CHARLES PROTEUS STEINMETZ
1865-1923

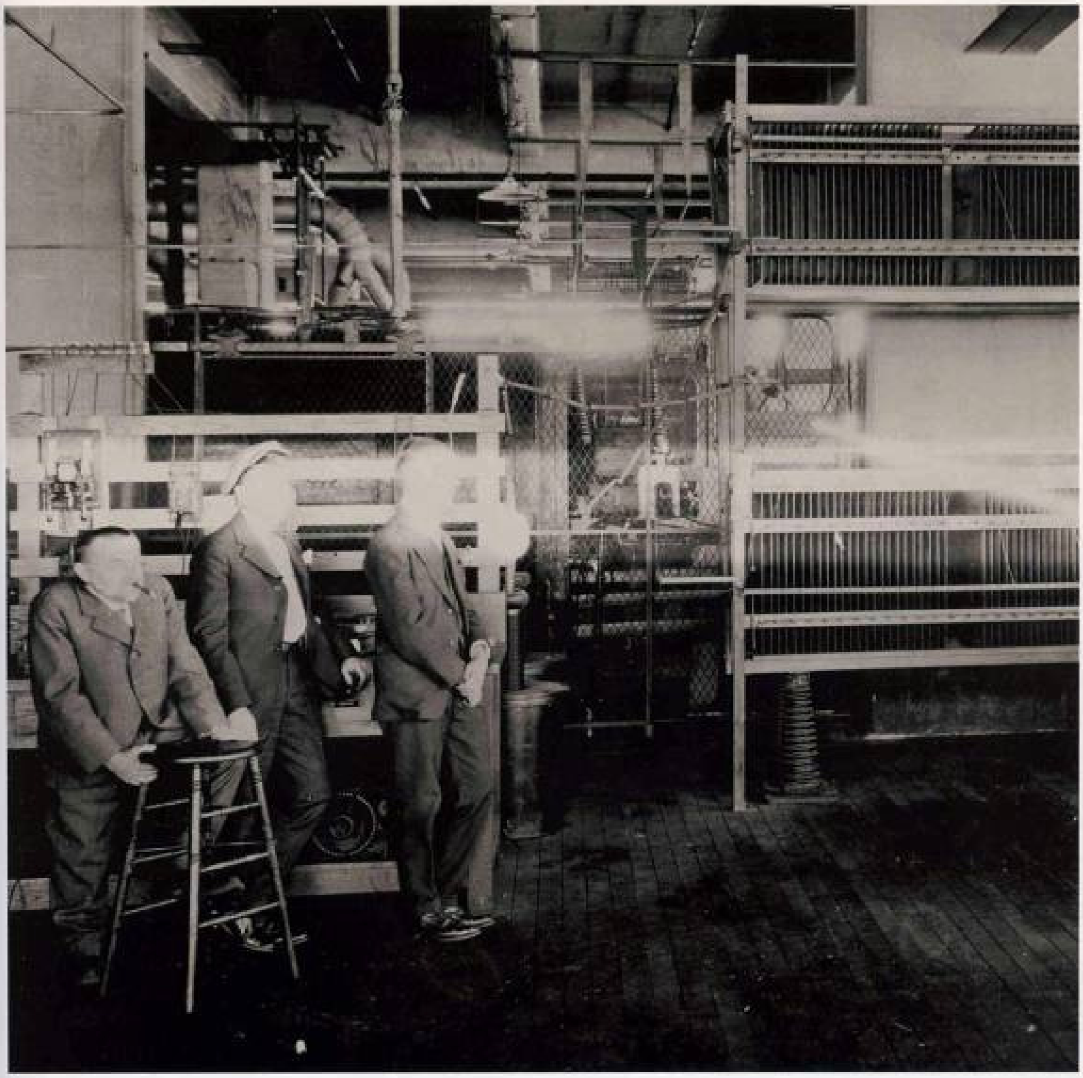
An Eccentric Genius who developed the Mathematical Theory of Alternating Current Systems

Charles Proteus STEINMETZ **1865-1923**

(Karl August Rudolf) German-American electrical engineer. Born in what is now Poland. A hunchback from birth, he "led a lonely, solitary life, lit only by the flame of his genius." Having emigrated to America, the small factory where he worked was taken over (1839) by General Electric where he worked the rest of his life. He became the architect of the mathematical theory of ac systems and his influence was responsible for important developments in electric motor design and other apparatus. He secured over 200 patents in electrical engineering, developing the work of Tesla [280]. He was considered an eccentric genius. In response to the issue of a No-Smoking order at work, he is said to have responded "No smoking, no Steinmetz."

(Mini-biography from CIBSE Heritage Group Records)

Steinmetz



The incredible electrical machines of the early twentieth century like those in Steinmetz's lightning laboratory were the subject of a new romance. Charles P. Steinmetz, inveighing against the literary men who failed to see the wonders coming out of engineering, wrote: "There is more poetry, more romance in the advances which we have seen in our lifetime than ever Homer described." These young scientists worked with the sense that their ideas could go out to change the world.

JOSEPH STREBEL
1851-1897

German Engineer and Boilermaker

[43] Joseph STREBEL **1851-1897**

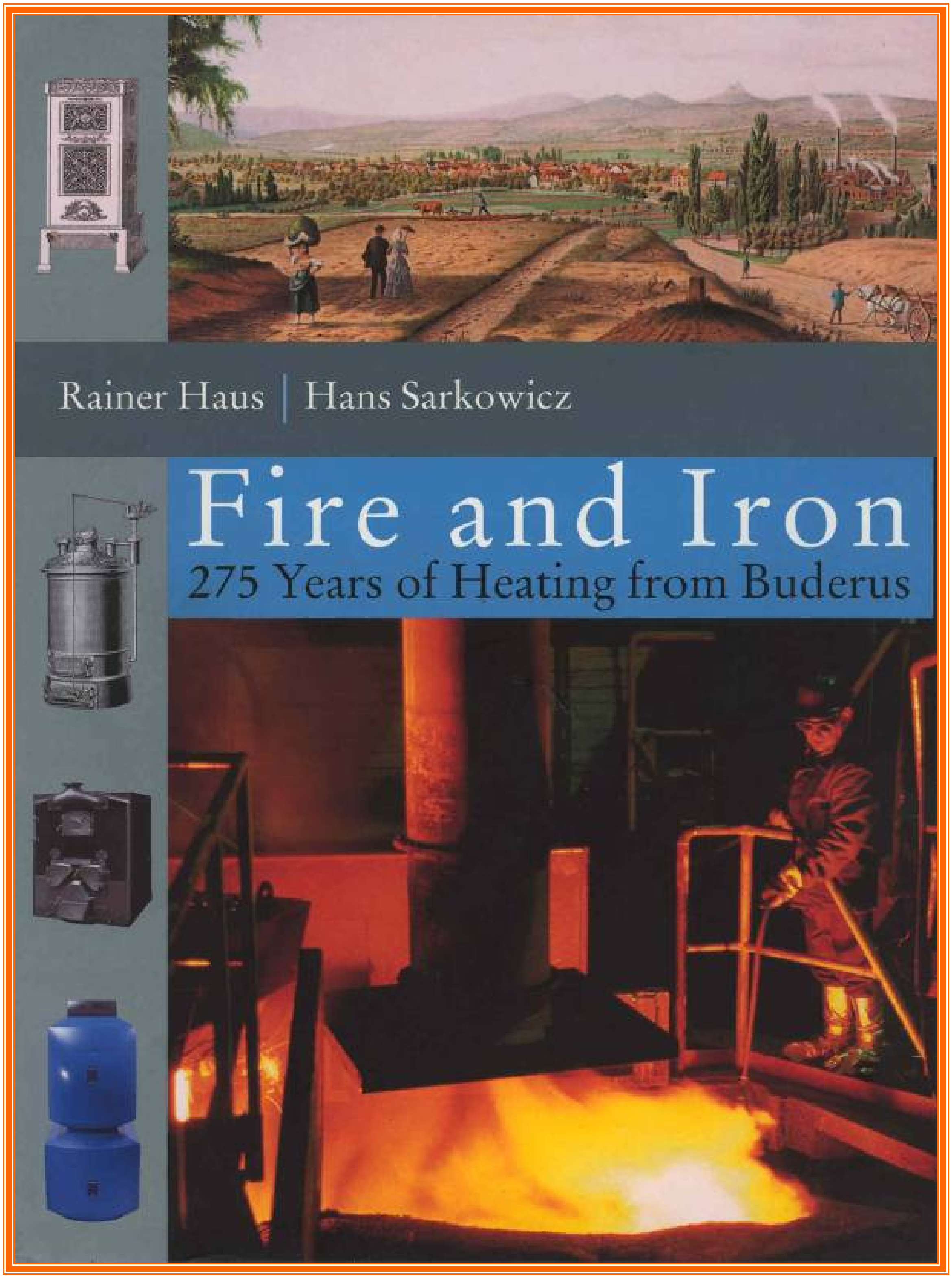
German engineer. Developed a sectional boiler with O-shaped cast iron sections (1893) that was patented by Rudolf Otto Meyer.

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

Joseph Strebel

Following the foundation of the new Hirzenhain and Lollar Ironworks joint-stock company, Hugo Buderus arranged for the two foundry operations to specialise. Hirzenhain now manufactured mainly stoves for heating and cooking, while at Lollar, from 1895 onwards, they cast elements for cast-iron boilers for the Hamburg firm of Rud. Otto Meyer. This was the start of the earliest industrial mass-production of cast-iron sectional boilers in Germany. The new appliance had been developed in 1893 by engineer Joseph Strebel, and Rud. Otto Meyer had applied for a patent. Strebel was a partner in the firm. One of Meyer's closest collaborators was Ernst Schiele (a partner from 1899, sole proprietor from 1906), son of Amalie Schiele (née Buderus) and Friedrich Schiele, chairman of the supervisory board of Hirzenhain and Lollar Ironworks.

