

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 both 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

Wilson W. Phipson

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*

Henry Y D Scott.

Mr. & Mrs. Singleton

*Witness to the signature of
Wilson Weatherly Phipson*

Wilson W. Phipson

Mr. & Mrs. Singleton

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.

WILSON WEATHERLEY PHIPSON
Victorian Engineer Extraordinary, 1838-91
And the ROYAL ALBERT HALL

Contract

To ventilate & warm Hall

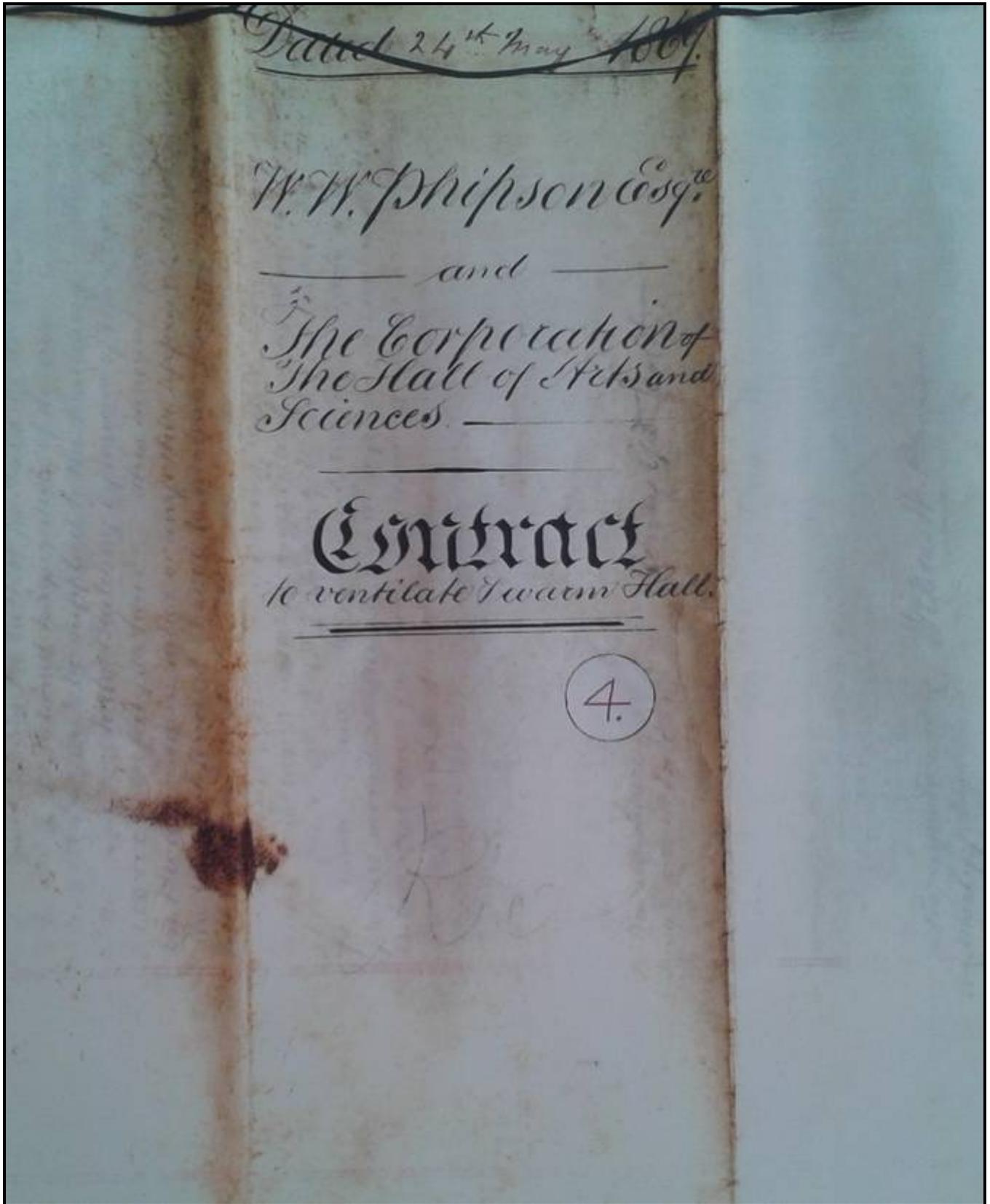
W. W. Phipson Esq,

And

*The Corporation of
The Hall of Arts and Sciences*

Dated 24th May 1869

The original contract documents



This Indenture

made the twenty fourth
day of May 1857 One
thousand eight hundred
and sixty nine **Between**

