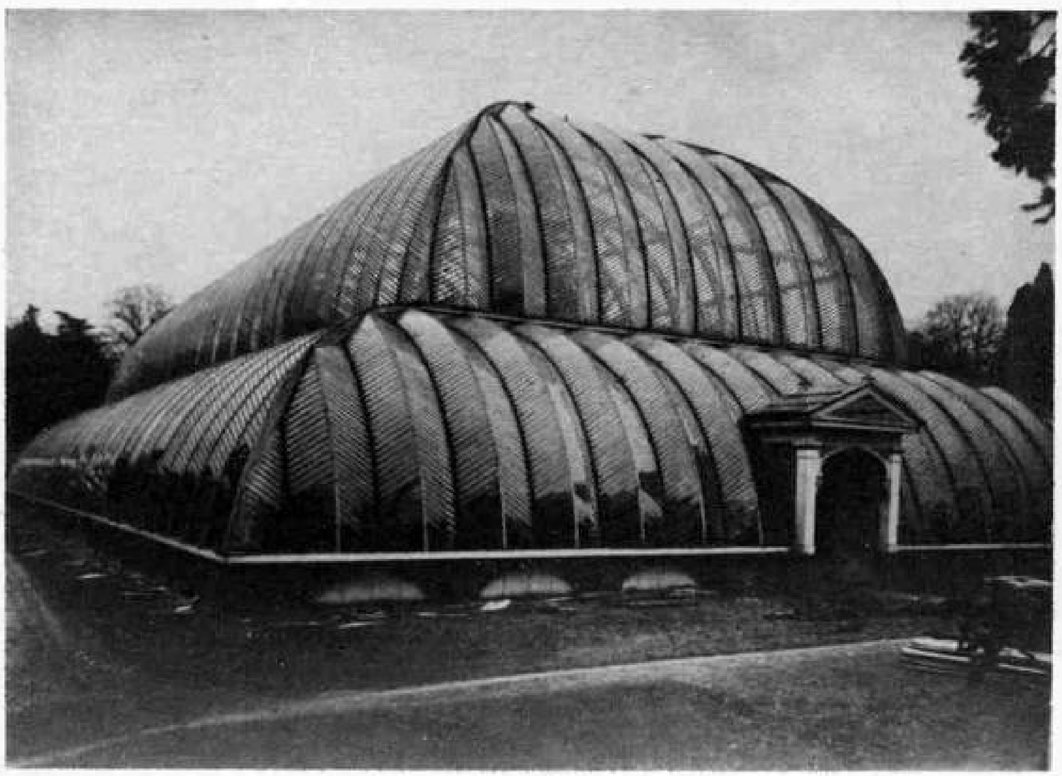
Sir JOSEPH PAXTON
1803-1865

English Gardener and Architect

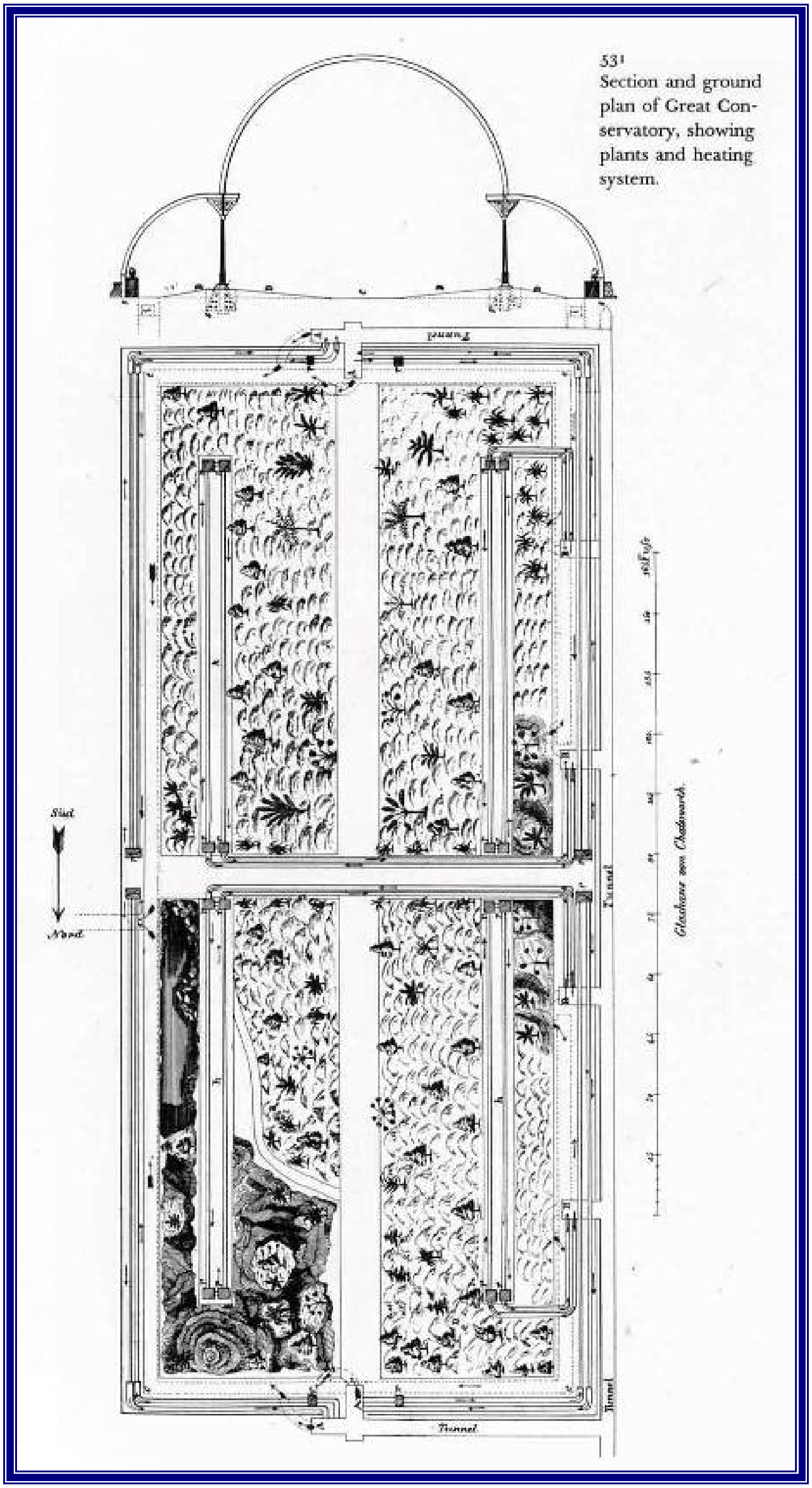
[192] Sir Joseph PAXTON **1803-1865**

English gardener and architect. Built the Great Conservatory at Chatsworth in Derbyshire (1836), heated by eight boilers and seven miles of four-inch pipe. Best known for designing the Crystal Palace, erected in London's Hyde Park for the Great Exhibition (1851). As a temporary structure, it was unheated but was provided with innovative controllable ventilation louvres and sun screens. When the Crystal Palace was re-erected and extended onto a permanent site at Sydenham in South London, it was provided with a large central boilerhouse where "no less than 22 boilers were arranged in pairs, each holding 11,000 gallons of water....Four pipes of 9 in. diameter were attached to each boiler, two flow and two return, and each boiler heated a certain transverse section of the Crystal Palace; the length of one flow and return was a mile and three-quarters, and the total length of heating pipes of all kinds was nearly fifty miles." Paxton also designed Mentmore Towers in Buckinghamshire (1859) for Baron Rothschild. It was an early example of central heating and "unusually employed hot water, at a time when heating by warm air seems to have been the favorite."

(Min-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)



The Great Conservatory, photographed shortly before its demolition after the First World War, was 277ft long, 123ft broad and 67ft high.



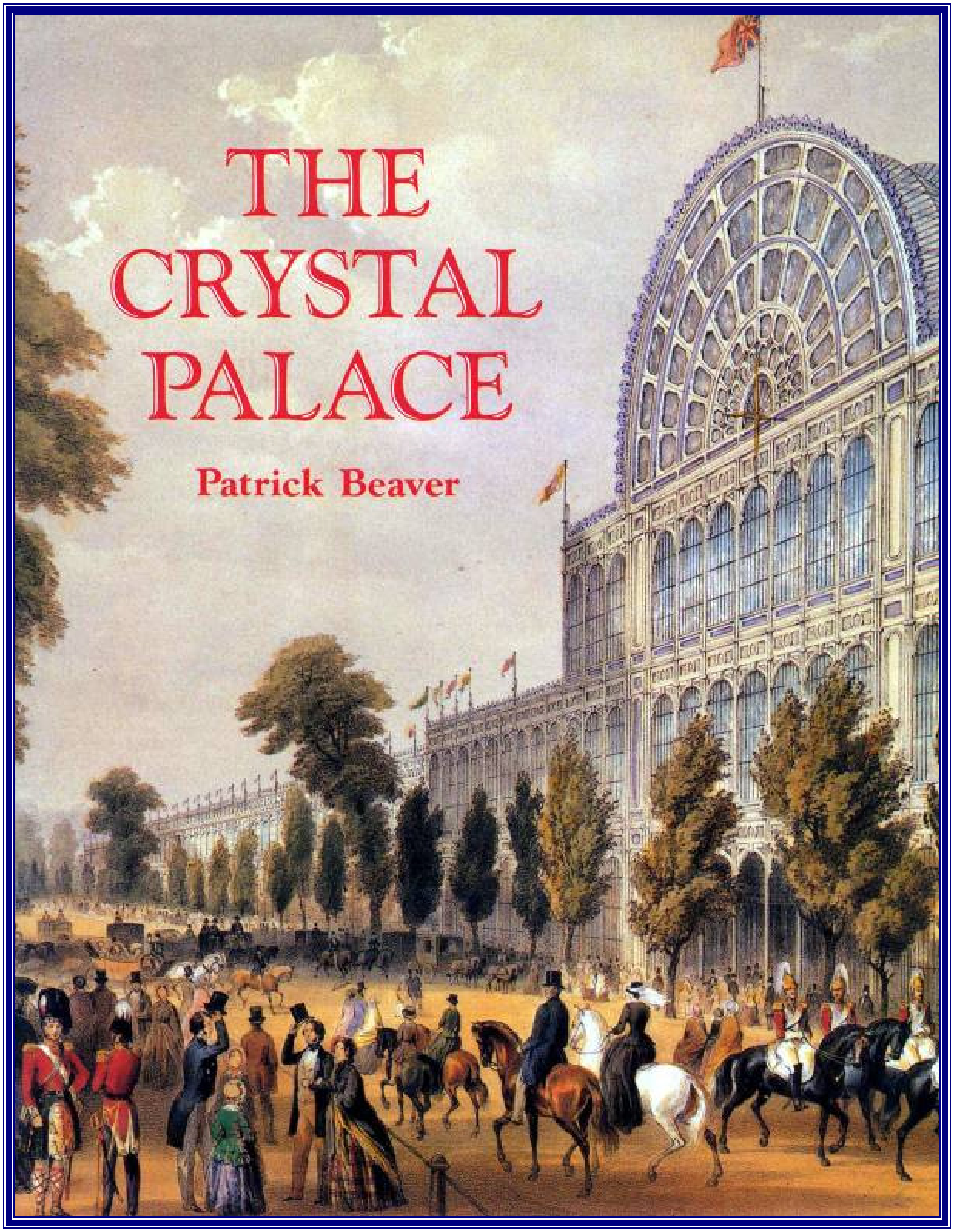
531
Section and ground plan of Great Conservatory, showing plants and heating system.

