JOSEPH CONSTANTINE
Active 1880

No portrait has so far been discovered

[66] Joseph CONSTANTINE **active 1880**

Heating and ventilating engineer. Devised the *Convoluted Stove* "constructed of ribbed sections bolted together and enclosed in a brick setting through which air could pass." His stove incorporated an arch of fireclay slabs over the combustion chamber to ensure efficient and complete combustion. Used to warm the Free Trade Hall, Manchester. He rated his stoves by the weight of metal employed, "The difference in weight gives the difference in heating power. Every pound of metal has a certain capacity for radiating heat and no more, and the heating power of an apparatus may be readily ascertained in this manner." Wrote *Practical Ventilation & Warming* (1881). He bemoaned the lack of attention to warm-air heating.

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

PRACTICAL VENTILATION AND WARMING,

WITH

ILLUSTRATIONS AND EXAMPLES,

AND

SUGGESTIONS ON THE CONSTRUCTION AND HEATING, &c., OF DISINFECTING ROOMS AND TURKISH BATHS.

BY

JOSEPH CONSTANTINE,

MANCHESTER.

LONDON:

J. & A. CHURCHILL, NEW BURLINGTON STREET,

1881.

1881 (CIBSE Heritage Group Collection)

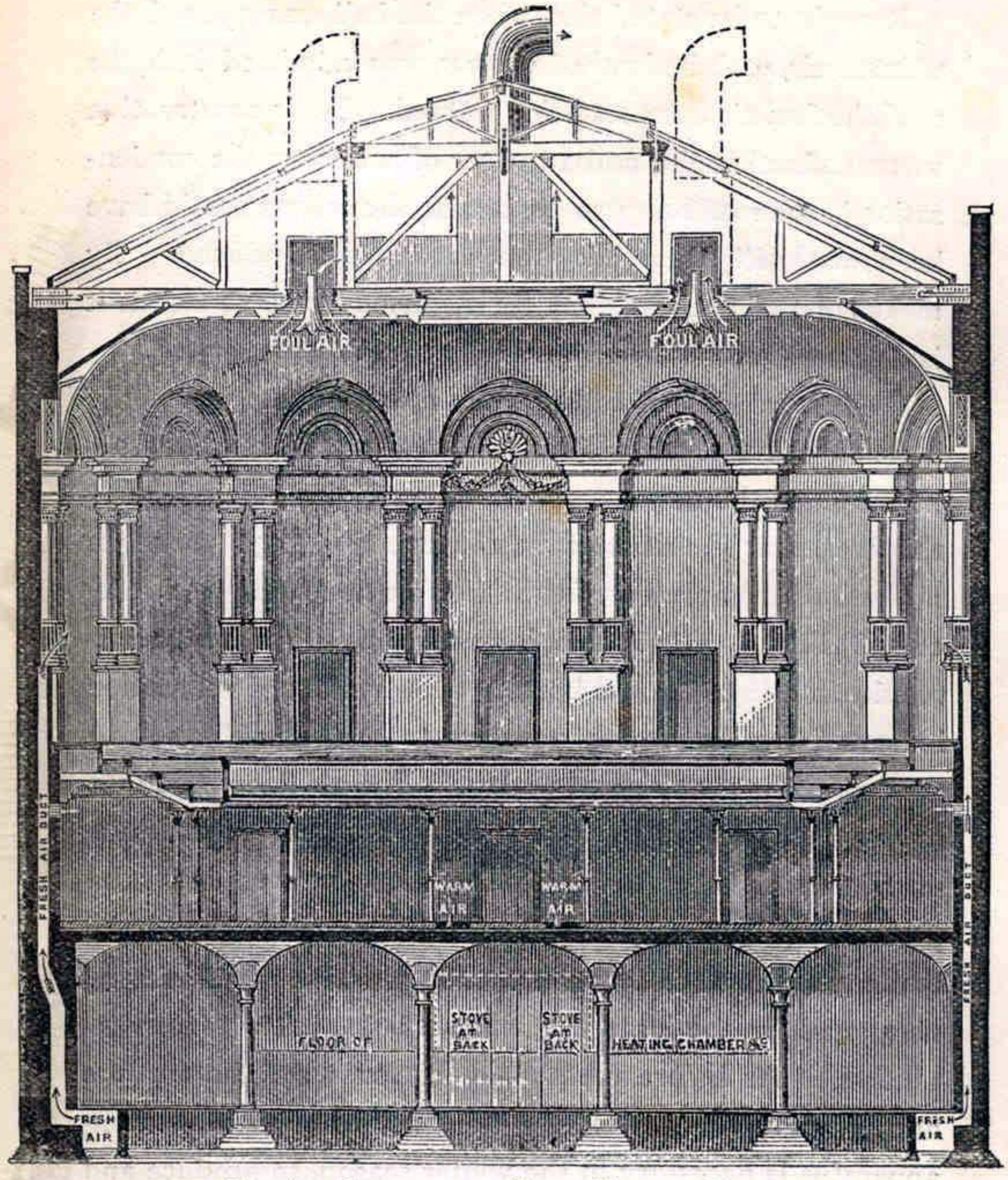


Fig. 8.—SECTION OF FREE TRADE HALL.