Wilson Weatherly Thompson of No 1 Salisbury Street Strand
in the County of Middlesex Civil Engineer 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 shown on
the Plans and Drawings already prepared a copy of which
Specification signed by Henry Young Devereux Scott a Lieutenant
Colonel in Her Majesty's Corps of Royal Engineers on behalf of the
Corporation and by the Contractor is herewith annexed by way
of Schedule and which Plans and Drawings have also been
signed by them at or for the price or sum 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
heirs executors and administrators **Doth hereby covenant**
with the Corporation their successors and assigns **And** the
Corporation for themselves their successors and assigns hereby
covenant with the Contractor his executors and administrators
as follows:

That the Contractor will at his own cost 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
fit 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 Devereux 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

That if the Corporation shall hereinafter of making any addition to the said works hereby contracted for the Contractor shall incur the same as the Designer 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 to be paid for in addition to the said Contract price by the Corporation.

That in the event of any difference or dispute arising between the parties hereto not hereinbefore provided for in settling the construction of these several Articles or in respect of any sum to be paid deducted or allowed the matter in dispute or dispute shall be referred to the arbitration of Mr Henry Arthur Hunt and Mr Charles Stephenson both of W.C. Parliament Street Westminster Surveyors who shall respectively have all the power given or provided for in and by the Common Law Statute Act 1854.

In witness

whereof the Contractor hath hereunto set his hand and seal and the Corporation have caused this to be hereunto signed the day and year first before written.

Agreed, sealed and delivered by the said
Contractor at the City of London in the presence of
Mr. J. H. Singleton
and Mr. J. H. Singleton
their functions.

Witness my hand and seal this 10th day of August 1884

Specification

for the Distribution and
Heating apparatus and ducts for gas, water
Albert Hall of 105 and 107 Strand
Henington in course of erection by the Corporation
of The Hall of Arts and Sciences on the site of
the Commissioners for the Distribution of Gas.

Description of Apparatus - All the ducts and fittings to be
near the Horticultural Gardens Lane shaft to be fixed and each
6'0" x 6'0" having access to the external air and communicating
by means of two air channels with two ducts at the top 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
proportions as follows - No. 1 under the seats of English
theatre Stalls - No. 2 under Floor of Boxes - No. 3 in
under outer Corridor of Dressing.

Arrangement of Heating Surface - In the Heating
Chambers are to be fixed a series of 4" dia. Pipes placed
in tiers as shown the fresh air from ducts being forced
through the interstices of these coils of Pipes by which the
Air becomes heated before it is distributed over the building
special provisions being made for the maintenance of the
Air.

Distribution of the Air for over-heating - The distribution of
the Air for the direct heating of the Hall to be as follows
vide list. From No. 1 Heating Chamber proportions to be

provided in the rows of seats - From N^o 2 Chamber by means of $\frac{1}{2}$ " interstices to be provided between the floor boards - N^o 3 Heating Chamber to be by means of Air Channels formed in the Walls having their inlets 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 as needed.

Distribution of 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 Apparatus of Inlet of Air to the Hall from N^o 1 and 2 Heating Chambers are to be closed by means of valves to allow only $\frac{1}{4}$ of the amount of air required for ventilation to pass through these sources the remaining $\frac{3}{4}$ to be distributed by means of four distributing Channels to the N^o 3 Heating Chamber formed in outer Corridor from whence the air 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 such case to be admitted at points distant from the inmates where practicable - The Air Channels for Ventilation to be arranged so as to allow an admission of 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' 6" in diameter fitted with Louvers running above the roof as shown on Drawings. The ascending power of this Shaft being increased by the heat generated by a ring of Gas burners in 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 its 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 Steam Cocks and valves being provided for this purpose - Steam to Condensing Hot Water Boiler. The Main pipe conveying Steam from Boilers to Condensers to be coated

107
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.

Superannuaries S. Boilers: The Superannuaries R. H. P. Boilers 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' 6" in diameter and on the principle of the Sorex and to have each four blades with the axis of Fans parallel to the axis of the Air Channels. The whole working in proper Gun Metal self-lubricating Plumber blocks.

Indicating Gages: In Main Air Shafts to be fixed a patent self acting valve with proper Counterpoise and attached to which to be an indicating Gage 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 before it passes to the Building during the summer months.

Meshing Apparatus: In all the air Chambers to be fixed a meshing Gage to insure the required degree of meshing to air.

Hot Water Pipes in Chamber: The Hot Water Pipes to be fitted in Air Chambers to be 2" Pipes 2' in diameter without the weight of same to be about 150 feet to the Sea. All joints of Pipes to be made in the best Iron Cement and proved before they are used. The Pipes to be fitted into C. A. 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 Fahrenheit as a mean during the Winter months and not lower than 55°.