(From "Houses of Glass," Georg Kohlmaier & Barna von Sartory, 1990)

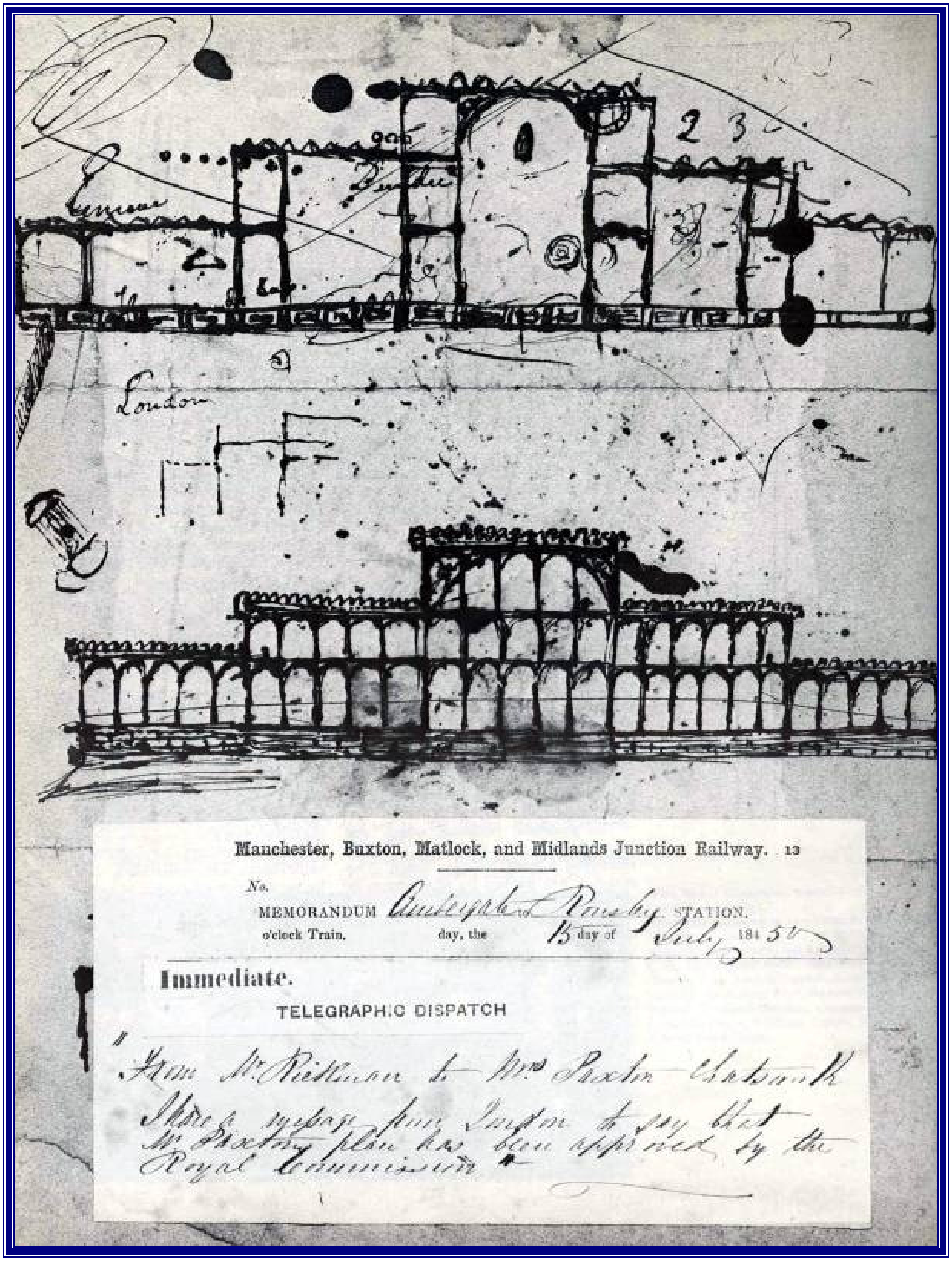
Hot water heating was the breakthrough that enabled the enormous mid-19th century glasshouses to be built and properly warmed, such as the Great Conservatory at Chatsworth (1841) and the Palm House at Kew (1848).

At Chatsworth it was said that seven miles of four-inch pipes, fired by eight boilers hidden underground, were needed to heat this "massive edifice". Coal was brought to the boilers on an underground railway, and the chimney flues taken underground to a chimney stack some distance away. Alas, the Great Conservatory was deliberately blown up in 1920, but Kew's Palm House survives and has recently been completely restored.

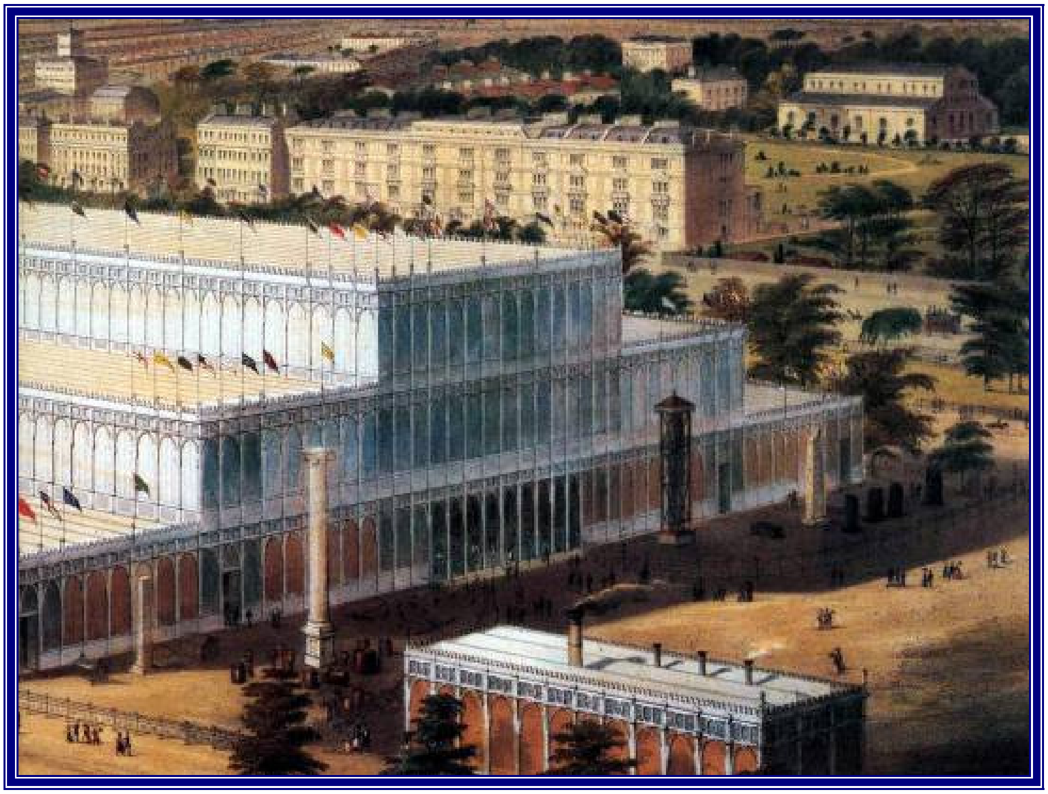
(From "Orangeries and Lemons," Brian Roberts, Building Services, December 1991)



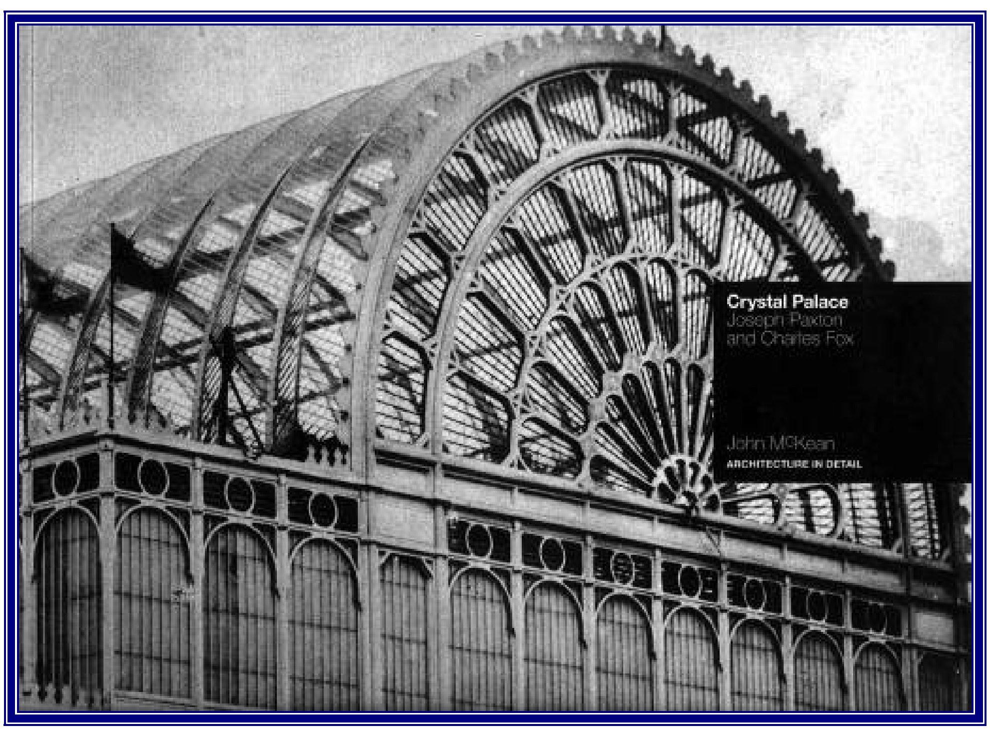
1970 (CIBSE Heritage Group Collection)



