THE VENTILATION AND WARMING OF THE ROYAL ALBERT HALL

Some notes by Brian Roberts

In May 2016, the CIBSE Heritage Group visited the Royal Albert Hall, touring the public areas and behind the scenes and obtaining, from their Archives, a copy of the 6-page hand-written Contract of 1869 between the Corporation and Wilson Weatherley Phipson, the Engineer and Contractor for the Ventilation & Warming of the Hall.

Phipson (1838-91) is no stranger to the Heritage Group. Our website features his Biography and many examples of his work in building engineering services. The Contract now provides important new information and throws light on the workings of the H&V industry in Victorian times.

The Legal clauses of the £5000 Contract are written using many words and phrases relatively unfamiliar to the present day Engineering Profession. In addition, the Legal section is written without punctuation as was the custom of the day.

The Technical clauses are a Specification covering the systems, equipment and standards of workmanship, but also include Design Criteria and Performance Requirements. The Specification lists information relating to boilers, fans, piping, controls and instrumentation and considerable detail of the associated builders work. Previously unknown to the Heritage Group are the notes relating to “moistening apparatus” (humidification) and to the use of water sprays to achieve “cooling in summer.” Thus, the system was intended to have the basic features of what would now be called “air conditioning.”

There is also reference to Hygrometric Data and “Masons Hygrometer” and the “Temperature of evaporation (of the air) not to exceed 10 degrees” which may relate to wet-bulb temperature or dew point depression.” There is also a note on instrumentation which refers to “Refrigerating Apparatus,” which probably means the cold water spray system. All fundamental units are given in Imperial, then in common use in Great Britain.

There are some doubtful technical requirement clauses, such as “noiseless fans” and “The temperature of the large Hall during the hottest portions of the Summer Months to be below the external temperature of the air” (with an audience of 6000 plus, extensive gas lighting and without refrigeration?).

All other reports on the engineering services in the Royal Albert Hall, held by the Heritage Group, were written shortly after the opening and, at this time, we have no details regarding the success or otherwise of the ventilating and warming installation.

The handwritten Contract has been transcribed into the following Word Document to enable further study. A copy of the original Contract is provided after the Word version.
This Indenture made the twenty fourth day of May

One thousand eight hundred and sixty nine Between Wilson Weatherly Phipson of No. 1 Salisbury Street Strand in the County of Middlesex hereinafter called the Contractor of the one part and The Corporation of the Hall of Arts and Sciences hereinafter called the Corporation of the other part Whereas The Contractor has proposed to ventilate and warm the Royal Albert Hall of Arts and Sciences now in course of erection upon the Estate of The Commissioners for The Exhibition of 1851 at South Kensington in the same County and to make provide and execute the necessary works machinery and apparatus according to the Specification and as shewn on the Plans and Drawings already prepared a Copy of which Specification signed by Henry Young Darracott Scott a Lieutenant Colonel in Her Majestys Corps of Royal Engineers on behalf of the Corporation and by the Contractor is hereunto annexed by way of Schedule and which Plans and Drawings have been signed by them for the sum or price of Five thousand pounds to be paid as hereinafter mentioned which proposal the Corporation have agreed to accept And whereas the Contractor and the Corporation have agreed to enter into the covenants hereinafter contained Now these presents Witness that in consideration of the premises the Contractor for himself his executors and administrators Doth hereby covenant with the Corporation their successors and assigns the Corporation for themselves their successors and assigns have by covenant with the Contractor his executors and administrators as follows:________________________

That the Contractor will at his own expense within six calendar months from the day on which he shall have had final possession given to him of all such part of the Hall and Buildings as may be necessary for the purposes of this Contract execute and complete with all proper and necessary materials workmanship and labor of the best kinds and according to the said specification and in every respect in the most substantial and workmanlike manner All and singular the works mentioned and set forth in the said Specification and Plans and Drawings under the direction and to the entire satisfaction of the said Henry Young Darracott Scott hereinafter referred to as the Director of Works ______________

That the Contractor shall forfeit and pay to the Corporation the sum of Fifty pounds for every week during which the said Works shall be and remain unfinished after the expiration of the above mentioned period provided such delay be occasioned by the act neglect or default of the Contractor which sum shall be recovered as liquidated damages or may be deducted from the sum payable to the Contractor under this Contract ________

That the Contractor shall and will at his own costs and charges for the space of twelve Calendar months this to be compiled from the date of the certificate of final completion uphold maintain and keep in proper working order with all needful reparation the said works machinery and apparatus and at the end of that term hand them over to the Corporation in perfect working order and condition ______________
That in case the Director of Works shall be dissatisfied with the conduct of any Foreman or Workman employed by the Contractor or with any materials, articles, or things used, fixed, or brought upon the said premises for the purpose of being used or fixed in the said Hall or Buildings and shall give Notice thereof in writing to the Contractor he the Contractor will forthwith discharge such Foreman or Workman and at his own cost remove the said materials, articles, and things and in the event of his failing to remove the same the Director of the Works shall be at liberty to remove them and the costs of such removal shall be deducted from the Contract sum.