Temperature of Corridors - Stairs &c: 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 of the Air / temperature of evaporation as shown on Masens 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 supplied to the Building by means of the Fans to be 3,600,000 cubic feet per hour - This amount of air to be proved by Bicani's 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 brick-work necessary for the completion of same: The necessary Hot Water Condensers with fittings Heating Apparatus equal to 26000 feet of 4" H. W. Pipes and 10 H. P. Boiler and Six H. P. Steam Engine with gearing complete to work Fans. Six Patent noiseless Fans equal to supplying combined 3600,000 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 & James Darnall Scott }

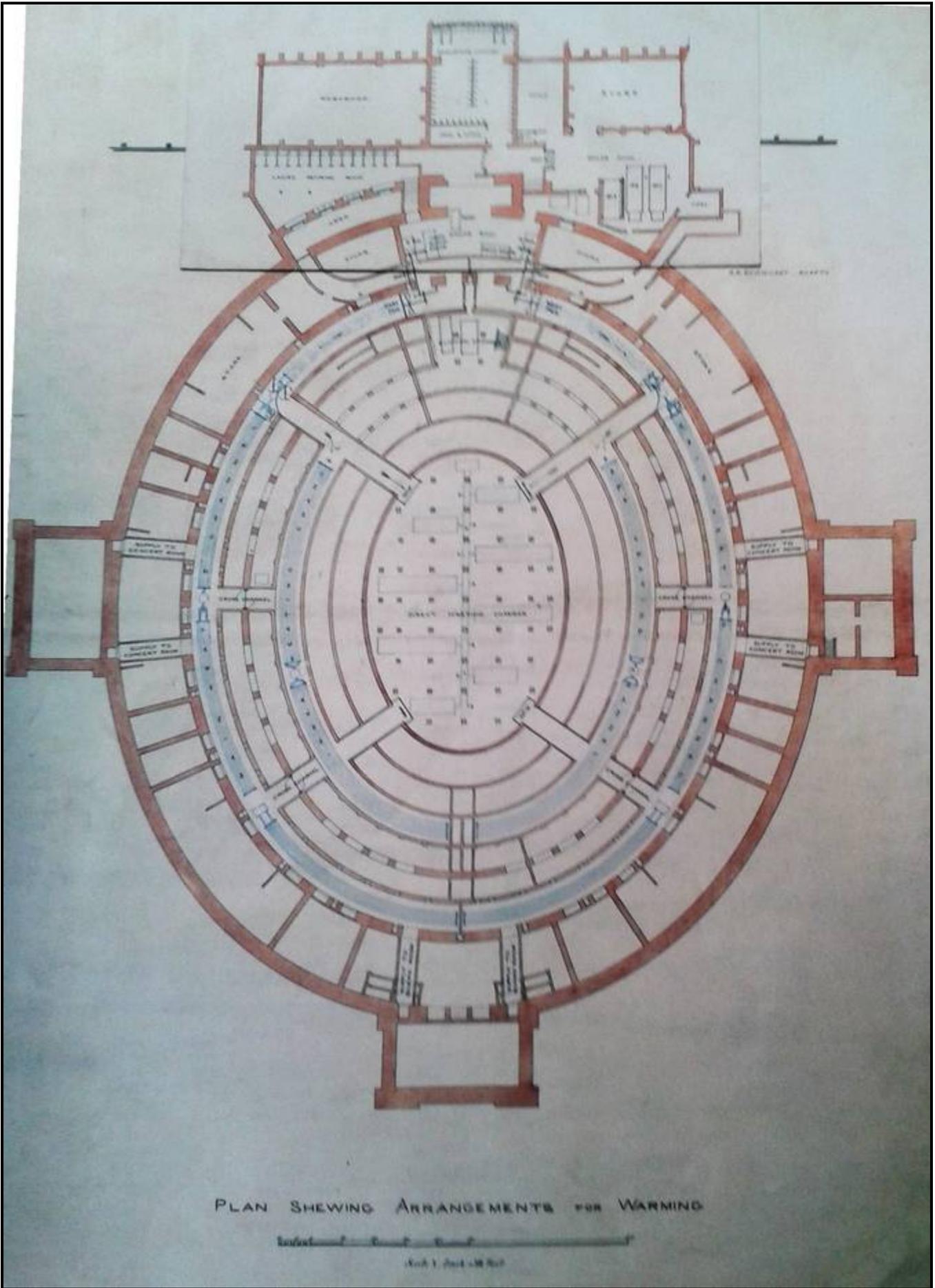
Henry & J. Scott.

Mr. Thos. Singleton.

Witness to the signature of }
Wilson Weatherly Phipson }

Wilson W. Phipson

Mr. Thos. Singleton.



PLAN SHOWING ARRANGEMENTS FOR WARMING

1 inch = 10 feet
Arch. J. J. & W. R. 1897

Plan Showing Arrangements for Warming