Paxton's Original Sketch for the Crystal Palace (from "Beaver")

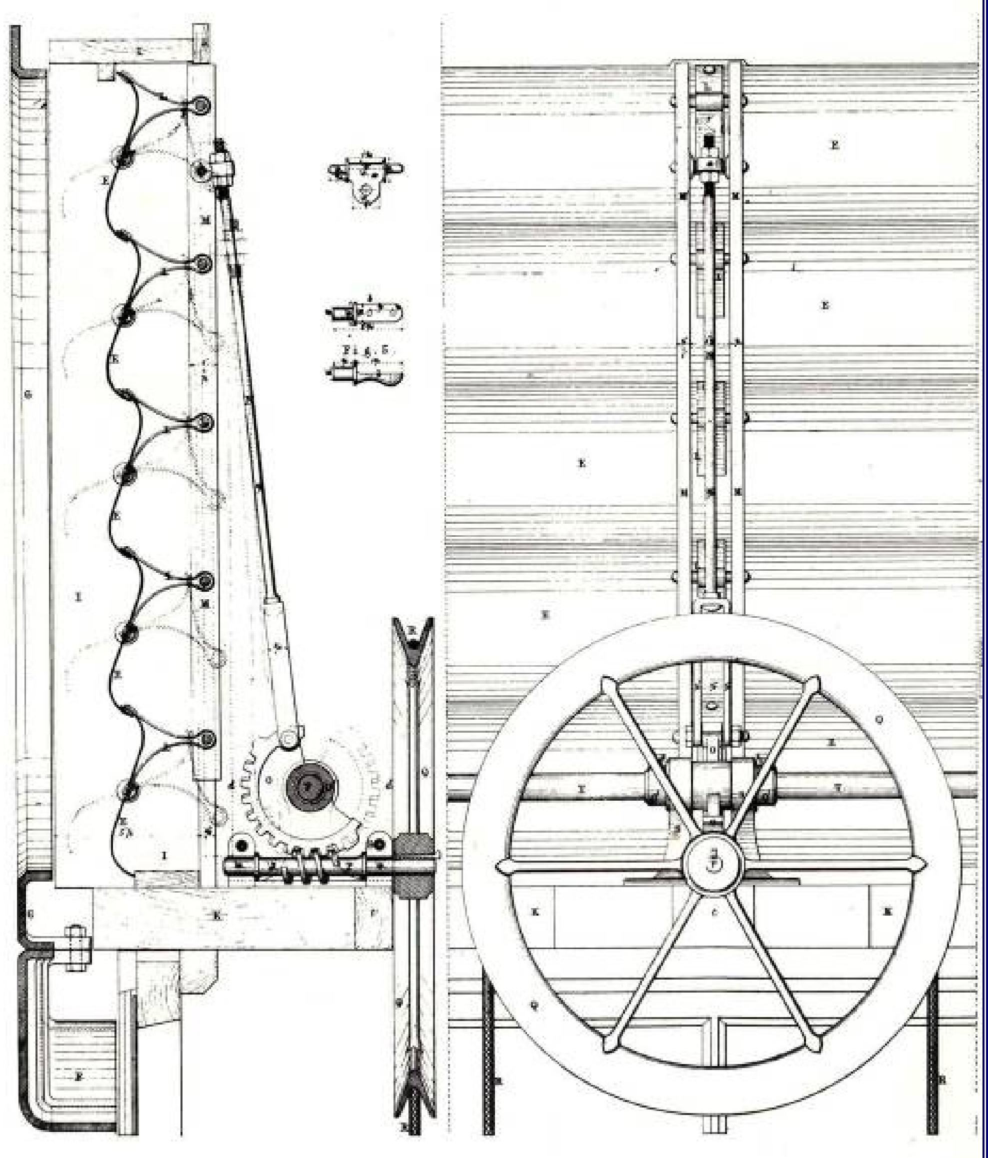


Detail of the Crystal Palace in Hyde Park; the boilerhouse (bottom centre) produced steam to drive exhibits in the Machinery Hall; the building was unheated



1994 (CIBSE Heritage Group Collection)

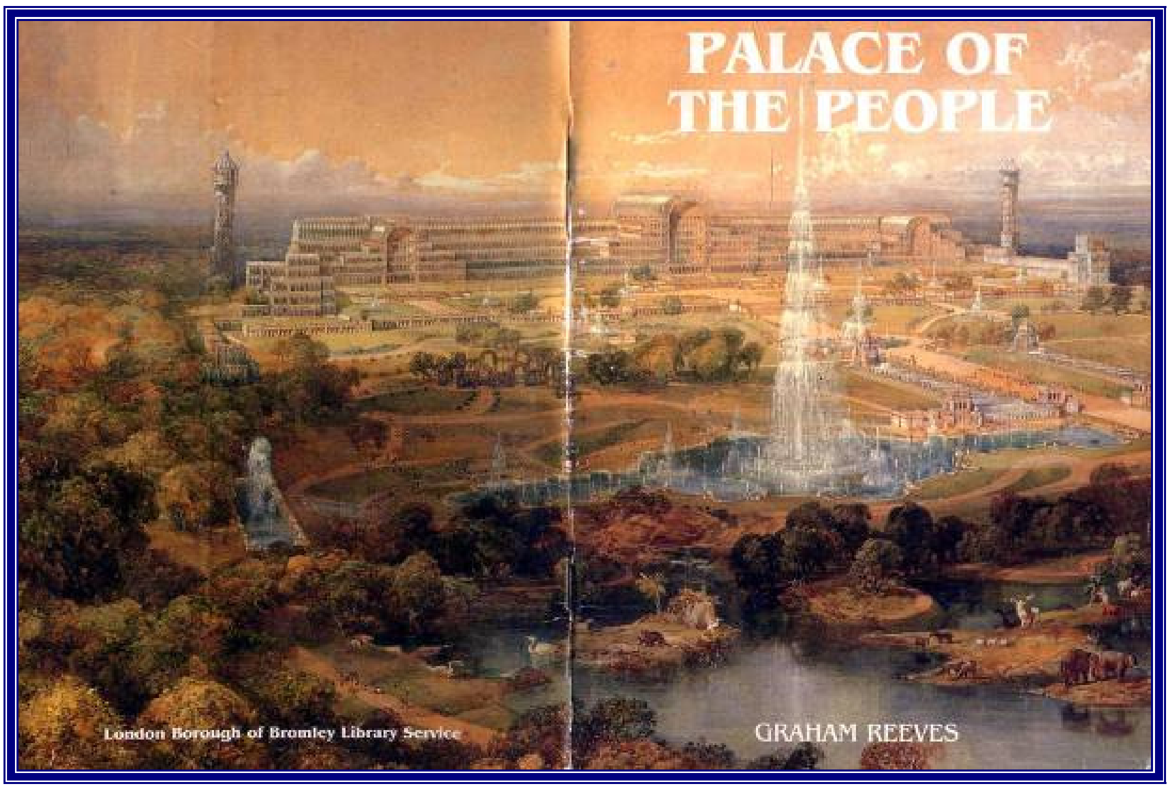
Details of the apparatus for opening and closing louvres. On the left, the galvanised sheet iron louvres are seen in section and elevation, and details of the turning mechanism are on the right. Opposite: internal details of gallery railing (above) and staircases (below). The railing runs around all galleries, landings and well-holes for the staircases; the 12 identical staircases, which seem so simple on plan but are most carefully designed for ease of movement to and from the galleries, are formed of 12 inch deep I-section cast-iron strings, which are bolted to columns and floors as rigid box frames.



Crystal Palace Adjustable Ventilation Louvres (from "McKean")

As with many of Paxton's building some of the most interesting features were hidden from normal view, but not thereby lacking in importance. Ventilation had been important for the Great Exhibition, and to this was now added the need for heating. This Paxton patterned on his successful experiments in low-pressure hot water heating at Chatsworth. An access roadway ran through the basement storey of the building, and here no less than twenty-two boilers were arranged in pairs, each holding 11,000 gallons of water; one extra boiler was added at the north end for a display of tropical plants, two in the lower storeys in each wing, and two small ones for the fountain basins at each end of the building containing *Victoria regias* and other tropical aquatics. Four pipes of 9 in. diameter were attached to each boiler, two flow and two return, and each boiler heated a certain transverse section of the Crystal Palace: the length of one flow and return was a mile and three-quarters, and the total length of heating pipes of all kinds was nearly fifty miles. The control of this intricate system was said to be by an unspecified new device invented by Paxton and Henderson.