(Text and Pictures from "Fire and Iron")

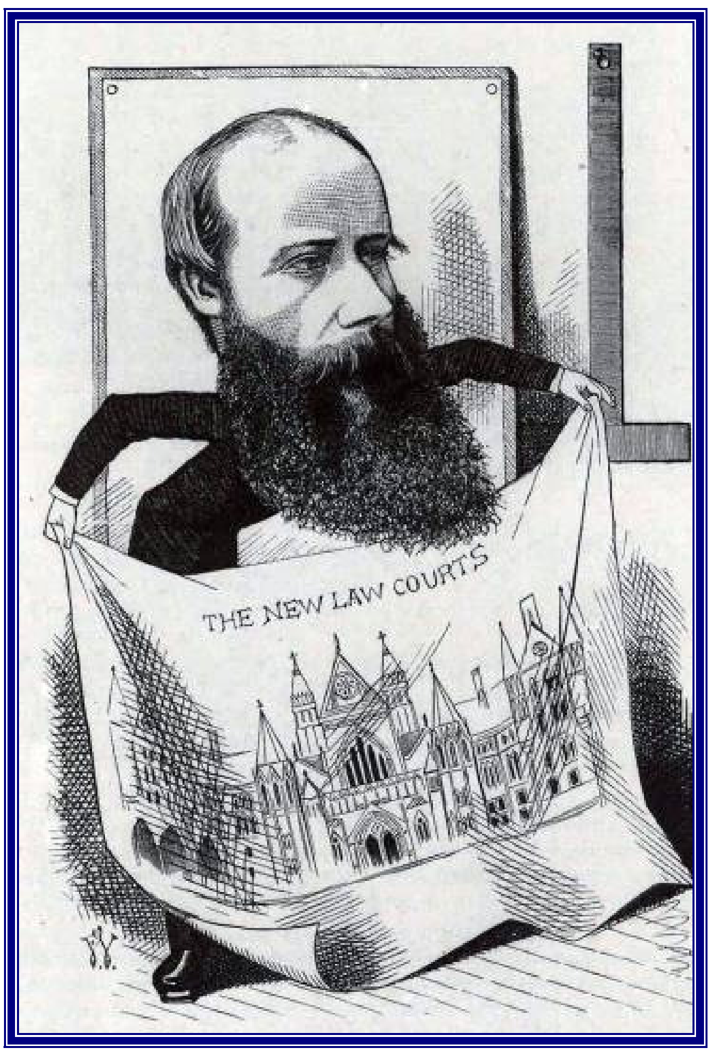


2006 (CIBSE Heritage Group Collection)

Advertisements for the Strebel Boiler

(From "The Theory and Practice of Heating and Ventilation," Arthur H Barker, 1912)

GEORGE EDMUND STREET
1824-1881



Architect for the Royal Courts of Justice

[195] George Edmund STREET **1824-1881**

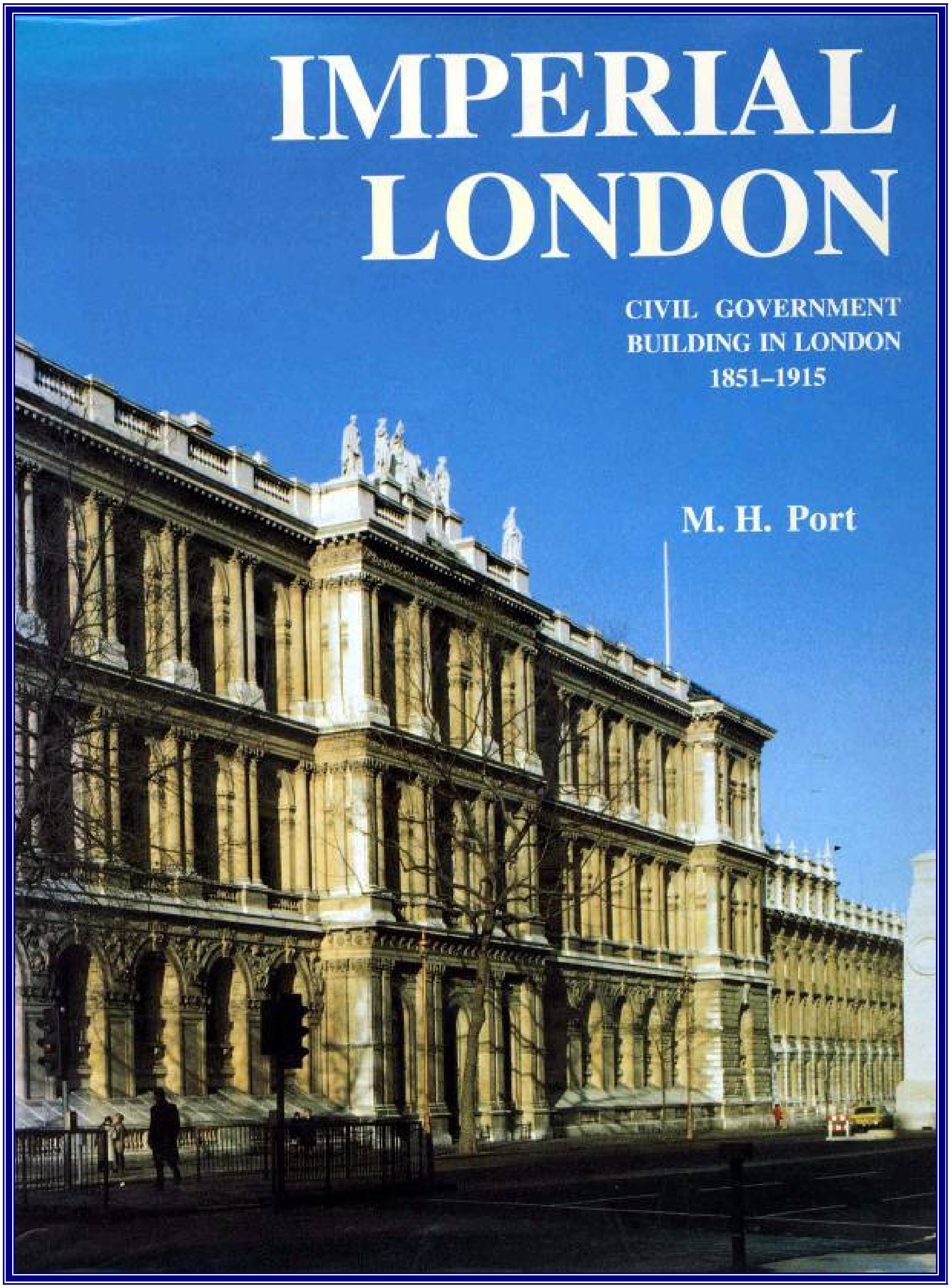
Notable church architect. Won the competition for the Royal Courts of Justice in the Strand, London (completed 1882), where the Great Hall has been called, "One of the grandest secular rooms of the Gothic Revival." According to George Haden [223], whose firm carried out the ventilation installation, "The Law Courts in London were fitted with Air Washing Films (achieved by a film of water flowing down a screen, being produced by a jet impinging on a small disc). The fans were driven by Steam Engines; one of the Lancashire Boilers under the main Hall being a Steam Boiler. In this case the water was cooled by refrigerating Apparatus. The Refrigerator was supplied by Halls of Dartford (Kent). Had a capacity of two tons of ice per hour."

(Min-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)
However, it is now believed that George Haden was referring to the original Law Courts which were situated in Whitehall. The new Law Courts (Royal Courts of Justice) in the Strand had engineering services provide by Rosser & Russell

Joseph Russell appears as a man of great character, of much enterprise and courage. These qualities show themselves in a letter he wrote in December 1871 to the First Commissioner of Works, in connection with the plans for George Edmund Street's new Law Courts proposed for the Strand. In this he pointed out that "the continued complaints which are made respecting the present Courts show the necessity of a thoroughly well devised system of warming and ventilation", a step which no doubt Russell calculated (though he left it to the late Dr. Oscar Faber 70 years later to say of the heating of the rebuilt House of Commons) "to encourage cool heads and warm feet, and not *vice versa*".

Not surprisingly perhaps, the First Commissioner received this communication coolly, replying: "It is the function of the Architect to suggest the mode of warming and ventilating the new Courts . . ." but adding that Rosser and Russell would be given the opportunity to quote "when the proper time shall come". In the end, Rosser and Russell got the job – a good one for the time, priced at £22,000. An early example of the firm's preference for a "nominated" contract.

(From "Rosser & Russell Limited: The First 200 Years")



1995 (CIBSE Heritage Group Collection)

The Royal Courts of Justice in the Strand (from "Port")

The Royal Courts of Justice in the Strand (an early photograph)