That, if the Corporation shall require any extra or additional works to be done or shall cause the Works to be delayed in their commencement or progress, the Contractor shall from time to time be allowed such additional time as shall have been necessarily consumed in the performance of such extra or additional work or as shall have been lost by the Corporation and the payment for delay shall not be payable until after the expiration of such additional time retrospectively.

That all the materials, articles, and things brought upon the premises for the purposes of being used or fixed in relation to this Contract except such as shall be disapproved of by the Director of Works shall immediately they shall be brought upon the said premises become the property of the Corporation and shall be used in the said Works. Provided always that any such materials, articles, and things remaining on the premises after the Certificate that this Contract has been fulfilled shall have been given shall thereupon become the property of the Contractor.

The Corporation shall pay to the Contractor his executors or administrators the Contract price or sum of Five thousand pounds and such additional sums if any shall become payable in respect of additional works in manner following that is to say: When and so soon as the Director of Works shall certify under his hand that work has been executed and fixed in the Hall and Buildings to an amount of not less than Five hundred Pounds after deducting the amount of any previous Certificate the Corporation shall pay the Contractor Eighty-five percent upon the balance remaining due upon the completion of the work to the satisfaction of The Corporation and shall and will pay the percentage from time to time retained by them and then remaining in their hands so soon as the Director of Works shall have certified that the Works and Apparatus have been severally proved to be practically in strict conformity with the said Specification, Plans and Drawings which Certificate shall not be given until the lapse of three Calendar months after the said Director of Works shall have given his final Certificate of completion.

That, if the Corporation shall be desirous of making any addition to the said Works hereby contracted for the Contractor shall execute the same as the Director of Works shall in writing direct and the cost of any such addition shall be ascertained by the Surveyors of the Corporation or by an Estimate approved by them and be paid for in addition to the said Contract price by the Corporation.

That in the event of any difference, question, or dispute arising between the parties hereto not hereinbefore provided for or touching the construction of these Presents or in respect of any sum to be paid deducted or allowed the matter in difference or dispute shall be referred to the arbitration of Mr. Henry Arthur Hunt and Mr. Charles Stephenson each of No. 4 Parliament Street Westminster Surveyors who shall respectively have all the powers given or provided for in and by the Common Law Procedure Act 1854. In Witness whereof the Contractor hath hereunder set his hand and seal and the Corporation have caused their Common Seal to be hereunto affixed the day and year before written.
Signed sealed and delivered by the said Wilson Weatherly Phipson in the presence of
Alex Thos Singleton Asst to Messrs Burchell 5 Broad Sanctuary Westminster

Specification for the Ventilation and Warming
Apparatus and Works for the Royal Albert Hall of Arts and Sciences South Kensington in course of erection by the Corporation of the Hall of Arts and Sciences on the Estate of the Commissioners for the Exhibition of 1851

Description of Apparatus
At the South end of building near the Horticultural Gardens 2 air shafts to be provided each 6'0" x 6'0" having access to the External Air and communicating by means of two air channels with two fans the size of each to be 6'0" in diameter to draw the fresh air down these shafts and force it along channels into the Heating Chambers placed in portions as follows- No. 1 under the seats of Amphitheatre Stalls- No. 2 under Floor of Arena- No. 3 in under outer Corridor of Basement

Arrangement of Heating Surface: In these Heating chambers are to be fixed a series of 4” H. W. Pipes placed in tiers as shewn the fresh air from Fans being forced through the interstices of these Coils of Pipes by which the Air becomes heated before it is distributed over the building special provision being made for the moistening of the Air

Distribution of the Air for warming: The distribution of the Air for the direct heating of the Hall to be as follows videlicet- From No. 1 Heating Chamber perforations to be provided in the risers of Seats- From No. 2 Chamber by means of interstices to be provided between the floor boards- No. 3 Heating chamber to be by means of Air Channels formed in the Walls having their own apertures of inlet to Rooms constructed as shown on Plans and Sections- By these distinct arrangements for the distribution of the Heat over the Building the entire power of Apparatus may be concentrated on the Hall at the same time affording the means of Heating the Enclosed rooms independently when needed