(From "The Works of Sir Joseph Paxton," George F Chadwick, 1961



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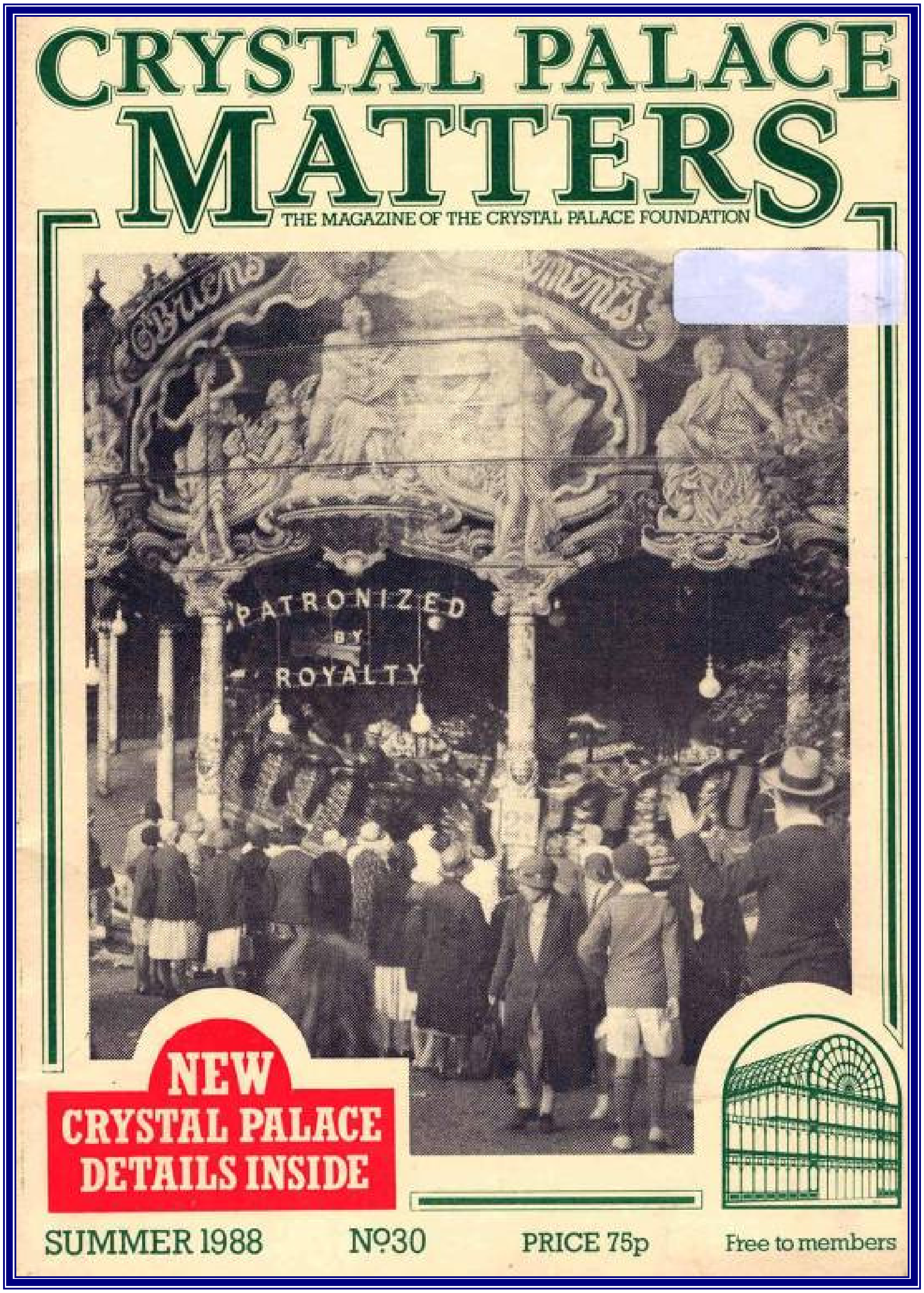

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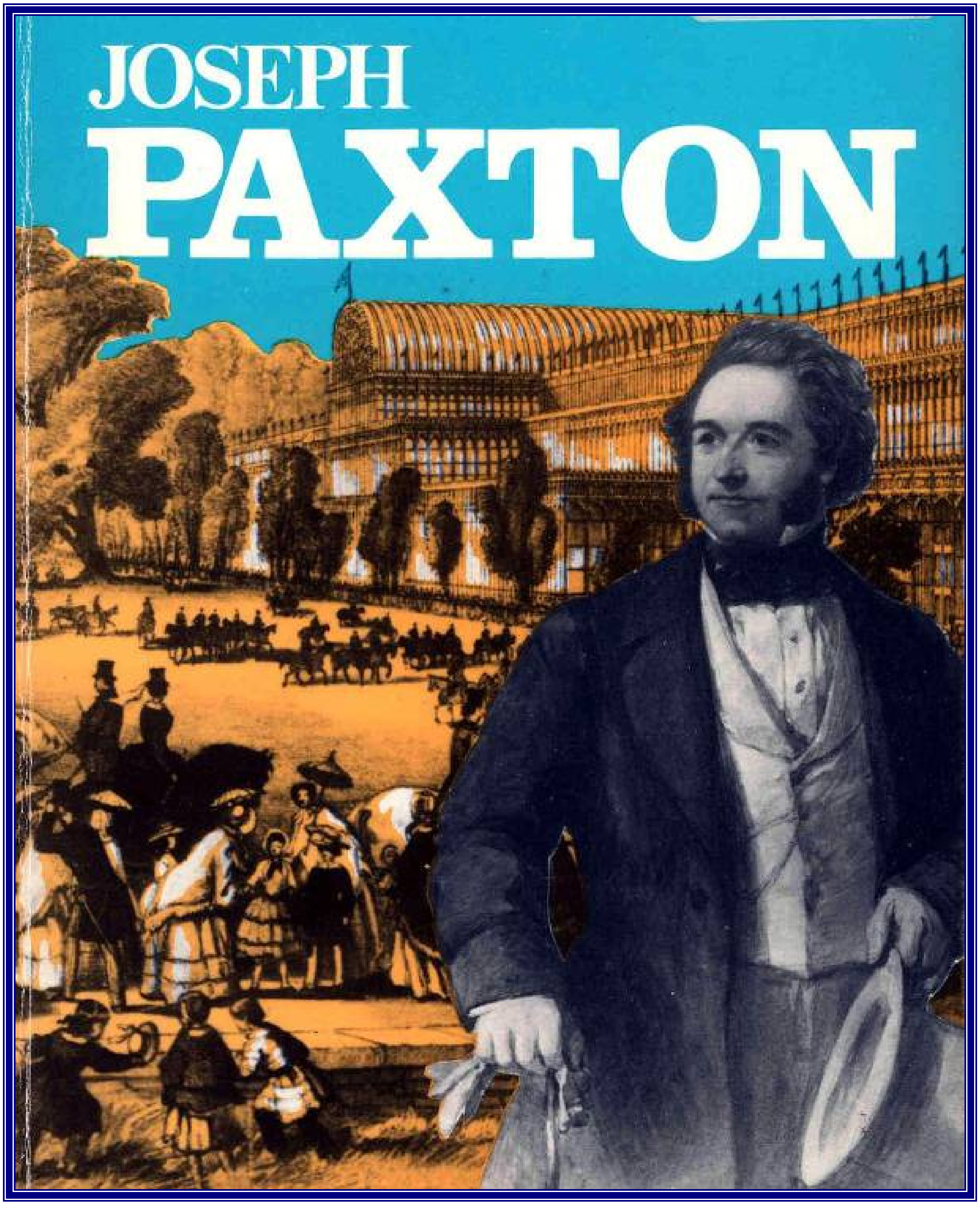
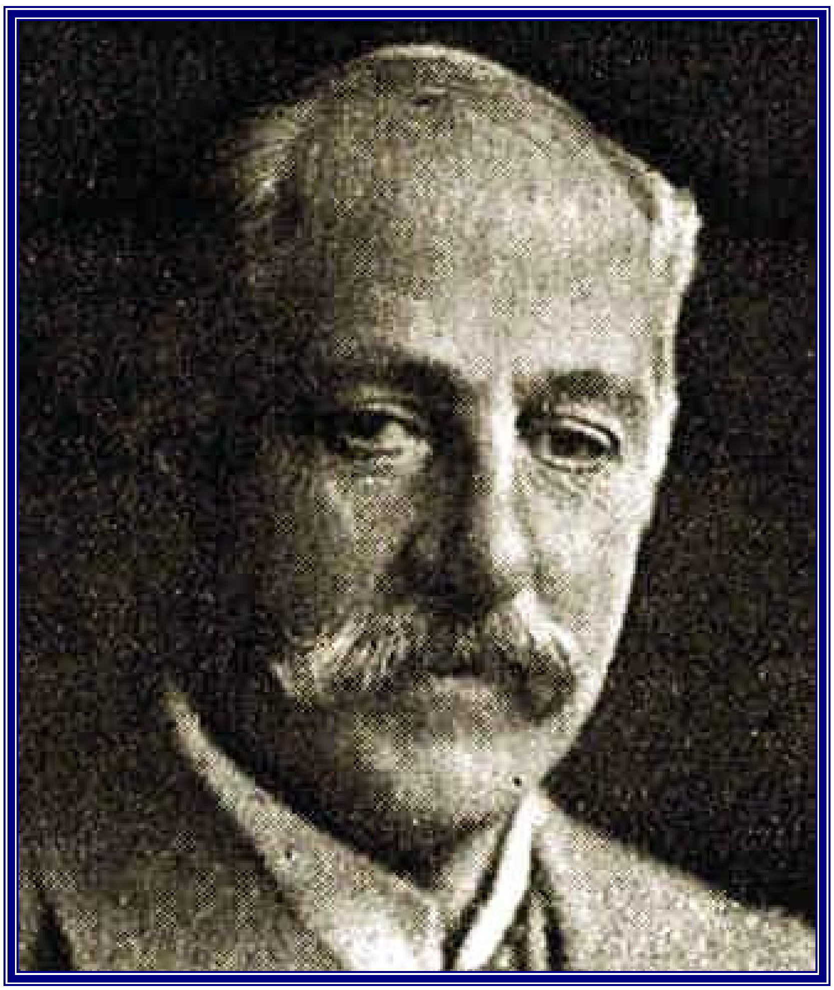


1973 (CIBSE Heritage Group Collection)

Sir LOUIS F PEARSON CBE
1864-1943



Founding Member IHVE, President 1903

Beeston

Another well known name in boilers is **Beeston.** The Beeston Boiler Co. (Successors) Ltd., has its origins in a firm of horticultural builders in Beeston, Nottingham. This firm began to produce the heating equipment for its greenhouses and conservatories in the second half of the 19th century. In 1895 a separate company, The Beeston Foundry Company, was formed and a new foundry opened specifically to manufacture cast iron heating equipment. Starting with one-piece boilers and hot water heating pipes, the company quickly expanded to include

(The Building Services Engineer, April 1977)

sectional boilers and radiators in its range of products. In 1923, the name was changed to The Beeston Boiler Company, by which time the range of heating products was appreciable, including sectional boilers.