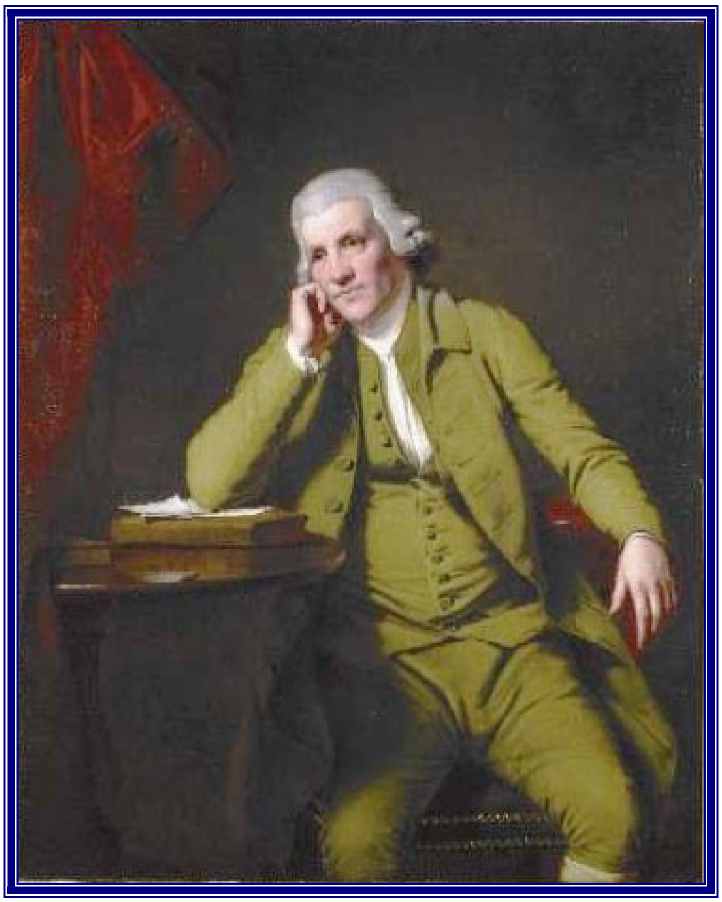
WILLIAM STRUTT FRS
1756-1830

Developed the "Cockle" heating stove

[22] William STRUTT **active 1806**

Derbyshire cotton mill owner. Improved on the Dutch and German iron plate stoves by developing (1792) a confined fire chamber stove, or *cockle*, "for the purpose of warming his extensive cotton works (at Belper)." Also known as the *Belper* stove, the cockle had a furnace that "itself consisted of a circular iron pot with a rounded top or dome. The fuel was consumed on a grate at the bottom of the furnace. Coal or coke was added through a charging door at one side, while primary air was surrounded by a brick chamber where the air was heated by direct contact with the firepot." The warmth was distributed by gravity air circulation, a fresh air tunnel connection often being provided. Strutt's best known application of the cockle was at the Derby Infirmary (1807). The cockle was subsequently adapted and improved by his son-in-law Charles Sylvester [221] and marketed with some success.

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



William Strutt's Father, Jedediah, 1726-1783
Founded eight mills at Belper in Derbyshire

ON THE

HISTORY AND ART

OF

WARMING AND VENTILATING

ROOMS AND BUILDINGS

BY

OPEN FIRES, HYPOCAUSTS, GERMAN, DUTCH, RUSSIAN, AND SWEDISH STOVES, STEAM, HOT WATER, HEATED AIR, HEAT OF ANIMALS, AND OTHER METHODS;

WITH

NOTICES OF THE PROGRESS

OF

PERSONAL AND FIRESIDE COMFORT,

AND OF THE

MANAGEMENT OF FUEL.

ILLUSTRATED BY TWO HUNDRED AND FORTY FIGURES OF APPARATUS.

BY

WALTER BERNAN,

CIVIL ENGINEER.

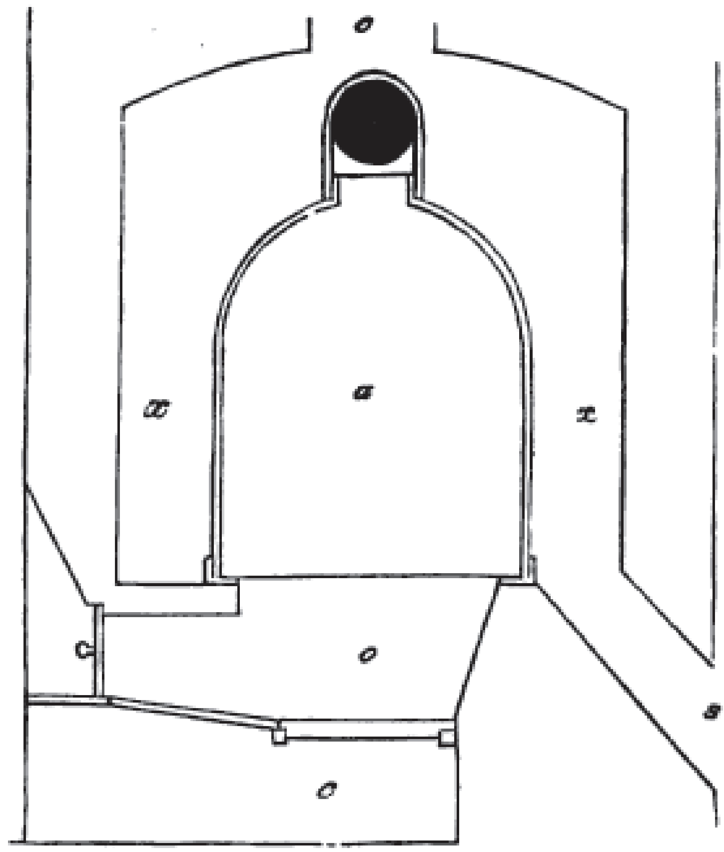
VOL. I.

LONDON:
GEORGE BELL, FLEET STREET.
MDCCCXLV.

(Google Books)

Mr. Strutt, whose method of ventilation by a descending current has been noticed in a previous essay, about 1792 observed that in stoves on the construction like that which has been described, "the combination of the heat from the fuel with the air was effected very imperfectly, on account of the latter being a bad conductor and incapable of being heated by radiation. The particles of air only which are in absolute contact with the iron are warmed by it, which, ascending in consequence of the decrease of its specific gravity, are replaced by others, but so slowly in comparison with the quantity of heat absorbed from the fuel, that the cockle is covered as it were by a blanket, and quickly becomes red-hot;" Mr. Strutt therefore thought, that by enclosing all the air to be heated in a perpendicular tunnel of considerable height, and by this means bringing it nearer to the cockle, the current would, by having this direction given to it, keep the surface of the cockle cooler, and be itself raised to a higher temperature.

An apparatus constructed on this principle is shown in section in Fig. CLXXX. : *c*, the ash-pit ; *o*, the fuel chamber, 14 inches deep from the surface of the bars to the base of the cockle. The grate bars were 13 inches long between the bearers, and the air admitted by three spaces between them. The cockle, *a*, was square on the plan, 30 inches on the side, and had 88 square feet of surface, and was 2 inches thick, and cast with a projecting faucet on its roof to receive the smoke-pipe, *i*, 8 inches in diameter, so as to overlap about 3 inches. It was set on an iron rim, as shown in the figure, 2 inches thick, 4 inches broad, and 3 inches high, which was bedded on the brickwork. A space, *x*, 10 inches wide, was left all round the cockle, and arched at top, and had an opening, *o*,



conveyed to the building. The cold air was admitted into the space, *x*, on three sides of the cockle, by the channel, *v*, which was constructed to give the entering air a direction so as to make it impinge on the surface of the cockle. The fireplace door fitted very accurately, and the ash-pit was enclosed by a door in which was a sliding valve to regulate the admission of the air. The cold air channel, *x*, was connected with another channel opening to the air on the level of the floor of the ash-pit, but by turning a valve this aperture was closed, and another opened that communicated with a perpendicular dry well terminating 23 feet under the level of the ash-pit. The cold air was admitted from the well when the cockle surface was becoming too hot, and from the greater velocity thus given to the ascending air a much larger quantity impinged on the heating surface, which by this means had its temperature lowered. The same expedient was resorted to when a brisker ventilation than usual was required. This was a much more effective apparatus than the cockle placed as usual in a room; and although it was not practicable to bring even the greater portion of the air into contact with the stove, still it comfortably warmed 19,200 feet of space, keeping it at 68° with an ample ventilation, when the air out of doors was at 25° F., which was nearly 329 cubic feet of space to 1 square foot of heating surface; and burning 27 lbs. of coal an hour.

Mr. Strutt subsequently applied his principle in a still more effective way. He enclosed this perpendicular wall within another wall, leaving a distance of 14 inches between them. And he divided this outer enclosure into nearly equal portions in its height. The inner wall, which was 9 inches thick, and placed at a distance of 7 inches from the cockle, he formed with openings like a honeycomb, through which the cold air rushed from the air-chamber and impinged on the cockle. He afterwards placed a wrought iron tube in each hole of this honeycombed wall, which reached to within a quarter of an inch of the cockle, by which means all the air admitted came twice into contact with the heated metal, and issued into the room at a temperature of 120° F. In 1806 an hospital at Nottingham was heated by a stove constructed in this manner. It was placed in a small apartment, about 17 feet below the wards to be warmed. The cockle was of wrought iron, ¼ of an inch thick, 4 feet on the side, and 5 feet high, having about 73 square feet of heating surface. The building, containing 200,000 cubic feet of space, enclosed with walls perforated with a great number of windows, was kept at a temperature of 60° F., night and day, from October to May, with an expenditure of 448 lbs. of coal daily; or each square foot of surface kept 2739 cubic feet of space at the temperature of 60° with about 18·7 lbs of coal an hour; if there be no error in the report.

A Committee of 1791 placed the planning of the ventilation of the House of Commons in the hands of Mr Henry Holland (an architect), whose estimate for the work was £45. The Committee also recommended a hot air stove to inject warm air through the floor of the House. The stove — an Empyreal stove, by Jackson and Moser — was 1.9 m square and 4 m high; it was placed in the Crypt, and an opening 1.1 m diameter in the House floor admitted the warm air. The stove cost £120, and the two thermometers 14 guineas.(46)

The cockle or Belper stove, devised by Mr Strutt of Derby was a further development of the system and was used at Marburg, St. Petersburg and Vienna. It was however probably the first attempt to heat a large building by means of a single gravity warm-air furnace (1791).(11)

The furnace itself consisted of a circular iron pot with a rounded top or dome (Fig. 4.5). The fuel was consumed on a grate at the bottom of the furnace. Coal or coke was added through a charging door at one side, while primary air was supplied through a duct to a chamber below the grate. The furnace was surrounded by a brick chamber where the air was heated by direct contact with the firepot. In Strutt's installation, air was brought from outside the building in a tunnel having an area of four square feet. The warmed air was distributed to the various parts of the building in brick ducts. The stove at Derby Infirmary was operated at a surface temperature of 150°C; and was able to warm 500 m^3/h of air to 55°C before discharge. Arrangement was also made to extract the vitiated air by means of further airways connected to a "funnel" on the roof of the building. No essential new principle is involved in the modern gravity warm-air furnace. (It is worth noting, that the use of the tunnel for introducing fresh air to the heating chamber served equally in summer for the introduction of cool air to the building. In winter, the air would be slightly preheated by passing through the tunnel. The same principle was later used in one of the schemes for heating and ventilating the House of Commons.).