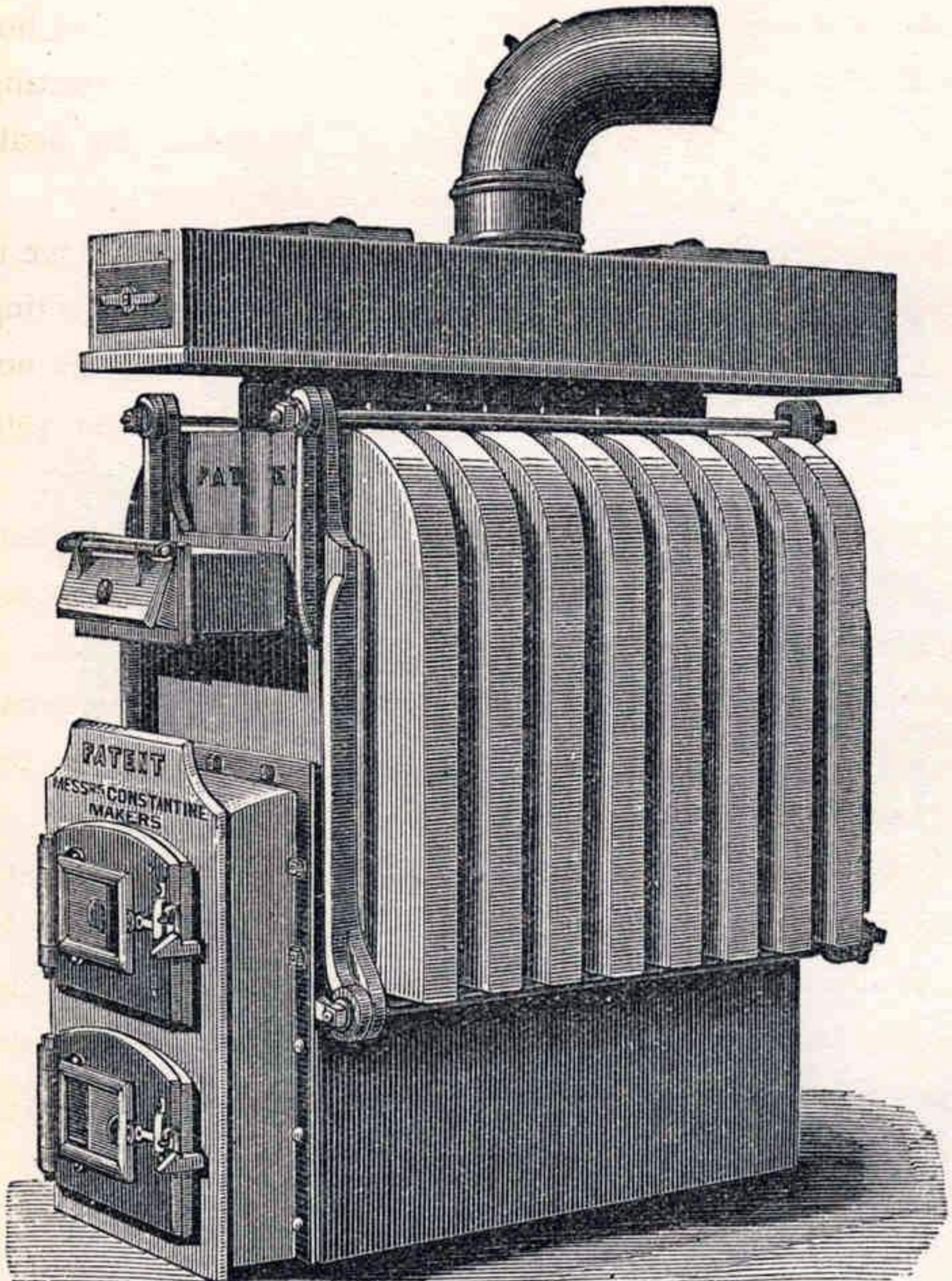


Fig. 44. — Convoluted Stove,