Development and expansion continued, interrupted only by World War II. In 1946, the first of the mechanised foundry units was installed, followed in 1952 by a specialised radiator production unit. During the two decades up to 1970, the product range was radically altered by the introduction of new designs, and by the development of existing ones, so that a more economical boiler could be produced. To match this product development, a new automatic moulding plant was installed for the production of large cast iron boiler sections. In January 1977, the company was acquired by Ley's Foundries & Engineering Ltd., and assumed its present title of The Beeston Boiler Company (Successors) Ltd. The new company will continue to manufacture the range of boilers which are the result of 75 years of continuous development in the cast iron boiler field.

Sir Louis F. Pearson of Beestons was IHVE President in 1903.

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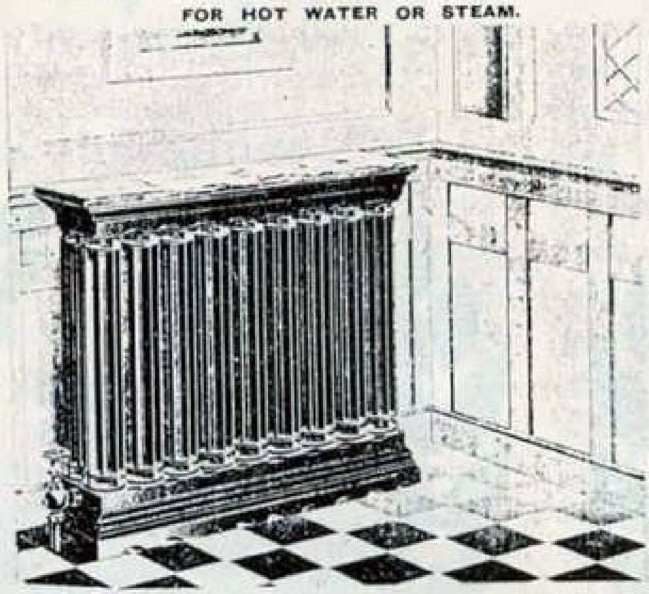
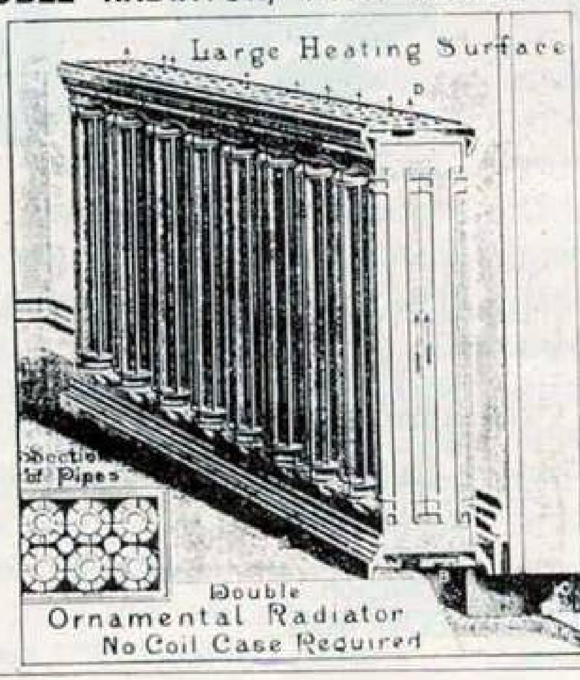


DOUBLE RADIATOR, WITH MARBLE TOP.



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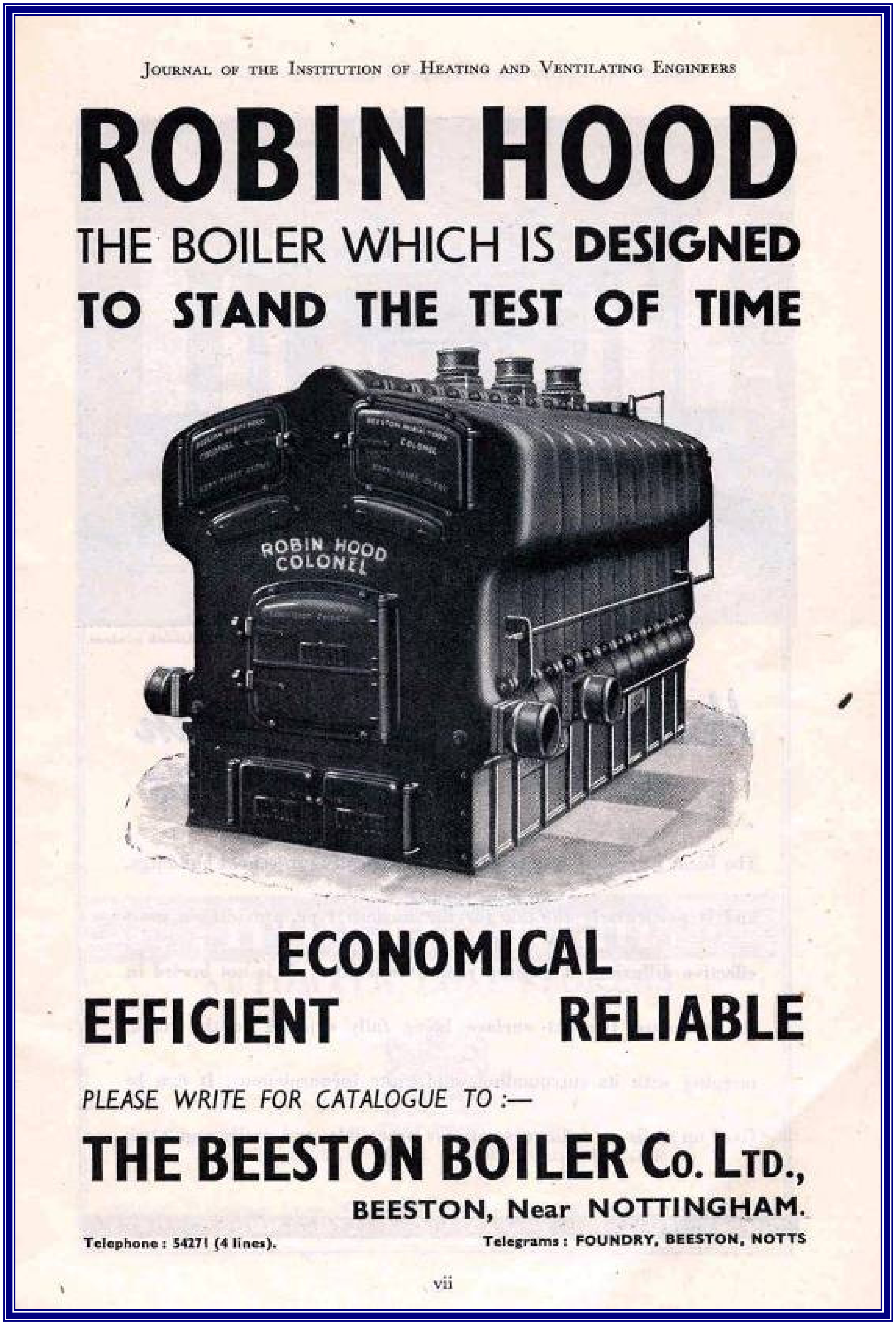

(JIHVE, September/October 1944)

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A32 Reader Reply No. 15 BSE □ APRIL 1977 □ VOLUME 45

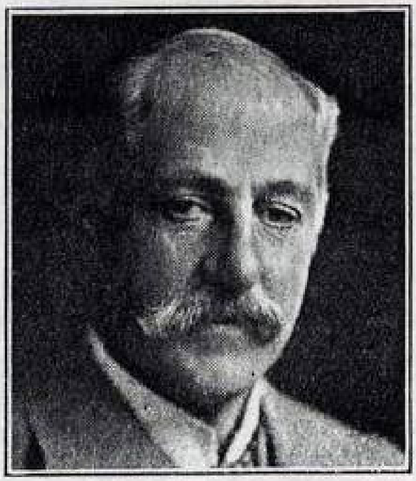
(1977)

DEATH OF SIR LOUIS F. PEARSON

One of I.H.V.E. founders : scientist and philanthropist

We regret to announce the death of Sir Louis F. Pearson, C.B.E., at his home, Lenton Grove, near Nottingham.

Chairman of Directors of the Beeston Boiler Co., Ltd., from 1913 until his death, within a few weeks of his 80th



SIR LOUIS F. PEARSON

birthday, Sir Louis was one of the founders of the I.H.V.E. His was the twelfth name on the Membership Roll, for he was elected in December, 1897, and in 1903 he became the Institution's sixth President.

Born and educated in Nottingham, he entered his father's firm—then the Beeston Foundry Company—on leaving school, and spent his whole professional life there.

His technical knowledge was called into the service of his country in both world wars. He was a lifelong worker in the Conservative cause in the Nottingham district and a noted benefactor of local hospitals and charities.

Sir Louis was married twice and had a son and daughter by his first marriage. At the funeral, held at Wollaton Church, the I.H.V.E. was represented by Mr. John Hughes (Member), Member of Council and former Chairman of the East Midlands Branch.

Sir Louis' gifts to the Nottingham General Hospital were munificent, and amounted to a total of more than £13,000.

He became a C.B.E. at the end of the last war, during which he figured prominently in the county's production of munitions. He was knighted in 1923 for his social, industrial and public services.

A tragic sequel to Sir Louis' death occurred less than a fortnight later, when his only son, Major L. N. Pearson, was killed in a tractor accident on a farm in Derbyshire.

MEMBERS LETTERS

(Contd. from page 37)

however, I shall hope to renew acquaintance with my old friends in the Institution as well as to meet the newer Members.

"Best wishes to all Members."

Mr. Yates' home is at Swinton, Manchester. His firm is Matthews & Yates Ltd., Cyclone Works, Swinton.

A Graduate Member who has just obtained his Commission in the R.A. adds his word to Mr. Yates' tribute.

Second-Lieut. A. G. Ludgater, whose home address is 105, Moordown, Shooter's Hill, London, S.E.18, writes :

"It is good to hear that the Institution is still flourishing for during the short space of time that I was a member, I really felt part of it."