Distribution of the Air for Ventilation: The distribution of Air for Ventilation to be as follows- As soon as the Hall has obtained the desired temperature and the Public are entering the Apertures of Inlet of Air are to be closed by means of valves to allow only 1/6 of the amount of air required for Ventilation to pass through these sources the remaining 5/6 to be distributed by means of four distributing channels to the No. 3 Heating Chamber found in outer Corridor from whence is by means of the Air Flues in the Walls distributed equally over the entire building on every floor as shown by the Plan and Sections; The Air in each case to be admitted at points distant from the inmates where practicable: The Air Channels for Ventilation to be arranged so as to allow the admission or warm or cold air to the Hall when required

Escape of Vitiated Air: For the escape of the vitiated air an aperture in Ceiling equal to 120 square feet is to be provided over which is to be fixed a shaft at least 8’0” in diameter fitted with Louvres running above the roof as shewn on Drawings. The ascending power of this Shaft being increased by the heat generated by a ring of Gas burners on the proportion of one burner to each square foot of area

Heating Power for Hot Water Pipes- The Coils of H. W. Pipes fixed in Heating Chambers to be worked by means of H. W. condensing boilers of approved construction and fixed in positions as shown on Drawings the Steam for condensation being supplied to them from two 30 H. P. Boilers fixed at the S. W. end of building- The condensing H. W. Boilers to be arranged so that each condenser has the distinct Coils of Pipes to work so that either the whole or part of number of coils may be at work according to the temperature of external Air proper Stop Cocks and Valves being provided for this purpose
Steam to Condensing Hot Water Boiler: The Steam pipe conveying Steam from Boilers to Condensers to be coated with a proper nonconducting Material to prevent condensation and the branch pipes to Condensers to be fitted with Gun Metal Steam Cocks so as to regulate or shut off the Steam from same when required.

Steam Engine: The Steam Engine for working Fans will be 6 Horse power horizontal or vertical and constructed on approved principle.

Supernumerary of Boiler: The Supernumerary of H. P. Boiler to be a Cornish Boiler with a double Safety Valve Steam and Water Gauge and all other necessary fittings.

Fans: The Patent Fans to be each 6'0" feet in diameter and on the principle of the Screw and to each have fan blades with the axis of Fans parallel to the axis of the Channels the whole working in self-lubricating Gun Metal Plumber blocks.

Indicating Dials: In Main Air Shafts to be fixed a patent self acting valve with proper counterpoise and attached to which to be an indicating Dial to register the amount of air passing through the Air channels to Fans and from thence to the Building to enable the Engineer to work the Fans according to the requirements.

Valves in Air Channels: Valves of simple construction to be fixed in all the Air channels so as to regulate in all cases the amount of air to these chambers from Fans. In main air shafts to be fixed a proper Water Spray to cleanse and cool the air the Air before it passes to the Building during the Summer months.

Moistening Apparatus: In all the air chambers to be fixed a moistening Tank to ensure the required degree of moisture to air.

Hot Water Pipes in Chamber: The Hot Water pipes to be fitted in the chambers to be C. I. Pipes 4" in diameter internal the weight of same to be about 130 feet to the Ton. All joints of pipes to be made in the best cement and proved before they are used. The pipes to be fitted with C. I. Coil boxes of most approved construction and the whole of the pipes to be fitted up with the necessary Expansion Cisterns air vents ball cocks for supply of Water and Shut off valves from the Expansion cisterns and coils of pipes proper waste pipes to be provided.

Temperature of Building in Winter: The temperature of large Hall and enclosed rooms to be Fifty eight Degrees 58 Fahrenheit as a mean during the winter months and not lower than 55.

Temperature of Corridors Stairs etc: The temperature of Corridors Stairs Entrance Halls to be a mean of Fifty five degrees (55) Fahrenheit and not less than 52.

Hygrometrical Degree of Air: The temperature Air 1 temperature of evaporation as shown on Masons Hygrometer shall not exceed ten degrees.

Temperature of Hall in Summer: The temperature of large Hall during the hottest portions of the Summer Months to be below the external temperature of the air.

