and committees, as well as the oddities which had been submitted to Congress for approval. Among the many suggestions presented, the following is worthy of mention: The plan suggested by Lavan C. Stiners required the remodeling of the building from foundation to roof, and in case a new building was to be constructed the committee thought it probable that his scheme might receive favorable consideration. They did not think it could be installed for a less sum than $1,100,000.

This committee found that the greatest obstacle to an even temperature was the construction of the roof. The roof had an area of over 17,000 square feet. About 4,000 square feet of this area was glass, while the remaining portions were of copper three-sixteenths of an inch, corrugated, and fitted loosely together where they lapped; the expansion and contraction of these plates left open fissures for nearly the whole area of the roof, through which streams of cold air had access to the space between the roof and the ceiling. This cold air chilled the Chamber into and from which the hot air was expected to pass and caused down currents to the floor of the House.

The committee caused a fireproof ceiling to be placed a few inches below the roof, and the effects of the downward currents were almost, if not completely, stopped. By using grate fires in the cloakrooms in connection with the changes suggested below the committee felt that the heating would be all that could be desired.

The defects in ventilation they found consisted in the difference between the theory that the air forced in at the registers would pass out through the roof, heating and carrying with it all the foul air of the room, and the fact that the currents of warm air passed up directly to the roof, leaving the foul air. At the same time the downward currents from the cold roof also prevented the foul air from passing off. These down currents were particularly perceptible in the central portion under the glass ceiling and over the heads of the members. The registers were in the floors in a horizontal position, across the Hall, scattered between the desks and under the feet of the members, and unavoidably became the receptacle for the dust and dirt which was driven out into the Chamber as soon as the fans were operated. This dust caused much irritation and coughing among the members.

[7] Ibid.

[8] *Memorial on Ventilation of the Halls of Congress,* S. doc. 110 (40–2), Serial 1319.

[9] See *Report on Lighting of the Capitol,* H. report 48 (41–3), Serial 1464.

No means were employed to moisten the overheated air from the coils. The cloakrooms with no ventilation, the great difference in the audiences of the Hall, and the effect of sun and cold on the roof are mentioned as disturbing elements in securing proper ventilation. The committee would not recommend radical changes, as it seemed by no means certain that the plans suggested would be successful when applied to halls of such magnitude as those under consideration. They recommended that the foul air be drawn from the space between the roof and ceiling, thus causing a vacuum and drawing out the foul air at the ceiling. A flue, already in existence, they thought could be utilized, which, with an additional flue which could be built, would give a sufficient area for the purpose. A similar plan had been adopted for the Senate Chamber with marked success. Ducts were to be arranged under the floors, and registers to be inserted in the steps in a vertical position. This plan had also been introduced in the Senate with successful results. Open fires were recommended for cloakrooms, and ventilating ducts for the gas, while exhaust ducts were to be placed in the cloakroom chimneys from the galleries. Similar ducts were recommended for the Senate Chamber. The suggested changes were made, with a marked improvement in the effect.

To improve the fresh-air supply of the House of Representatives, two large air flues were constructed, during the year 1876, leading to the men's gallery and opening into boxes under the seats. The fronts and sides of the seats in the gallery were perforated so as to distribute the air evenly over the total area.[10] During this year Joseph Henry, Thomas Lincoln Casey, Edward Clark, F. Schumann, and John S. Billings were appointed as a Commission to consider the subject of ventilation. The report of this Commission, printed in connection with the report of the Architect of the Capitol, October, 1877, makes the following recommendations: They do not think it desirable to change the present upward system of ventilation, and do not consider it possible to obtain natural ventilation by means of windows. While they consider the fresh-air supply sufficient for ordinary conditions, they think that it should be increased so as to be ample for extraordinary conditions. They recommend a large increase of fresh air to the galleries and the substitution of galvanized-iron flues for the brick flues under the floor, as well as a duct leading to a tower in the grounds which should be 30 feet high, through which the fresh-air supply should be taken. They urgently recommend a method of moistening and cooling the air before it is introduced into the Hall, as well as an additional supply of air for the upper lobbies. They also recommend that outlets in the roof should be arranged so that the wind would not affect the outflow of air; that electric signals be placed between floor and engine room; that the heating and ventilation be placed under one man, and that the person who is to have charge of construction and the work after completion should be one of the above Commission.[11]

To carry out the suggestions of the Commission, Robert Briggs was employed, and during the years 1877 to 1879 the following changes were made in the heating and ventilating system:

A fresh-air inlet or duct was built running to the principal fan from the inlet tower, located at a point 200 feet west of the Capitol.[12] The ducts leading from the fan were changed, and a large delivery main was constructed from the fan to a point near the center of the wing, where one of the central rooms was changed into a heating chamber. The air, after passing through the heating coils, was forced into a moistening and dust-cleansing chamber. Two ducts led upward through the

[10] "Annual Report of the Architect of the United States Capitol" [For the Fiscal Year Ended 30 June, 1876], 755.