Péclet reports some tests on Strutt's cockle: 252 m^3 of air were heated through 33°C by the burning of 1 kg of coal. Strutt's cockle was adapted and improved by Charles Sylvester and marketed with some success, particularly to warm halls, staircases and passages. Girouard records that hot air heating was installed in Tullynally Castle, Ireland (then Pakenham Hall) around 1807, at Coleshill (Berkshire) in 1811 and later (*ca.* 1823) at Woburn where Prince Pückler-Muskau was able to revel in the luxury of the gallery round the courtyard which

> "affords a walk as instructive as it is agreeable in winter or bad weather, and is rendered perfectly comfortable by the 'conduits de chaleur' which heat the whole house".(24)

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

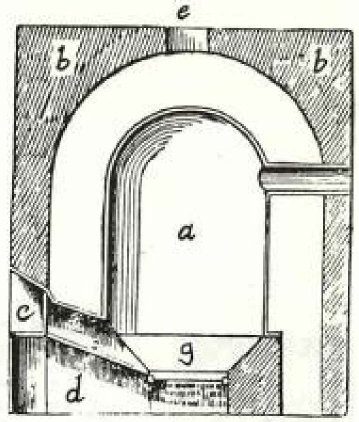
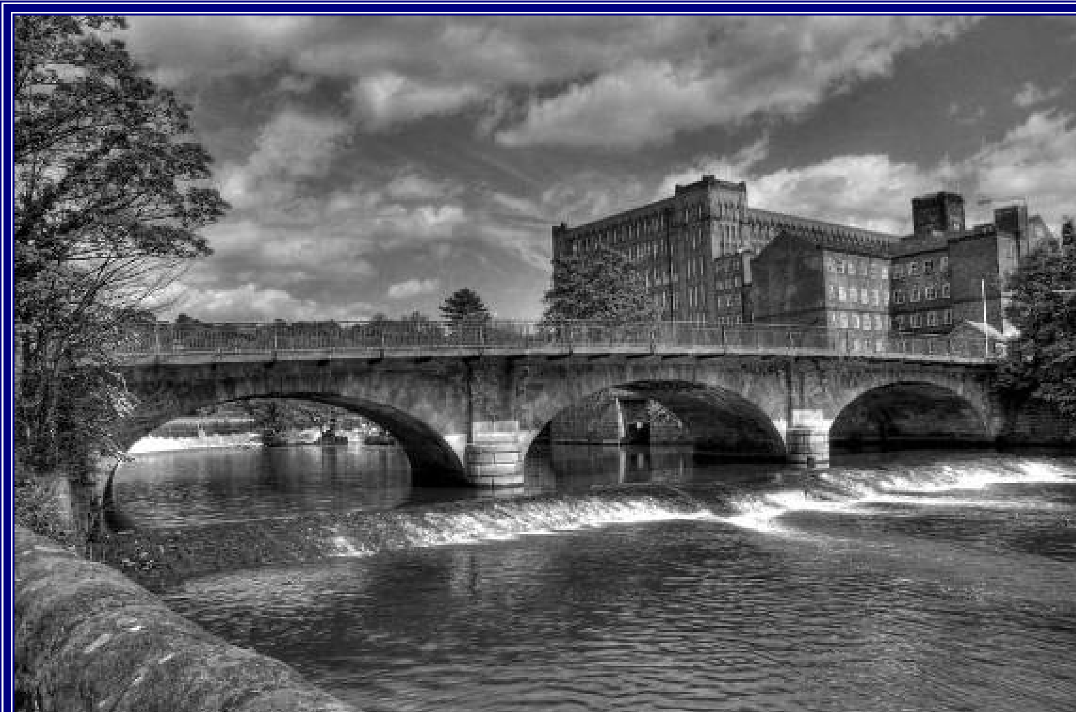


Fig. 4.5. Strutt's cockle stove. (a) cockle, (b) brickwork, (c) fuel door, (d) ashpit and draught hole, (e) aperture to room or shaft, (g) grate.

Soon after Strutt's invention, a regular warm-air heating industry was thriving in England, France, Austria and Russia. The Strutt system was used, in the early 19th century, for a number of important buildings on the Continent — e.g. the prison at Heidelberg.(19) Warm-air stoves, with ventilation, were installed at Windsor Castle in 1826 by Haden.



Belper Mill

The "cockle" stove is described in great detail by Mickleham ("An Engineer") as a confined fire chamber stove based on the "Dutch or German plate iron stoves" and first improved upon by "Mr. Strutt of Derbyshire; for the purpose of warming his extensive cotton-works. . . . This iron fire-room, . . . from its figure has obtained the name of the cockle."[18] Strutt's design used a cylindrical iron fire chamber set on a brick base with a fine-grate and ash pit beneath. The fire chamber is surrounded by brickwork with a space between for air circulation. This air is heated by the iron fire chamber where, by gravity, it then passes to the rooms to be warmed. A variation on this basic design uses a fire chamber with a serpentine chimney to increase the surface area and heat transfer to the air (Figures 4-22 and 4-23).

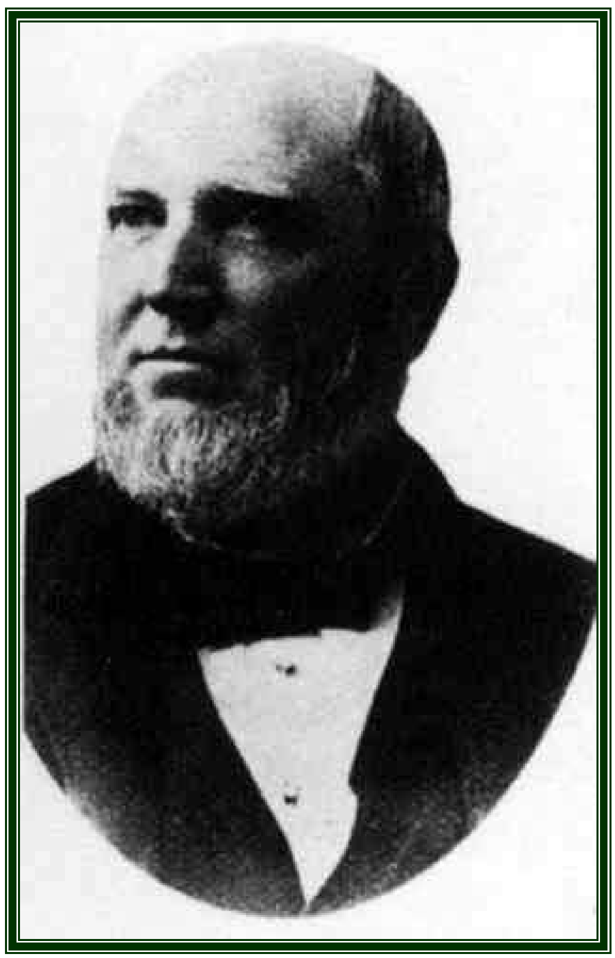
Another variation is the vase "cockle" stove made from a single cast-iron fire chamber set on thick masonry with multiple openings for air circulation to the space being heated. The vase "cockle" stove represents "a very simple and economical stove on the principle of the lime-kiln. . . . The fuel is applied at the top, which is closed by an iron plate or fire-tile."[19]

The largest and most well-known application of the "cockle" stove was for the Derby Infirmary by William Strutt.

(Extract from "Heat & Cold: Mastering the Great Indoors," Barry Donaldson & Bernard Nagengast, ASHRAE, 1994)

The old Derby Infirmary

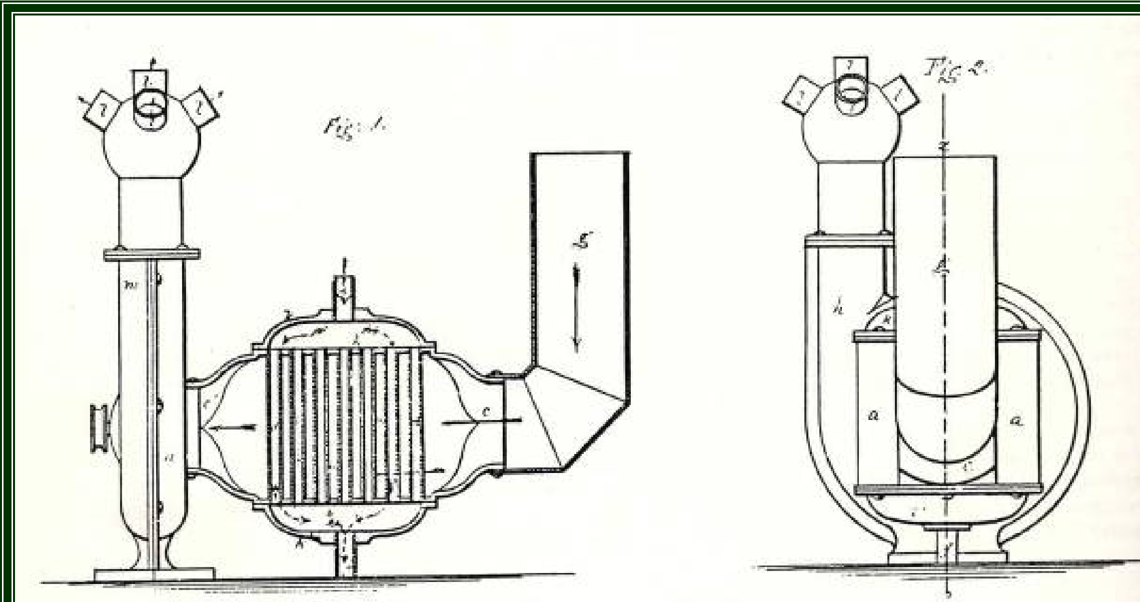
BENJAMIN FRANKLIN STURTEVANT
Born c.1824



An important engineer in fan development

American fan engineer, possibly the most important name in ventilation during the second half of the 19th century. "Started out as a shoemaker and cobbler. Being a very large man, he was greatly bothered with the heat....so he rigged up, (in) about 1850, a stand with a disc (4 blade) fan run by a belt on an eccentric pulley to a pedal which he worked with his foot." Invented a pressure blower (1861), patented a hot-air furnace blower (1869), and patented a compound air heater and steam condenser (1870). Started commercial fan manufacturing (1855) and formed the Sturtevant Blower Co. in Boston. Later known as B.F. Sturtevant Co., the firm produced steam fan drives and then electric fan drives, a wide variety of types and sizes of fans, including the *Cone-Wheel Fan* (c. 1896, a type of plug fan) and dual-duct fan apparatus. Also, devised a combination fan and heat exchanger for heating or cooling (USP 92460: 1869). Company publications, such as *Ventilation & Heating* (c. 1886) were widely used in both the USA and Europe.