Amount of air to be supplied to the Building: The amount of air to be supplied to the Building by means of the Fans to be 3,600,000 cube feet per hour. This amount of air by Bivans Anemometer or any other approved Instrument. The Contract price of £5000 to include the supplying and fitting up complete the following items, exclusive of any brickwork for the completion of same. The necessary Hot Water Condensers with fittings Heating Apparatus equal to 26000 feet of 4" H. W. Pipes one 10 H. P. Boiler, one Six H. P. Steam Engine with gearing complete to work Fans. Two patent noiseless Fans equal to supplying combined 3,600,000 Cubic Feet of air per hour. Indicating Dials Valves to regulate the supply of fresh air moistening and Refrigerating Apparatus and in general all necessary Ironwork connected with the Engineering part of Apparatus.
Witness to the signature of
Henry Young Darracott Scott

Witness to the signature of
Wilson Weatherly Phipson

Note 1: Phipson’s middle name is correctly written as Weatherley, not Weatherly as shown in the Contract. This correct spelling is shown on Phipson’s Death Certificate, his “A Memoir” and on his tombstone.

Note 2: H Y D Scott in his description of the H&V installation gives the fans as 5’9” diameter not the 6’0” specified.
Contract

To ventilate & warm Hall

W. W. Phipson Esq.

And

The Corporation of

The Hall of Arts and Sciences

Dated 24th May 1869
The original contract documents

W.W. Phipson Esq.

and

The Corporation of The Hall of Arts and Sciences

Contract

To ventilate Swann Hall.
This Indenture

Made the twenty fifth day of November, in the year of our Lord one thousand eight hundred and forty six, between

Walter Macfarlane, of Ballycastle, in the County of Antrim, in the Province of Ulster, tenant farmer of the estate of

the Corporation of the City of Dublin, and

The Corporation of the City of Dublin,

For and in consideration of the premises,

Witnesse whereof the said Contract is executed.

...
for the space of two hundred and sixty days from the day of
the sale of the severalty and not before, without any
interference, and keeps in a proper working condition with all necessary provision that
said works, tools, and apparatus, and at the end of that term shall pass over to the Corporation in perfect working order and
condition.

That in case the Director of Works shall become disturb with the con-
duct of any workman or workmen employed by the contractor or with
any materials articles or things sent or brought upon the said
premises for the purpose of being used or fixed in the said Hall or in
buildings, and shall give notice thereof in writing to the contractor he
or the contractors shall forthwith desist from all such workman, workmen,
and at his own cost remove the said materials, articles and things, and in the
event of his failing to remove the same the Director of the Works
shall be at liberty to remove them and the costs of such removal
shall be deducted from the Contract sum.

That of the Corporation shall report any extra or additional works
to be done or shall cause the Works to be delayed in their commence-
ment or proceed the contractor shall from time to time allow or
such additional hours as shall have been necessarily consumed in the
performance of such extra or additional work or as shall have been lost by the Corporation, and the payment for delay shall not
become payable till after the expiration of such additional time.

That all the materials, articles and things brought upon the said
premises for the purposes of being used or fixed or retained in the said
premises except such as shall be disapproved of by the Director of
Works, shall immediately after the said premises become the property of the Corporation and shall be used in the said
premises. The said Director always to see that any such materials, articles and things remaining on the premises after the Certificate that the Contract had
been completed shall have been given shall thereupon become the
property of the Contractor.

Consequence shall pay to the contractor his executors or adminis-
trators the said price or sum of $500 for and in the said premises,
following that day when and so soon as the Director of Works shall
certify under his hand that works have been executed and
fixed in the Hall and buildings to an amount not less than
Five Hundred Pounds after deducting the amount of any previous
Certificate the Corporation shall pay to the Contractor Eighty five per
cent upon the amount so certified and in like manner Eighty five per
cent upon the balance remaining due upon the completion of the
work, with the satisfaction of the Corporation, and shall and will pay the
percentage from time to time preserved by him and their remunera-
tion in their hands, so soon as the Director of Works shall have certified
that the works and apparatus have been severally preserved to be
in fact in strict conformity with the said Specification Plans and
Drawings which the Certificate shall not be given until the lapse of three
Calendar months after the said Director of Works shall have given his
final Certificate of completion.
That the corporation, having executed the above document, shall be void and the corporation shall indemnify the corporation in the event of any such action to be commenced by the corporation or by an insufficiency of power and be paid for an additional to the said bonds. The corporation shall indemnify the corporation in the event of any such action to be commenced by the corporation or by an insufficiency of power and be paid for an additional to the said bonds. The corporation shall indemnify the corporation in the event of any such action to be commenced by the corporation or by an insufficiency of power and be paid for an additional to the said bonds. The corporation shall indemnify the corporation in the event of any such action to be commenced by the corporation or by an insufficiency of power and be paid for an additional to the said bonds. The corporation shall indemnify the corporation in the event of any such action to be commenced by the corporation or by an insufficiency of power and be paid for an additional to the said bonds.