[11] "Annual Report of the Architect of the United States Capitol" [For the Fiscal Year Ended 30 June, 1877], 3–5.

[12] Two inlet towers for ventilating the Capitol were built and remain on the west front grounds.

basement story to different parts of the hall on each side of the central Hall, where they ended in inclosed chambers. From these chambers the air passed into circular ducts directly under the desks, while others led into the space behind the desks. Separate ducts took the air to the galleries. The distributing branches to the space beneath the seats were made of sheet iron and controlled by dampers.

The ducts were increased to the following dimensions:

	Square feet
Principal supply duct	120
Delivery duct	80
Main duct to Hall	40
South gallery duct	14
North gallery duct	7

The area for the exit of the foul air in the attic was increased by the construction of a large louver with an area of 140 square feet.

The old steam coils were reconstructed and made into four sections, containing 45,000 feet of radiating surface and made of 1-inch pipe. The sections were placed in the lower part of the heating chamber and inclosed by sheet-iron coverings, separating them from the upper portion. The entrance of the air into this chamber was controlled by a louver partition; by opening the lower slats and closing the upper ones, the air passed through the coils and by opening the upper slats and closing the lower ones, the air passed over the coils without being heated, except to a very moderate degree.

In the moistening and cleansing chamber both steam and water jets were placed, through which the air could be forced. Around this chamber a passageway was arranged, so that the air, when desired, could be passed directly to the points of distribution without being charged with moisture.

The air entered the Hall as it formerly did through perforations in the risers of steps, various registers being placed around the Speaker's desk and large registers retained in the corners of the Hall, in the space beyond the desks. During the year 1880 the registers were enlarged.[13]

In the report of the Architect of October 1, 1881, he states that the result of the changes in the heating and ventilating system had proved very satisfactory with the exception of a deficiency in the moisture of the air. The changes left no perceptible drafts, and only a variation of 1° was noticed in different portions of the Hall. The conditions remained satisfactory throughout the year 1883.[14]

Additions were made to the inlets and outlets of the Senate in 1885. In 1889 the heating apparatus was reported as still working satisfactorily. In 1890 a tower for the fresh-air inlet to the Senate was built 400 feet west of the Senate wing.[15]

The Senators in 1896 determined to completely remodel the heating and ventilating system of the Senate wing, and by act approved June 11, 1896, authorized alterations of the apparatus according to plans made by S. H. Woodbridge. The changes were made during the years 1896 and 1897.[16]

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[13] "Annual Report of the Architect of the United States Capitol" [For the Fiscal Year Ended 30 June, 1880], 3.

[14] "Annual Report of the Architect of the United States Capitol" [For the Fiscal Year Ended 30 June, 1881 and 1883], 4–5.

[15] "Annual Report of the Architect of the United States Capitol" [For the Fiscal Year Ended 30 June, 1885 and 1890], 3–4.

[16] "An Act Making Appropriations for Sundry Civil Expenses of the Government for the Fiscal Year Ending June 30, 1897, and for Other Purposes," 54th Cong., 1st sess., in *United States Statutes At Large,* vol. 29, 433. See also "Annual Report of the Architect of the United States Capitol" [For the Fiscal Year Ended 30 June, 1897], 3–6, especially the appendix by Professor S. H. Woodbridge, "Report Rendered on the Material Furnished for and Labor Performed in Improving the Ventilation of the Senate Wing of the United States Capitol, Under the Appropriation Made Therefor June, 1887," 25–26. Improvement of the ventilation of the Capitol remained a recurrent issue with the members of Congress until the introduction of modern air-conditioning systems in 1935–36. For a discussion of the effects of summer heat on the deliberations of Congress before and after the introduction

The entire woodwork of the Senate Chamber and gallery floors was removed, and replaced by an iron framework on which were laid substantial wooden floors with air and dust proof joints.