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

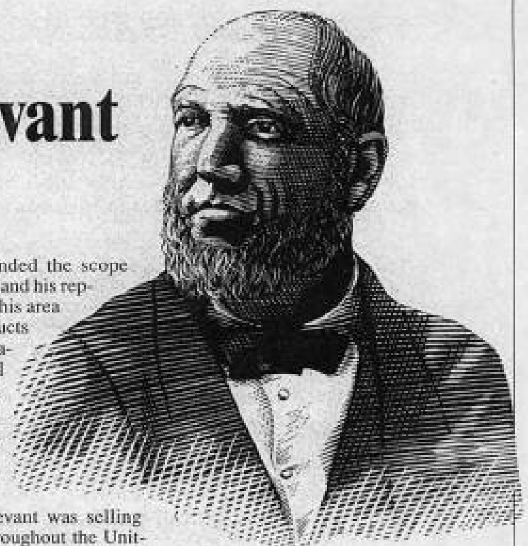


B F Sturtevant compound air heater and steam condenser, patent drawing 1870

HALL OF FAME

Benjamin F. Sturtevant

From Shoes To Fans



BY BERNARD NAGENGAST

The heart of all air-side air-conditioning systems is the fan, usually a centrifugal blower, unobtrusively pumping heated or cooled air throughout the building environment. That makes sense. But would you believe that the American centrifugal-fan industry was begun by a shoemaker?

The Cobbler Makes A Fan

Perhaps Benjamin Franklin Sturtevant's inventiveness was preordained by the name he was given at his birth in Maine about 1824. However, little is known about his life there, except that he learned the trade of making and repairing shoes. He later moved to Boston, seeking work in his trade.

Sturtevant was mechanically inclined, and he soon became interested in designing machinery to automate his shoemaking. About 1850, he turned his inventive mind to a means of alleviating summer heat, shoe dust and relentless flies: Sturtevant rigged up a foot-operated, four-blade disc fan next to his workbench.

As his business expanded, the frequent buffing and cutting of leather generated even more dust. And the little disk fans, which simply blew the dust around the room, became more nuisance than help. Sturtevant recognized the solution: Remove the dust! Around 1861, he designed a centrifugal blower, which he used to suck the dust and leather clippings away from the work area.

Other shoemakers saw the blower and wanted their own. Soon Sturtevant had set up a shop on Sudbury Street, where he employed eight men to build centrifugal blowers. It was the beginning of the centrifugal-fan industry in the United States.

Expanding horizons

It wasn't long before Sturtevant realized that his blowers had other applications. They could be used as pressure blowers for stoking blacksmith forges, creating artificial drafts for boilers and furnaces, and distributing air for ventilating buildings.

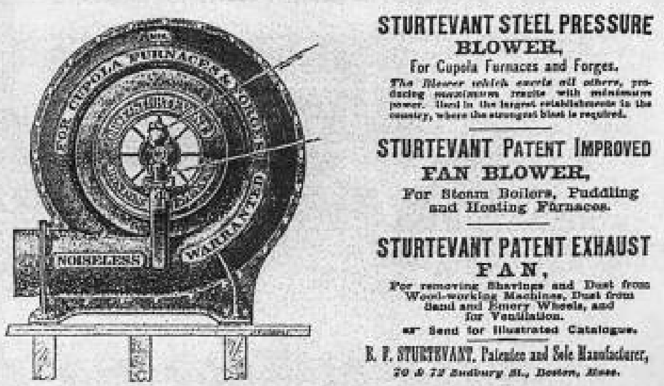
So Sturtevant expanded the scope and size of his blowers, and his reputation as an expert in this area spread. When his products were chosen for installation at the U.S. Capitol about 1866, they were the largest encased blowers in the country up to that time, with wheels approximately 16 feet across.

By this time, Sturtevant was selling blowers of all sizes throughout the United States, and soon he had customers in England and Europe. His Boston shop couldn't keep up with the demand, so in 1878 larger facilities were constructed in Jamaica Plain, Mass. The company's growth continued: Twelve years later, an advertisement boasted of offices in New York, Philadelphia, Chicago and London.

The Fan System Of Heating

Sturtevant believed that it was logical to incorporate heating as part of the ventilation process, and the former cobbler received a patent in 1870 for a fan and heater combination, which he named "the independent unit heater." Actually, he had designed a fan-forced heating system that used a shell-and-tube heat exchanger to transfer heat from steam to air. Not only could live steam from a boiler be used to heat the air, but the exhaust steam from the engine driving the fan could be passed through one of the heaters, capturing heat that would otherwise have been wasted.

The idea of using a steam heater with a centrifugal blower was enthusiastically accepted by heating engineers. They saw the advantage of a combination venting-and-heating system, particularly for large commercial buildings. Sturtevant's catalog, which first appeared in 1870, was continually re-issued with more fans and information.



An 1870s advertisement for Benjamin Franklin Sturtevant's products touted their versatility and effectiveness in a variety of commercial and industrial applications.

SUPPLY HOUSE TIMES

Hall Of Fame: Benjamin F. Sturtevant

Electric power systems were in their infancy in 1890. Electricity was expensive, and many centralized power systems were subject to periodic failures. Consequently most commercial and office buildings were constructed with their own power plants, which typically consisted of steam boilers and steam-engine-driven electric generators or alternators. If the building had a fan system for heating, the ventilating fans were also driven by steam. Usually three fans were used: one to draw in fresh air, one to circulate the air through the building and one to exhaust air to the outside.

The electricity from these generators and alternators was mainly used for lighting, but also powered some smaller machines such as disc fans. Exhaust steam from the fan and electric-power engines was frequently used to heat the building, with steam passing through heat exchangers at the blower-fan inlet.

In larger buildings, exhaust steam was also fed to radiators located on the perimeter walls. During particularly harsh winter weather, live steam from the boilers was added to the exhaust steam to meet the heating demand. This fan-type heating system, sometimes referred to as the hot-blast or plenum system, was frequently specified in the early decades of the 20th century.

Improved Systems

But B.F. Sturtevant was not satisfied with the design of his blower-heater combination, and he continued to refine it. He also improved the design of the steam heater. The shell-and-tube design was abandoned in favor of pipe banks placed in the air stream. Sturtevant tried straight pipes with manifolds at each end. However, when steam went through the pipes at 30 pounds with no room for the pipes to expand, they "went all to pieces," according to an engineer's article in the Aerologist magazine in 1930.

Around 1880, Sturtevant devised a system with a solid cast-iron base into which one-inch wrought-iron pipe coils were screwed. Steam was admitted into the base and rose into the pipes, where it transferred heat to the passing air, was condensed, and flowed back into the base and out to a trap. Twenty years later, the pipe coils were supplanted by various types of extended surface heat exchangers.

Sturtevant was always keenly alive to whatever would improve his work or add to its importance.

SUPPLY HOUSE TIMES

Hall Of Fame: Benjamin F. Sturtevant

Sturtevant was always keen to apply the latest innovations. Starting around 1890, he offered systems that controlled the steam supply in response to a duct thermostat. Soon after, he marketed dual-duct systems that mixed hot and cold air at the room outlets in response to manual controls. The room's occupant was able to maintain proper ventilation without freezing or roasting!

Sturtevant's fans were installed in prestigious buildings all over the world. One showcase was the mechanical system for the New York Stock Exchange building, designed by heating-and-ventilation engineer Alfred Wolff. This installation, probably the most significant of its time, was in fact a modern co-generation system, using power-plant exhaust steam to both heat and cool the building. During the summer, engine-exhaust steam was passed through absorption-type refrigerating machines, which cooled brine that was then circulated through 10,000 feet of pipe coils. Sturtevant fans drew air over the coils and circulated it to the stock-exchange floor, providing 300 tons of cooling. This system worked so well that it remained in use for a quarter century.

Sturtevant's Legacy Continues

By the 1890s, Sturtevant's success had attracted many competitors. The Buffalo Forge Co., which originally manufactured portable blacksmith forges, began making blowers for heating and ventilating. The Huyett & Smith Manufacturing Co., founded to produce a centrifugal fan for removing wood shavings in lumber mills, entered the heating-and-ventilation business and was renamed the American Blower Co.

Meanwhile, Samuel Davidson had patented a centrifugal blower that featured very quiet operation. Known as the sirocco fan, it was sold by Sirocco Engineering Co. of New York. A host of other, smaller companies were formed to manufacture fans and blowers. However, B.F. Sturtevant Co. remained the dominant force well into the 20th century.

Sturtevant fans are still manufactured today. The company became a division of Westinghouse Electric & Manufacturing Co. in the 1940s, and was recently sold to Howden Fan Co. Curiously, Sturtevant's old competitors, Buffalo Forge, American Blower and Sirocco, are also owned by Howden.