(JIHVE 1943)

JEAN CLAUDE EUGENE PECLET
1793-1857

Put heating and ventilation on a scientific basis

[27] J. Claude Eugéne PÉCLET **1793-1857**

French Professor of Physics and a university Inspector-General. Published books on chemistry and physics (1823), illumination (1827), and heat (1830). "His writings are distinguished by their clarity, logical argument and judicious views." Wrote a remarkably detailed account of heating in his *Traité de la Chaleur* (3rd edition, 1844). An avid experimenter, he investigated air flow and resistances in fittings, heat emission by radiation and convection, fresh air requirements, development of the open fire, and heat losses. He was probably the first to discuss intermittent operation of heating systems in a quantitative manner and appreciated the fact of heat storage in the structure. He stressed the importance of ventilation and considered class of building, occupancy, air change rate, fresh air amount, CO_2 content, and humidity. He also took an interest in fan design and evaporative coolers.

(Mini-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)

13.2 THE DEVELOPMENT OF THERMAL TRANSMITTANCE

By the time Péclet wrote his *Traité de Chaleur*, the physical principles were better understood, mainly owing to the work of French physicists, including Péclet himself. Péclet[46] was well aware that the solid parts of the wall as well as the glass transmit heat from the inside to the outside of a building, although according to him "most designers size their equipment on the basis of the volume to be heated — an obvious error" (this in spite of Tredgold's treatise). He realised that the inside surface receives heat by convection from the air and by radiation from the surrounding surfaces; and that the loss from the outside surface occurs by the same processes. The laws of heat conduction between the two surfaces were known, and Péclet applied them to this problem.

13.8 INTERMITTENT HEATING CALCULATIONS

Péclet was probably the first to discuss intermittent operation of heating systems in a quantitative manner.[46] He appreciated the fact of heat storage in the structure, and made crude attempts to compare the quantity of heat to be replaced after cooling with the quantity of heat lost by steady transmission. He knew of Fourier's work, and applied it to the penetration of sinusoidal temperature waves into solids, but he did not go on to use it for intermittency calculations. In spite of his attempts Péclet failed to give the designer any guidance as to sizing or energy use. It was, he said, impossible to calculate, even approximately, the amount of fuel used when heating is intermittent, on account of the large quantity of heat absorbed by the walls.

(Text extracts from "Building Services Engineering,"
Neville S Billington & Brian M Roberts, 1982)

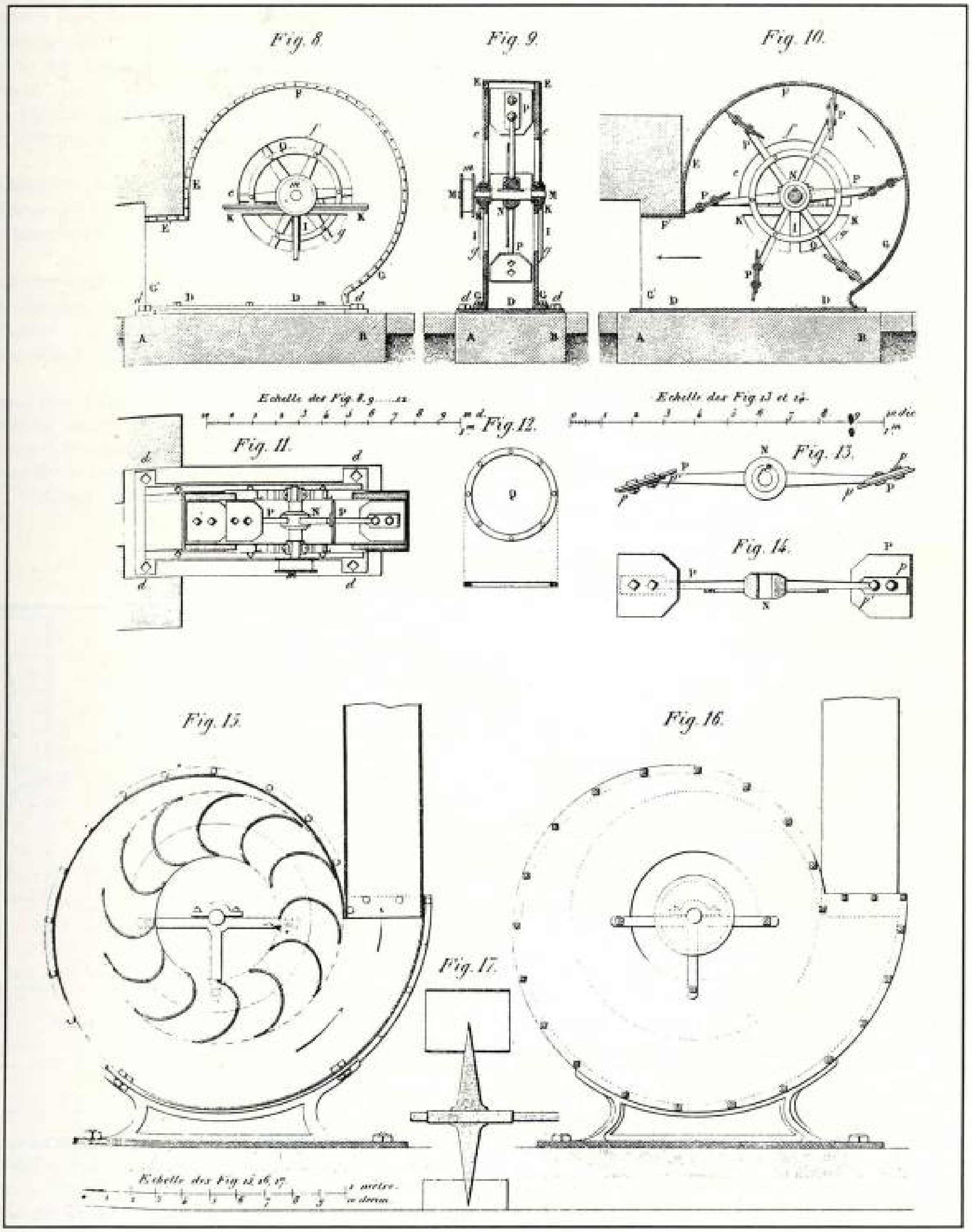


Figure 7-59 *E. Peclét—Forward/backward blade blower (from* Traité De La Chaleur, *3d ed., Paris, 1844, plate 7).*

JOURNAL

OF AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Vol. 28 October, 1922 No. 7

EUGENE PECLET AS A HEATING AND VENTILATING ENGINEER

BY P. NICHOLLS, PITTSBURGH, PA.

Member

WITH the rapid advance of technical knowledge and the increasing importance of more recent and the corresponding disregard of earlier investigations, the rising generation of engineers has a tendency to regard anything less recent than 20 years as out-of-date, and to believe that engineers before that time had little data available for computations other than rule of thumb. This particularly applies to heating and ventilating science and practice, and it may be somewhat enlightening to review the work and writings of probably the earliest engineer who attempted to treat the subject from a technical or scientific standpoint.

Claude Eugene Peclet was a French physicist born at Bescanon February 10, 1793 and who died in December, 1857. Although destined for commercial life he showed such a liking for mathematics and physics that in 1813 he was allowed to enter the Upper Normal School in Paris. In 1816 he was appointed as assistant professor of physics at 'the College of Marseille, and while in that district was struck with the lack of application of scientific principles to the manufacturing arts.

Returning to Paris to continue his studies he had the good fortune to gain the esteem of the savant Ampere, who greatly helped him with his advice and influence. Peclet taught in the Upper Normal School and while there wrote his earlier books. He published books on Chemistry and Physics in 1823, on Illumination in 1827, and on Heat, in its appli-

Paper presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Buffalo-Detroit, June, 1922.

cations to industrial arts, in 1830, with an enlarged edition in 1843, and a supplementary volume in 1853. His writings are distinguished by their clarity, logical argument and judicious views.

He was one of the principal founders and a continuous director and teacher of the Central School of arts and manufactures, which was established by private enterprise in 1829, and taken over by the State in

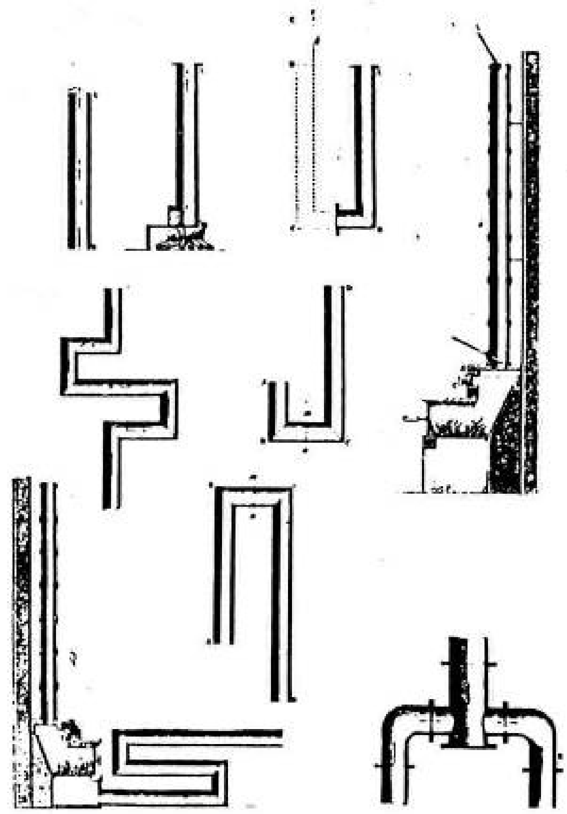


FIG. 1. PECLET'S APPARATUS FOR FINDING CHIMNEY AND DUCT LAWS AND RESISTANCE COEFFICIENTS, SHOWS ARRANGEMENT FOR CHIMNEYS WITH THERMOMETERS AT TOP AND BOTTOM. METHOD USED FOR DUCTS AT LOWER LEFT HAND. ALSO SOME FORMS OF DUCTS TESTED

1857, and it was in these capacities that he was able to apply his ideas of combining science and practice, and to carry out the experimental work on heat for which he is best known.

The eulogies on his life enlarge on his personality, both as a man and as a teacher, and he appears to have given his best to his pupils and to have won their affection, while later, as Inspector of the Academy of Paris and then as a Supervisor of Schools, he was able to extend his influence over both teachers and scholars.