These floors were made tight enough to make two plenum chambers, one in the space beneath the Senate Chamber floor and another under the gallery floor. The air is forced into the Chamber through registers at a high velocity near the seat of each Senator, at various points on the perimeter of the Chamber, near the President's desk, and in the galleries. The velocity of the incoming air is reduced where it enters the Chamber by large diffusing surfaces, the area of the openings being 100 square inches for each Senator's desk, 120 square inches for each desk-leg diffuser, and the same for the chair-leg diffusers in the galleries. These openings are all placed in a vertical position, so that it is difficult for them to become receptacles for dust and dirt. The total area of the openings is 169 square feet for the floor of the Senate and 600 square feet for the gallery.

The openings in the central portion of the ceiling were closed, and openings were made in the perimeter of the Senate Chamber, near the ceiling, with the object of preventing downward drafts in the center of the Chamber. The air passes out over the galleries through areas smaller than the areas of the inlets. The old iron and wood fan was replaced by a light steel fan, which delivers 35,000 cubic feet of air per minute when making 125 revolutions a minute, and 48,000 cubic feet per minute when making 150 revolutions a minute. The old battery of steam coils was replaced by four batteries containing 23,000 square feet of surface each. Two of these coils are intended for steam only, one for steam in winter and refrigerating brine in summer, and one for refrigerating brine exclusively.

The air is led to the Senate Chamber and to the galleries by separate ducts or channels, from different coils, so that the air to the galleries may be heated to a greater temperature than that to the Chamber floor; this provision is intended to prevent a downward draft.

In the attic space above the ceiling steam coils have been located in sections to equalize the temperature in this space. This is intended particularly for night use, when the Chamber is usually cool and has a tendency to downward currents. A thermophone gives the engineer in the basement the temperature of the attic. The air is removed from the roof space by an 8-foot inverted Blackman wheel fan run by a direct-connected electric motor with 130 revolutions a minute. The Senate coat rooms, which were supposed to be ventilated by registers in the ceilings with ducts terminating under the galleries, were found to contain an inadequate amount of fresh air. The ducts were extended to the space above the corridors, where they were connected with fans which are capable of withdrawing 800 to 1,000 cubic feet of air per minute from each room.

Arrangements were made to heat and ventilate the corridors and committee rooms, with 35,000 feet of cubic air per minute, by installing a new 10-foot fan and tempering coils to heat the air to 65°. The air is then forced to the stacks at the base of flues which were intended to run to one direct outlet, but in many cases it was found upon investigation that the coils were connected with the flues of several rooms. In the new arrangement the ducts were so arranged that the air could be forced through these coils or be allowed to pass around them, in all cases depending upon the temperature desired in the rooms.

The old apparatus in the Supreme Court room was also completely remodeled. A new fan was put in capable of supplying 15,000 cubic feet

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of air conditioning, see "Cooler Air and Longer Sessions: Air Conditioning Keeps Congress on Job," *Heating, Piping & Air Conditioning* 18 (October 1946): 76–77; for a description of the project, see "Cooling Congress: Capitol, Senate, and House Office Buildings Air Conditioned," *Architectural Forum* 67 (July 1937): 82.

of air per minute, the air entering the room at various points through diffusing and baffling surfaces so as to prevent unpleasant drafts.

The kitchen and toilet rooms were also rearranged so as to obtain better ventilation.

Pneumatic steam valves were placed so as to govern the temperature in different portions of the Senate wing and Supreme Court section, by the automatic operation of thermostats which were placed in different parts of the Senate rooms and halls.

By means of a thermophone the temperature is indicated in the corridor tunnel, committee-room and Senate fan chambers, plenum chamber beneath the Senate on both the north and south sides, plenum chamber of the north and south galleries, also in the north and south galleries and Senate Chamber attic. Pneumatic steam valves are operated automatically from all these points, controlling the heat according to the adjustment of the apparatus.

In the engineer's room are placed rheostats for starting and stopping the various fans, as well as meters to indicate the power and rate of current on each fan. Charts show the speed and volume of air delivered by the various fans.

Mr. Woodbridge recommends, in his report of 1897, that all flues from corridors be run in galvanized-iron ducts to an exhaust chamber, where the air would be withdrawn by an exhaust fan.