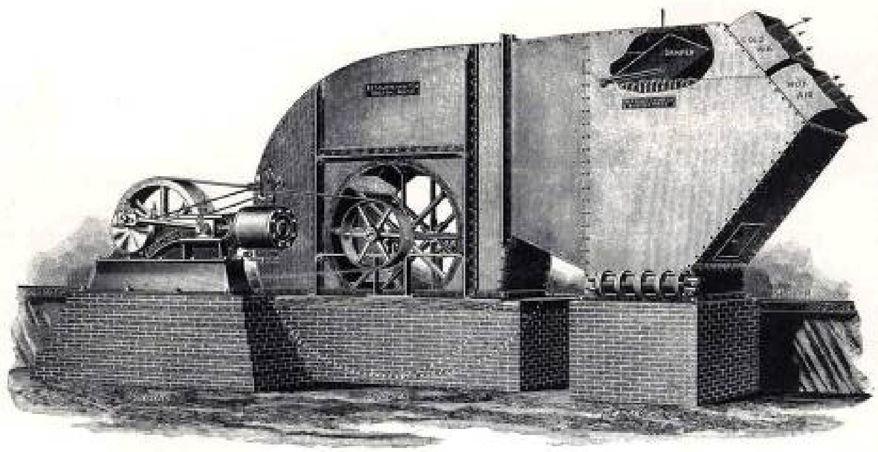
Sturtevant's fans were installed in prestigious buildings all over the world.

Thousands of Sturtevant fans are in use throughout the world, many of them dating to the last century. Although the date of Sturtevant's death is unknown, his products — and their descendants — hum a continuous tribute to the man who founded the American blower industry. An article on industry pioneers that appeared in the Boston Globe in 1916 summarized Sturtevant's career: "He was always keenly alive to whatever would improve his work or add to its importance. He made a large fortune, but his one idea was to spend his money freely in enlarging his business and making it of greater importance in the world of scientific manufacture." □

The Sturtevant System

OF HEATING AND VENTILATION

By a Forced Circulation of Warm Air is applicable to all classes of buildings



The Sturtevant System Is Superior to Direct Heating

BECAUSE

- The apparatus is centralized and under one man's control.
- There is no steam piping scattered around the building.
- Consequently no danger of freezing or of damage from leaky joints, valves, or aircocks.
- The heater is specially adapted to the use of exhaust steam.
- Heating can be accomplished with great rapidity.
- Building can be cooled and ventilated in summer.
- Humidity can be regulated.

BECAUSE

- Ample and positive ventilation is provided.
- Quantity and quality of air are under absolute control.
- Constant temperature can be maintained and air volume varied when "hot and cold system" is used.
- The heating surface is inclosed in a fireproof casing.
- The air-ducts are fireproof.
- There is no tendency to noise.
- Operation is independent of wind and weather.

Send for Catalogue No. 112, describing the system in detail

B. F. Sturtevant Company, Boston, Mass.

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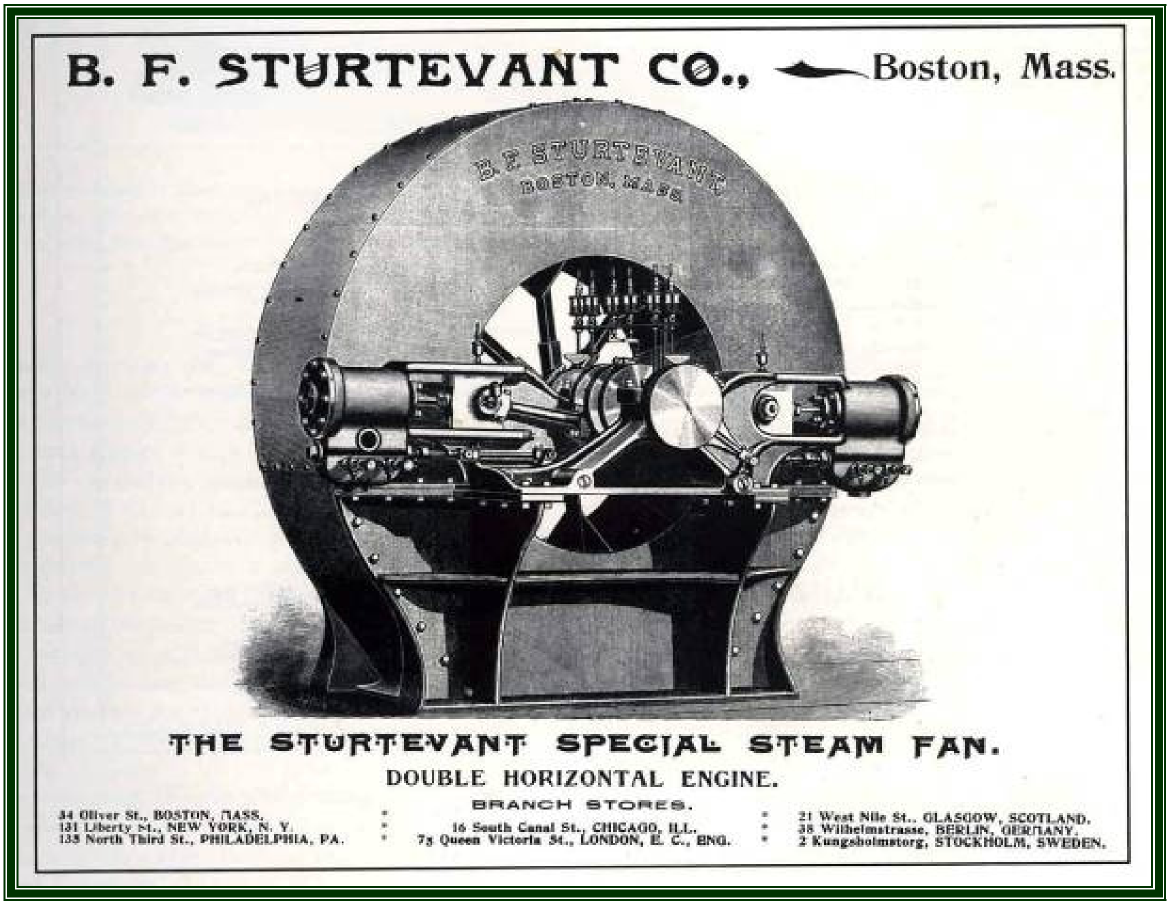
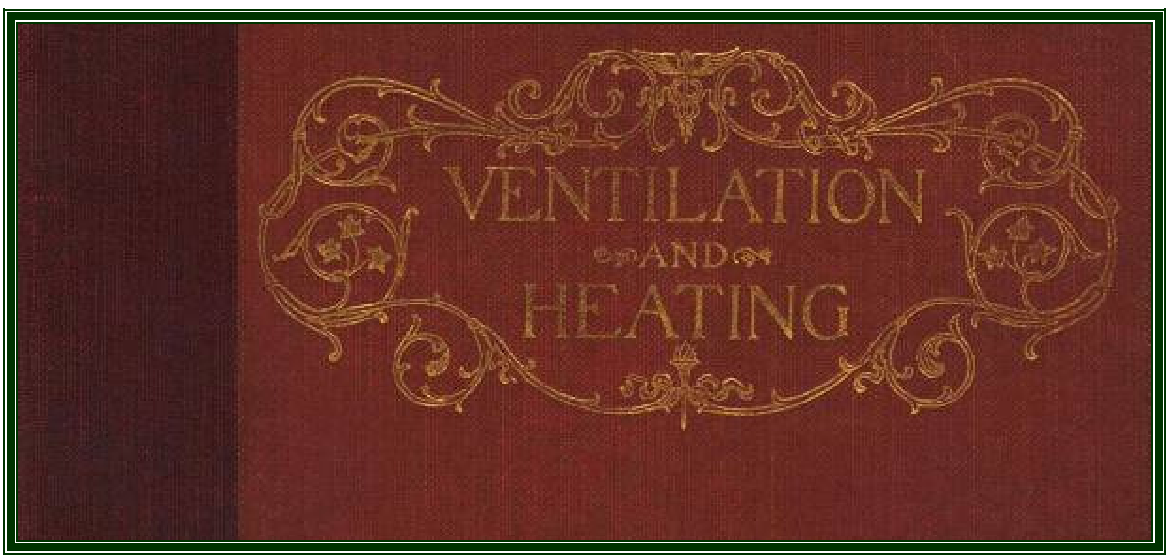
131 Liberty St.	135 No. Third St.	16 So. Canal St.	75 Queen Victoria St.



B. F. STURTEVANT CO., Boston, Mass.
B. F. STURTEVANT BOSTON, MASS.
THE STURTEVANT SPECIAL STEAM FAN.
DOUBLE HORIZONTAL ENGINE.
BRANCH STORES.
34 Oliver St., BOSTON, MASS.
131 Liberty St., NEW YORK, N. Y.
135 North Third St., PHILADELPHIA, PA.
16 South Canal St., CHICAGO, ILL.
75 Queen Victoria St., LONDON, E. C., ENG.
21 West Nile St., GLASGOW, SCOTLAND.
38 Wilhelmstrasse, BERLIN, GERMANY.
2 Kungsholmstorg, STOCKHOLM, SWEDEN.



VENTILATION
AND
HEATING

VENTILATION

AND

HEATING

Principles and Application

A TREATISE

B. F. STURTEVANT CO.

BOSTON, MASS.

NEW YORK. PHILADELPHIA. CHICAGO.

Sturtevant Engineering Co.

LONDON. GLASGOW.

STOCKHOLM. BERLIN. PARIS.

STURTEVANT ENGINEERING CO., LTD

147, QUEEN VICTORIA ST,

LONDON, E.C.