Although he retired in 1852 he still kept his connection with the Central School and just finished revising the third edition of his Treatise on Heat before he died in 1857. Apparently he did not practice as an engineer, but he seemed to have served on committees and boards as a technical adviser, particularly for government buildings.

Peclet was primarily a physicist, but nowadays he would be classed as a Heat Engineer for he dealt with all phases of technical work involving the application of heat to the industries, including the theory of combustion, fuels, furnaces, boilers, distillation, evaporation, drying, heating and ventilation. His writings on any one of these subjects are well worth reading and his exposition would make a good introduction

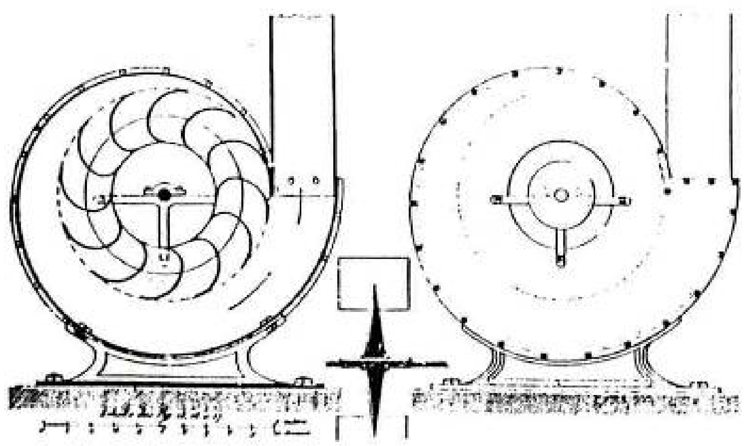


FIG. 2. PECLET'S SUGGESTED FAN DESIGN WITH BLADES CAST IN HUB

to any one subject even now. He invariably points out the underlying theoretical principles, and works out his results on both a heat unit and a cost basis.

As to how far his knowledge and suggestions reflected those of the better informed engineers he mixed with cannot be stated, but it is probable that he was far ahead of his time. Naturally he is weak at times on the engineering construction end, and the forms of apparatus shown to carry out his own suggestions are constructively inferior to those of the period.

In examining his heating and ventilating work it must be remembered that the practical art in France was in its infancy and only a few of the more important buildings made any pretense at a definite method. For example, when he wrote only one church, one hospital and one prison had an installation which could be called a system, although of course stoves were in common use. The main difficulty seemed to be the cost, and, as a result, the style and size of installation he suggested had to be of the cheapest type. He laments over the backwardness of the practice and blames it on the official attitude, showing that at the most he only hoped for it to be used in public buildings. He fought hard for its general adoption in prisons, but in vain, and the argument against it seems to have been that the prisoners would be better off than men in the factories. He, however, thought, that the restraint, the hard work, poor food and the severe discipline were sufficient deterrent.

As to whether he was able to read English is doubtful, as he does not quote direct from such journals and probably was not thoroughly acquainted with what had been done in England, where the practical use of steam and hot-water was much further advanced.

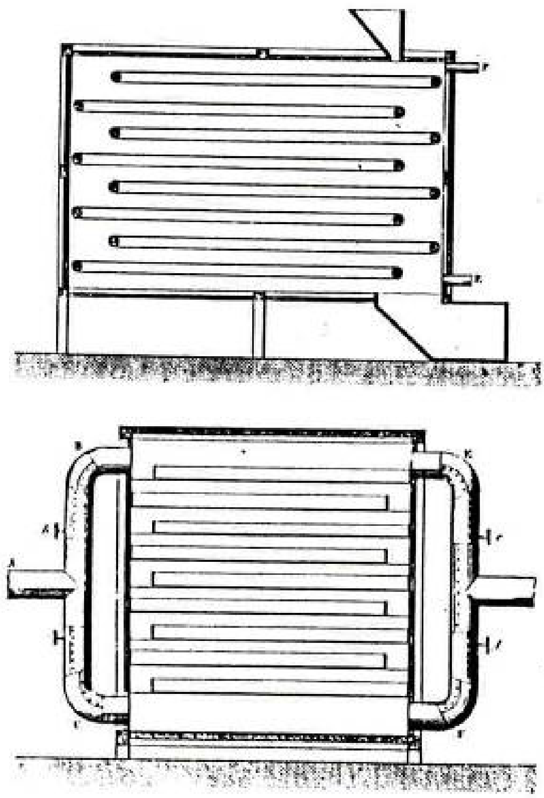


FIG. 3. SUGGESTIONS FOR DRIERS. UPPER FIGURE AUTOMATIC CONTINUOUS, LOWER FIGURE COMPARTMENT TYPE, PIPED FOR REVERSING DIRECTION OF AIR FLOW TO OBTAIN EQUAL DRYING FOR ALL TRAYS

His own experience seems to have been confined more to hot-air installations, and although he recognized the advantages of steam he does not seem to have been connected personally with any installations using it. One reason for this was undoubtedly the severe restrictions in France on the placing of boilers in or near dwellings.

He should be respected for the important place he gives to ventilation. He deals with this before heating, and in general he makes the production of ventilation the primary feature, with heating a subsidiary factor.

It is in the quantity of air needed that he shows most his attempt to keep the cost down. He bases his argument on the amount of fresh air needed to absorb the moisture given off in respired air, and deduces that 125 cu. ft. per hour is sufficient as a minimum, but neglects the effect of the mixing of the fresh air with the other air. In fact, he assumes that with correct ventilation the air has more or less distinct currents, so that they do not mix. The CO_2 change he calculates, but neglects it in his arguments as he bases the criterion of sufficient ventilation on there being no difference in odor between the outside and inside air. He reports tests on schools where air, as he measured it, was 125 cu. ft. per hour and found this was satisfactory. However, as the anemometer had only just been developed and as this was his means of measuring velocity, and as also he neglected air leakage, it is very probable that the air supply was greater than he found, as is indeed shown by his CO_2 measurements.

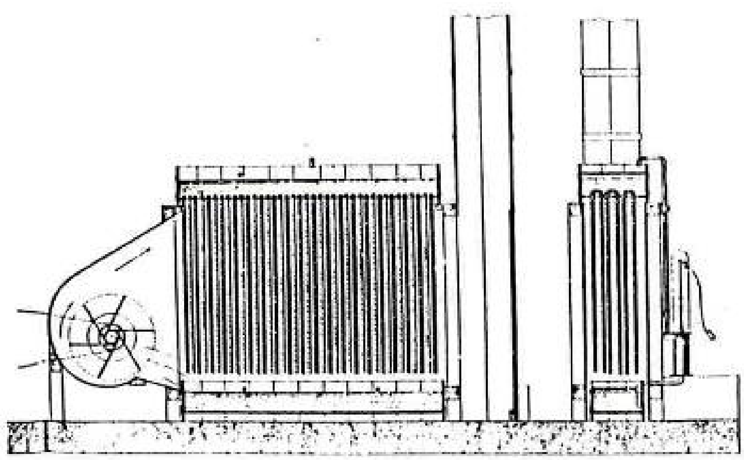


FIG. 4. SUGGESTION FOR AIR COOLING APPARATUS

In spite of his early error in quantity, the general principles he sets out in ventilation are sound. He noticed that the feeling of hotness was not dependent on the temperature, as in experiments with all forced ventilation cut off in a school for a period of five hours, he noted that they felt very hot, though the temperature was only 61 deg. Fahr. He deals very thoroughly with air inlet, outlet and air currents, advises large openings (that is for his quantities), and recommends that there should be some means of control. In fact he advises, as an ideal, that there should be an anemometer installed so that the quantity of air could be noted and regulated to the number of individuals present. This recommendation again is for the sake of economy, so that the supply could be reduced when not needed.

He frequently brings into his calculations the number of persons present and their length of occupancy of the room, and suggests, as a heat economy, the recirculating of the air for some conditions, or during some periods.

He recommends in one case that the inlet air should be humidified so that it would have 50 per cent humidity at its inlet temperature of 59 to 64 deg. Fahr., this being the range of temperature that he considered comfortable.

He treats each class of building—auditoriums, hospitals, schools, dormitories, prisons, factories, large houses, etc., and outlines the systems he considers most suitable, and considering that in most cases it must have been simple theorizing, it shows the thoroughness of his conception of the principles.

It must be remembered that he was very much limited in means of producing air movement and in the main had to rely on chimney effects. Fans were in their infancy, but, what is more important, there was no means of driving them except in factories. They had therefore to depend on man power, though he suggests that water or weights could be raised during the day and their power used for night service. He is particularly keen on the use of fans for prisons, due to the surplus man power available.

He early recognized that data was needed on chimney effects, resistance in ducts, power and fuel required to move air, and the cost. He therefore, experimented extensively, with his limited means, and developed formulae and coefficients of friction for sheet iron, cast iron and pottery. His apparatus consisted of a small furnace with a thin wood-charcoal fire covering the grate, and chimneys up to 8 in. in diameter and 51 ft. high. To measure the velocity, he introduced a turpentine match into the fire and noted the time for smoke to appear at the top. He attached his ducts to the inlet of the furnace, the fire drawing the air through them, and tested straight, return bends and other forms. He acknowledges the inconsistency of some of his results, but obtains formulae which he uses in his ventilation designs.

He also recognized the need for information on heat transmission through walls, and the work for which he is best known was that which he did on surface transmission and thermal conductivity. Considering that he was the first man to extensively investigate on these lines, his method of attack, his ingenuity, his clarity of exposition and the putting of his results into a form so that they could be used to solve problems and take into account all varying conditions, cannot be too highly praised.

In dealing with the heating of buildings he again shows his full grasp of the principles influencing the actions, and though his practice would now be considered weak, yet requirements were not high. As has been said, he only treats it as a part of the ventilation problem, but he covers the whole field. Perhaps the method of the English engineers of that period in proportioning radiation to cubical contents was better suited to the times, but Peclet's method and investigations were the foundation of more correct calculations and were used by later writers.

He includes the heat necessary for air changes, and the heat supplied by the people in the room in his calculations, and separates his wall and glass losses. He acknowledges air leakage by cracks, etc., but had not got so far as to have any values for this factor.