Specification

for the Dwellings and

Hall of Residence

Housing Estate in course of erection by the corporation of the Hall of Residences and dwelings on the site of the Commissioners for the Redevelopment of the

Description of Dwellings

The dwellings are to be of such width as to have a room of 6' x 6' and a living room of 8' x 8'. The doors are to be of wood with glass panels. The rooms are to be furnished with beds, tables, chairs, and other necessary furniture. The kitchens are to be equipped with stoves, sinks, and refrigerators. The bathrooms are to be equipped with toilets, sinks, and shower stalls. The hall is to be a spacious room with a dance floor and a stage for performances. The hall is to be equipped with a sound system and lighting fixtures.

Arrangement of Heating Surface

The heating chambers are to be placed in a series of 6' x 6' rooms, with each room having a fireplace. The fireplaces are to be of cast iron with a mantel and a chimney. The heating chambers are to be equipped with thermostats and a system of pipes to distribute the heat throughout the building. The heating system is to be maintained by a heating contractor, and the corporation is to be indemnified for any damages or losses that may occur.

Distribution of the Air for Ventilation

The distribution of the air for the direct heating of the Hall is as follows:

- The heating chambers are to be ventilated with fresh air from the outside, with the air being distributed through the interstices of the doors and windows of the building.
- The fresh air is to be distributed throughout the building, with the heating chambers being ventilated with fresh air from the outside.
- The heating chambers are to be equipped with air vents and fans to distribute the air throughout the building.

The corporation is to be indemnified for any damages or losses that may occur due to the distribution of the air for ventilation.
with a proper non-conducting material to prevent condensation and the branch pipes to be fitted with Gun Metal. Arrows for both the central and top-off the steam from such a point as required.

Steam Engine: The steam engine for working fans will be a Horse power horizontal or vertical and constructed on approved principle.

Superintendent J. B. Biddle: The Superintendent & C.P. Biddle to be a Cornish Boiler with a double safety valve and a valve gauge and all other necessary fittings.

The patent fans to be each 6 in diameter and on the principle of the box and to have each joint double with the axes of fans parallel to the axes of the fans.

The whole working on proper Gun Metal self-lubricating bearing blocks.

Indicating Valve: In main air shafts to be fitted a patent self-acting valve with proper counterpoise and attached to which to be an indicating dial to register the amount of air passing through the air channels to fans and from hence to the building to enable the Engineer to work the fans accordingly to the requirements.

Valves in air channels, values of simple construction to be fitted in all the air channels to each & regulated as all causes the amount of air to those chambers from fans. The main air shafts to be fitted a proper water spray to clean and cool the air before it passes to the building during the summer months.

Washing Apparatus: In all the air chambers to be fitted a washing tank to ensure the required degree of moisture to act upon the air before entering the chamber. The jet water pipes to be fitted in air chambers & C.P. A pipe to deliver water into the centres of pipes at an amount of water (to be about 150 jet to the ton) all pipes of water to be made of the best iron and each inserted before they are used - The pipes to be fitted with C. J. Coe's & Co's of most approved construction and the whole of the pipes to be fitted up with the necessary.

Expansion Chambers are vents ball cocks for supply of water and shut off valves from the Expansion Chambers and coils of pipes for proper waste pipes to be provided.

Temperature of Building in Winter: The temperature of the kitchen and constant rooms to be Fifty eight degrees 58° Fahrenheit as a mean during the winter months and not lower than 55°.

Temperature of corridors-Mains 70°. The temperature of corridors, Sheds, Entrance Halls to be a mean of Fifty five degrees 55° Fahrenheit and not less than 52°.

Hygrometrical Degree of Air: The hygrometrical degree of air to be maintained by the wet temperature of evaporation of steam on Masons.
Temperature of Hall in Summer: The temperature of large Hall during the hottest portions of the Summer months to be below the external temperature of the air.

AMOUNT of air to be supplied to the building - The amount of air supplied to the building - 15000 cubic feet per hour. This amount of air to be joined by means of an air-cooler or any other approved Instrument. The Contract price of £1200 to include the supplying and setting up complete the following items, exclusive of any work necessary for the completion of same. The necessary Hot Water Condensers with fittings. Heating Apparatus equal to 26000 feet of H.P. Pipes and 10 H.P. Boilers; one 10 H.P. Steam boiler with gearing complete to work Fans. The Patent gasless fans equal to supplying contract. 6000 cubic feet per hour. Indicating Dials to regulate the supply of fresh air moistening and refrigerating; FF, FF, and general all necessary Ironwork, connected with the engineering part of apparatus.

Witness to the signature of
Harvey Young Baragio Scott

William T. Langston

Witness to the signature of
Wilson W. Phipson

William T. Langston.
Plan Shewing Arrangements for Warming