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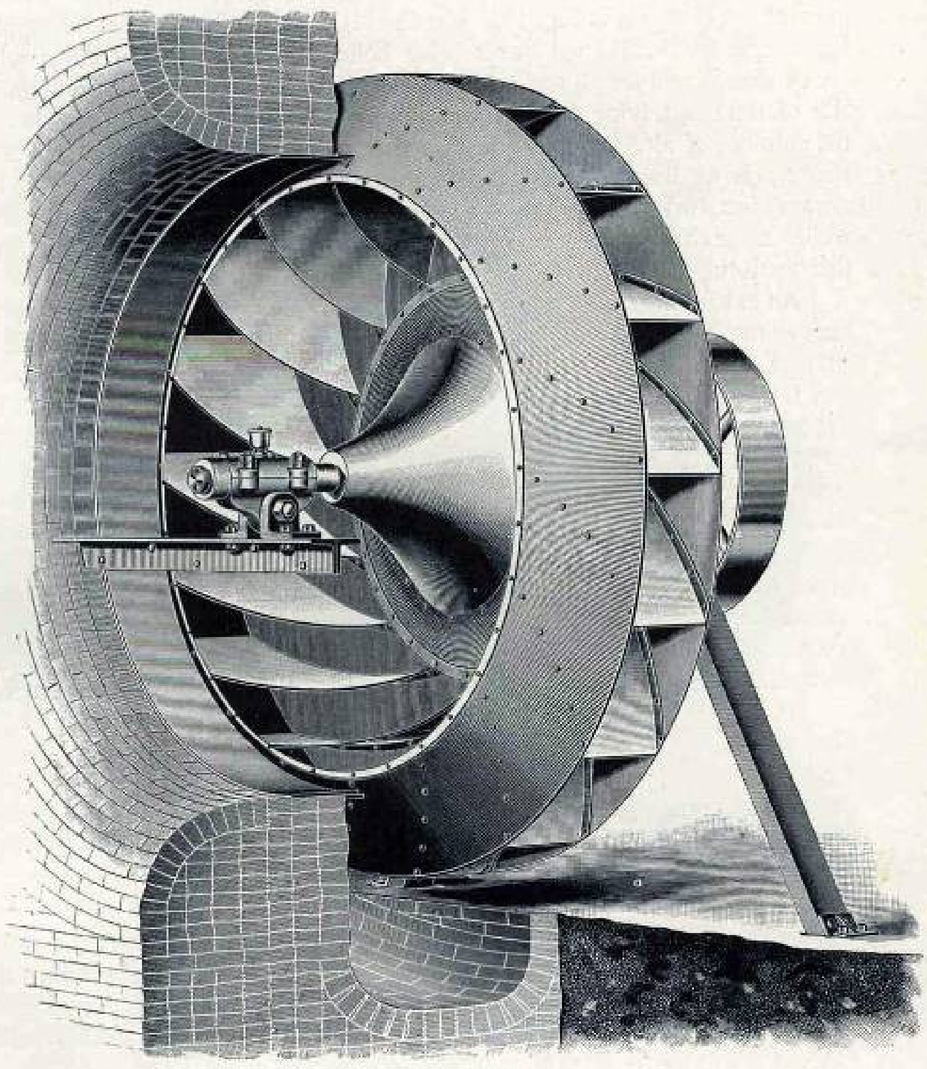

FIG. 18. CONE WHEEL.

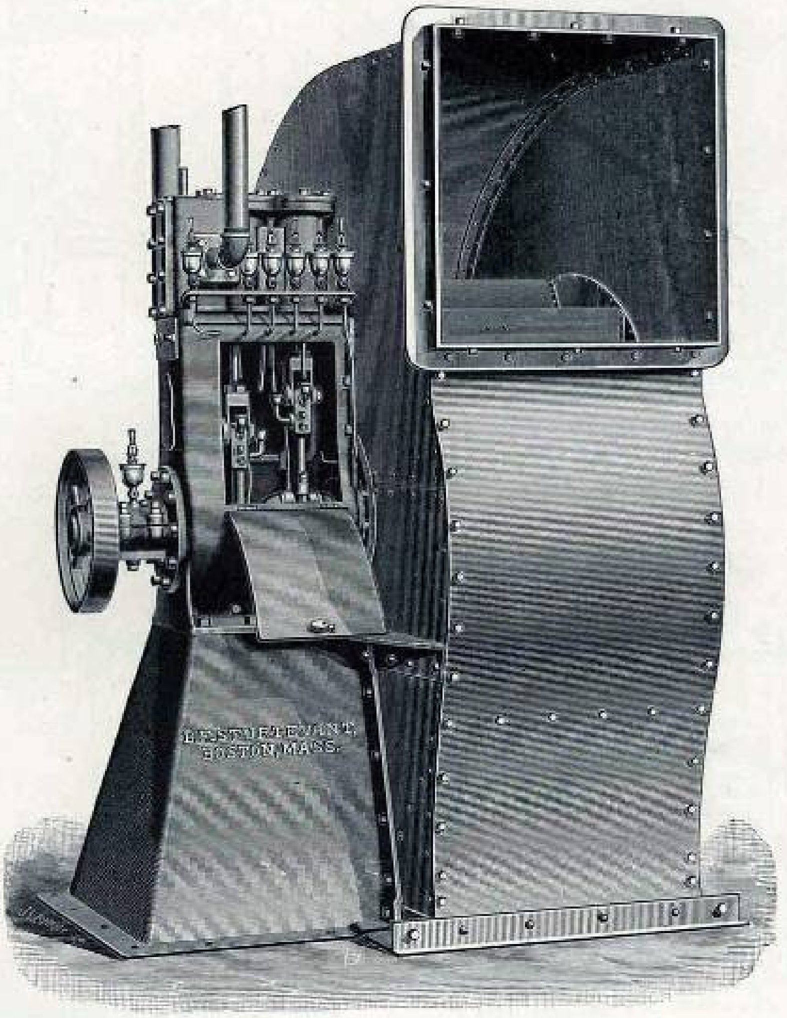

FIG. 26. SPECIAL STEEL PLATE STEAM FAN,
WITH DOUBLE ENCLOSED ENGINE.

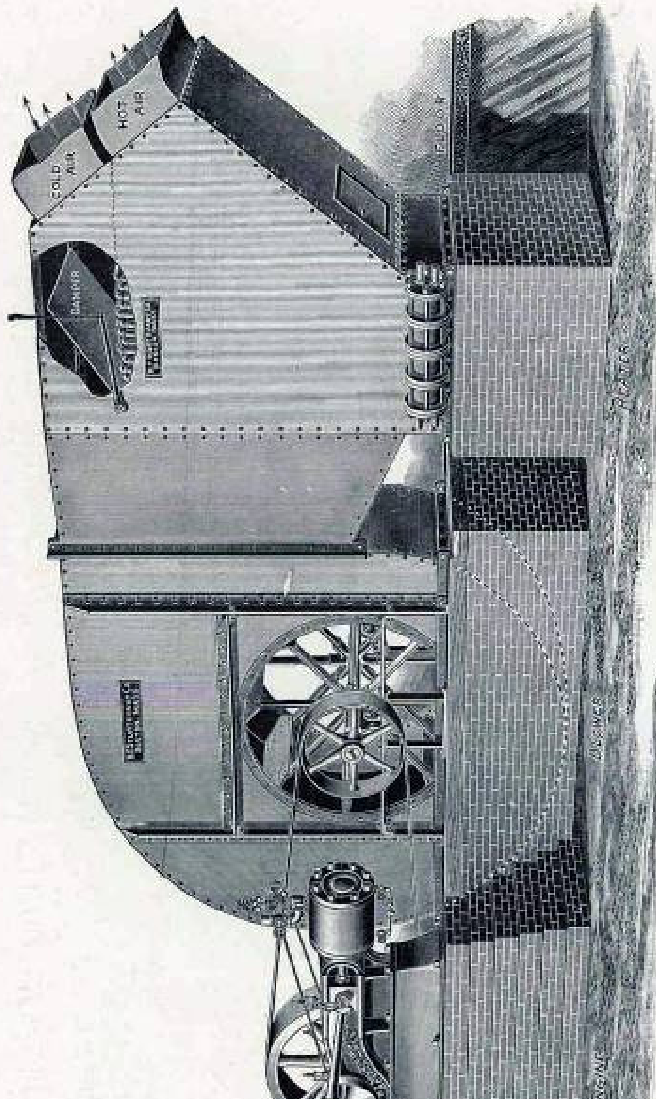

FIG. 54. HEATING AND VENTILATING APPARATUS,
FOR HOT AND COLD SYSTEM.

MECHANICAL

DRAFT

A PRACTICAL TREATISE

EDITED BY

WALTER B. SNOW,

OF THE ENGINEERING STAFF OF THE

B. F. STURTEVANT CO.

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Electric Fan, Steel-Plate Pattern. — For comparatively large plants where an electric fan is employed the pattern presented in Fig. 44 is well adapted. The shell is of the same steel-plate construction as the steel-plate exhauster already