The second is the most interesting edition of his Treatise on Heat in its applications to the arts as it is in three volumes and includes one with 115 double page, 10 x 18 in., of wood cut engravings, with an average of at least 10 figures on each. These cover the whole range of heat engineering, and among them are shown embyro designs of apparatus embodying principles which are often thought of as modern developments. They range from a Vanstone joint to a furnace with coal crusher, automatic feed and rocking grate. His plates showing proposals for the ventilation and heating of buildings in existence deal with such ones as the parliamentary assemblies, and the difficulty in running adequate ducts in such massive stone constructions can be understood, especially when the fans are to be driven by man power.

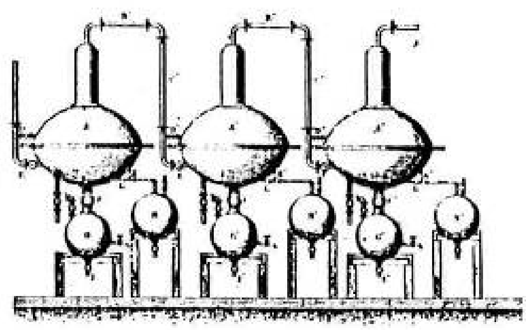


FIG. 5. SUGGESTION FOR MULTIPLE EVAPORATION

He devotes 45 pages of test to drying and illustrates principles of all types, including compartment, automatic continuous reversible and dehumidifying the air possibilities. In evaporation and distilling he was strongly for the principle of the multiple type, and shows illustrations for the construction necessary and calculates the savings in fuel. Cooling and refrigeration he only touches on as far as it can be done by evaporation with air currents.

Comparatively little attention was given to fuel economy in his early days and his eulogists lay particular stress on his efforts to introduce into the arts a greater appreciation of such possibilities. He discusses all phases of it and points out the advantages of smoke consumption and the supplying of air, preferably hot, to the incandescent gases so that combustion could be complete. He encourages the utilization of waste heat from industrial processes, such as iron furnaces and lime kilns but his personal opportunity for experimentation was evidently limited to small factory boilers. A summary of his own experience is given in a reply to a student who asked him what was the best type of furnace to use on a boiler, "A good fireman" he advised.

Heating and ventilating engineers would probably be most interested in his supplementary volume in which he includes copies of some of his official reports on plans for and the testing of installations in public buildings, as well as the first publication of his experiments on heat transmission.

The reports and his discussion of the equipments and tests are quite long, but the following short extracts will give some idea of their style and trend. These are taken from those dealing with the prison at Mazas, the first to be equipped with a mechanical system.

The analysis of the carbonic acid in the air collected, carried out by the method described by one of us, has shown, in this air, the presence of 33 parts by weight of carbonic acid in 10,000. (When ventilated.)

. . . .

Analysis of the air of a room of the same capacity as that, closed and not ventilated, and occupied during ten hours by the same observer, showed one part of carbonic acid per 100.

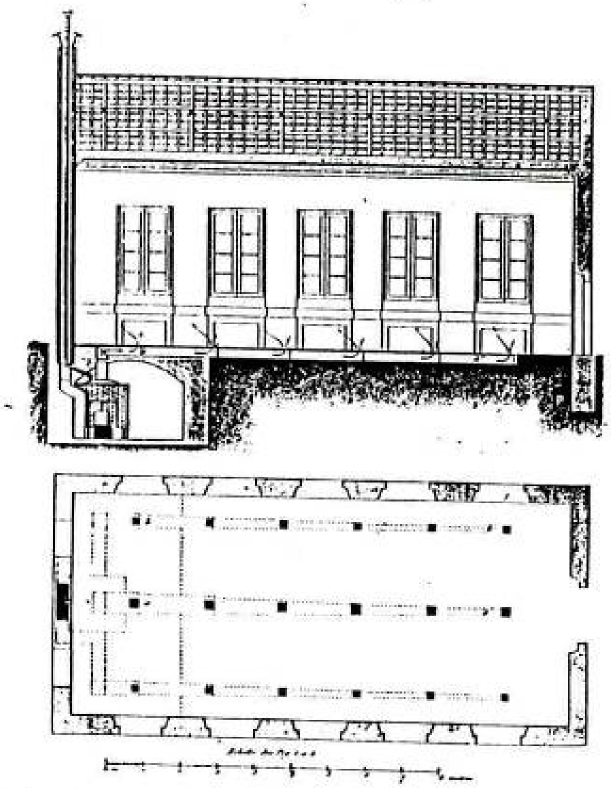


FIG. 6. SUGGESTED HEATING AND VENTILATING FOR SMALL SCHOOL, *AA* HOT AIR DUCT, *BB* AND *CC* POSITIVE EXHAUST DUCTS THROUGH CHIMNEY HEATED BY FLUE PIPE

In starting the tests the exterior air was at 35.6 deg. Fahr.; the observations of the psychrometer gave 75 per cent for the hygrometric state; each cubic foot of air thus contained 1.7 grains of aqueous vapor.

. . . .

In the cell, the initial hygrometric state was 80 per cent, at a temperature of 38.3 deg. Fahr.; each cubic foot contained then 2.3 grains of water vapor; at the end of some hours of feeble ventilation, the hygrometric state was 73 per cent for a temperature of 50 deg. Fahr. The quantity of aqueous vapor was 3.2 grains per cubic foot. At the end of the day the hygrometric state was 76 per cent for a temperature of 53 deg. Fahr., and the quantity of water vapor was 3.4 grains per cubic foot.

The results prove that the hygrometric state in the cell has varied little with a ventilation at the rate of 355 cubic feet per hour.

. . . .

For the seven months of heating, during which the mean temperature in Paris is about 43 deg. Fahr.; assuming an interior temperatured constant at 57 deg., the mean excess will be 14 deg., and the mean fuel consumption per cell and per hour will be 595 lb., and 220 for the administration.

. . . .

The total exposed wall surface is 15,300 sq. ft.—and their thickness 22 in. The total glass surface is 23,000 sq. ft.

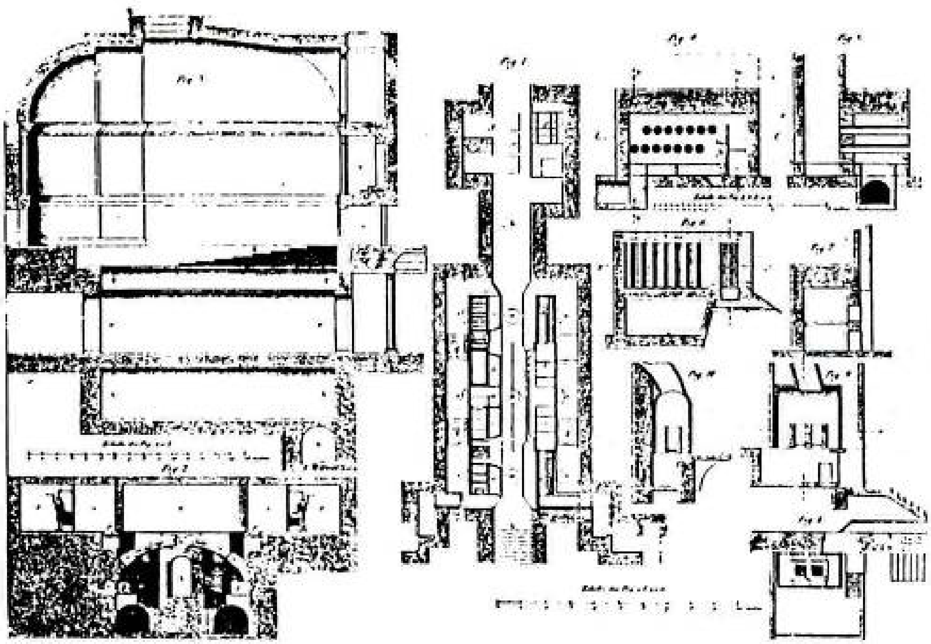


FIG. 7. INSTALLATION FOR CHAMBER OF DEPUTIES ASSEMBLY HALL, FIGS. 4, 5 AND 6 SHOWING FURNACE FOR HEATING THE AIR, WHICH PASSES THROUGH THE PIPES—NOTE THE MANUALLY DRIVEN FANS, TWO MEN FOR EACH

The conclusions of the report are, 1st, that the ventilation should be considered the principal means of sanitation; 2nd, that the amount should be 355 cu. ft. per person per hour at least; 4th, that the temperature of the cell should be maintained at 59 deg. Fahr.

. . . .

A large number of prisoners chosen haphazard, from each gallery and from each stage, were questioned without the officials being present in order to give them greater freedom in their complaints. Their reply was uniformly the same. They stated that their cells, as a living place, appeared to them perfectly comfortable, that the temperature had not made them uncomfortable, that they did not lack air, and that, since their imprisonment, they have not felt any change in their health. Several even added that they would consider themselves fortunate if they were assured of always having as comfortable dwelling conditions when at liberty.

. . . .

(The last paragraph is from a report of a committee appointed by the Chief of Police.)

These few extracts will show how thorough was his conception of the problems, and in no case does he use rough empirical rules. The report with the tabulations and drawings would be quite a bulky publication; in the tests for example 1400 air temperatures were taken over a period of five weeks.

It makes one like Peclet better to find that he was human like the rest of us. It has been said that he concluded that 220 cu. ft. of air per child per hour should be sufficient as a minimum, though he raises this to 350 as a working figure. M. Morin, director of the Conservatoire, later claimed that it should be from 1400 to 2000 per bed for hospitals, and also recommends this as a regular amount. In 1852, M. Morin published a report on some tests he had made, and Peclet does not miss the opportunity to thoroughly criticise it, especially a new type of anemometer designed and used by M. Morin. If, however, Peclet could not get ventilation for the prisoners when he only asked for 350 cu. ft., what could he expect if he were forced to ask for 2000?

In taking this opportunity to call attention to the work of Peclet and to accord him due honor, the writer does not wish in any way to belittle that done by his contemporaries. It is quite possible that his position enabled him to gather many of his ideas from men too busy with actual manufacturing to have time to study the scientific principles underlying them, but however that may be it was an innovation at that time for a man with scientific training to devote his whole ability and life to its application to the arts. Considering that the greater part of his time must have been taken up with his teaching duties, his contact with the practice of some portions of the large field he covers could only have been very slight, and consequently, his power of analysis high.

In conclusion, to Peclet we can at least assign the honor of being the founder and director of the first research laboratory to develop data needed by the heating and ventilating engineer.

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