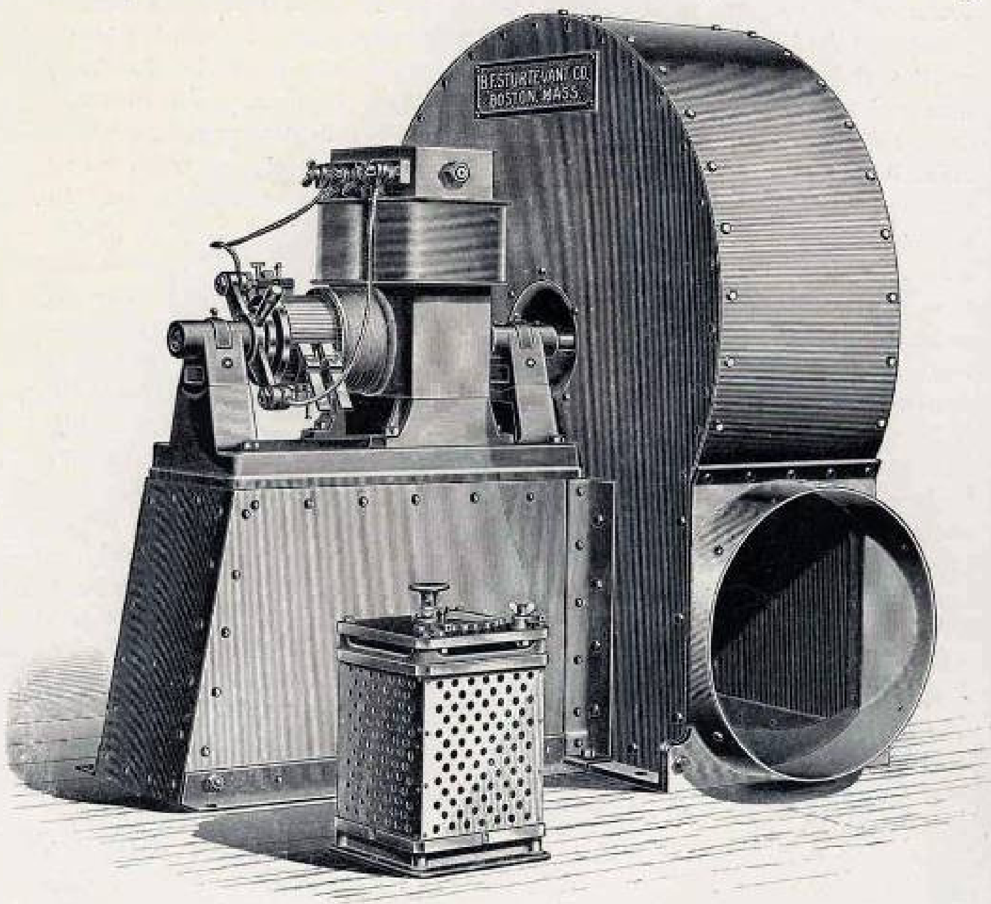

FIG. 44. ELECTRIC FAN, STEEL-PLATE PATTERN.

shown in Fig. 22. The motor shown is of the independent bi-polar type, but in large sizes a multi-polar machine is employed. For small sizes the circular form shown in the preceding illustration is also adaptable. This type lends itself to a great variety of arrangements.

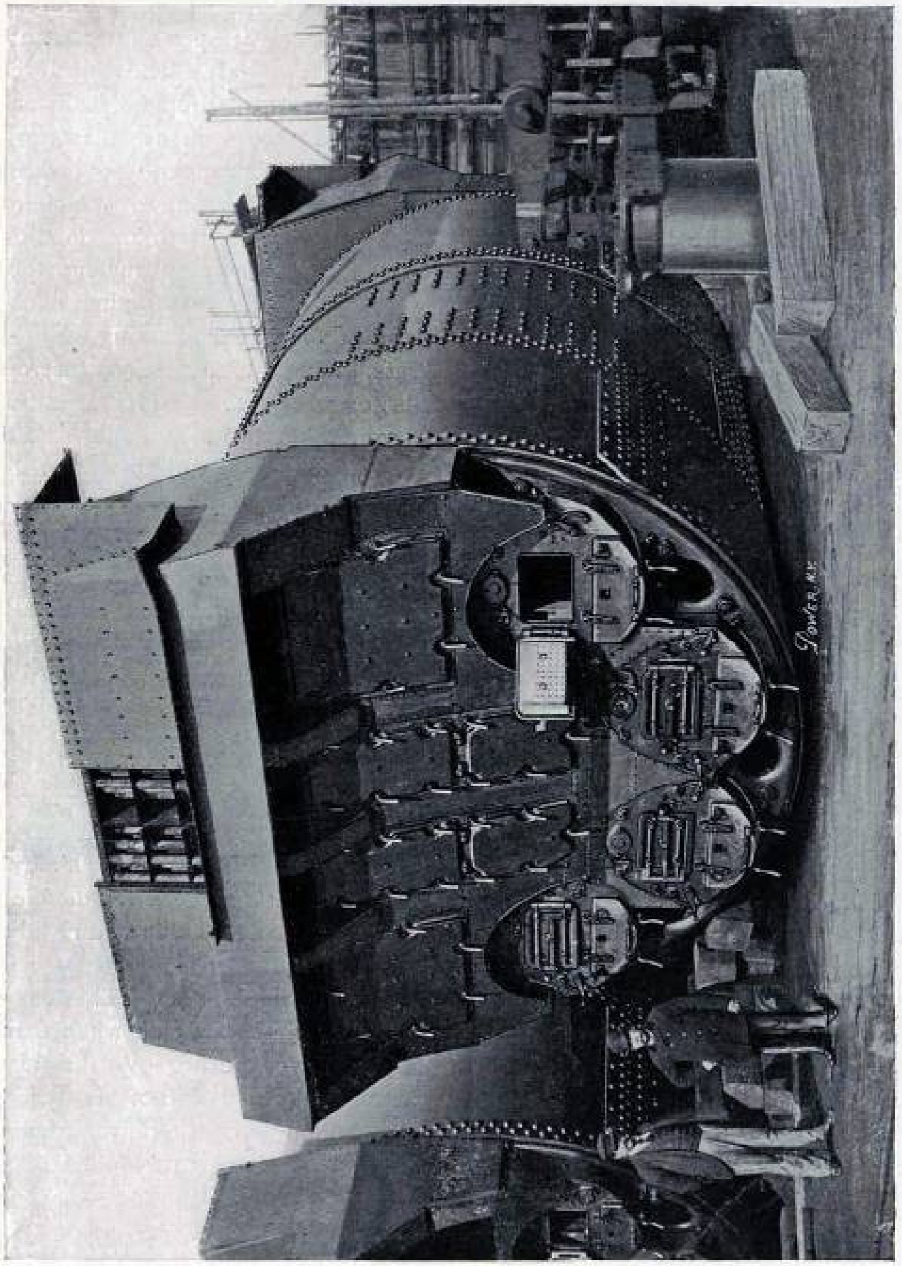

FIG. 90. BOILER EQUIPPED WITH HOWDEN HOT-DRAFT FOR USE WITH STURTEVANT FANS ON S. S. ST. PAUL OF AMERICAN LINE, INTERNATIONAL NAVIGATION CO.

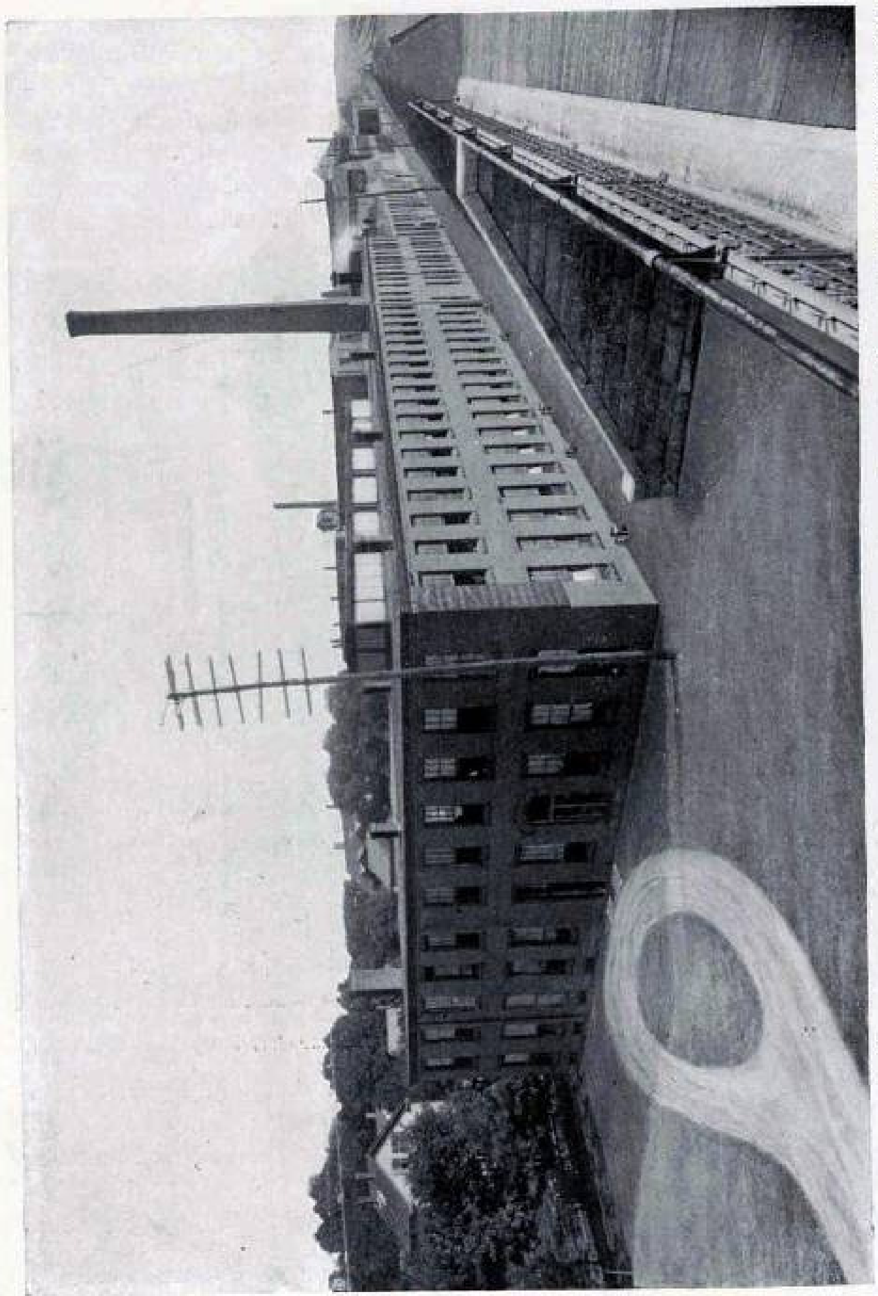

FIG. 49. VIEW OF B. F. STURTEVANT CO.'S WORKS, JAMAICA PLAIN, MASS., SHOWING RELATIVE SIZES OF CHIMNEY AND INDUCED-DRAFT PLANT STACK.