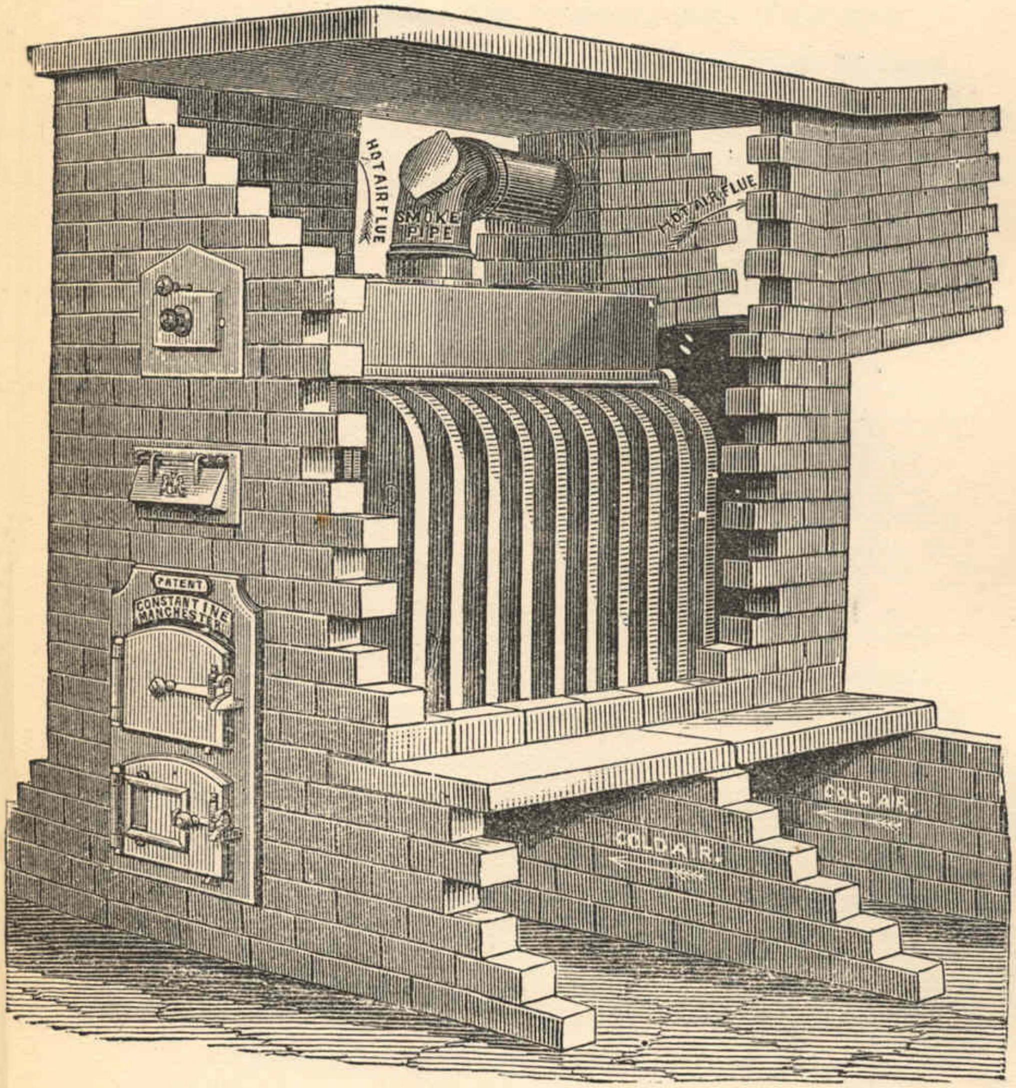


Fig. 48. — CONVOLUTED STOVE IN BRICKWORK.

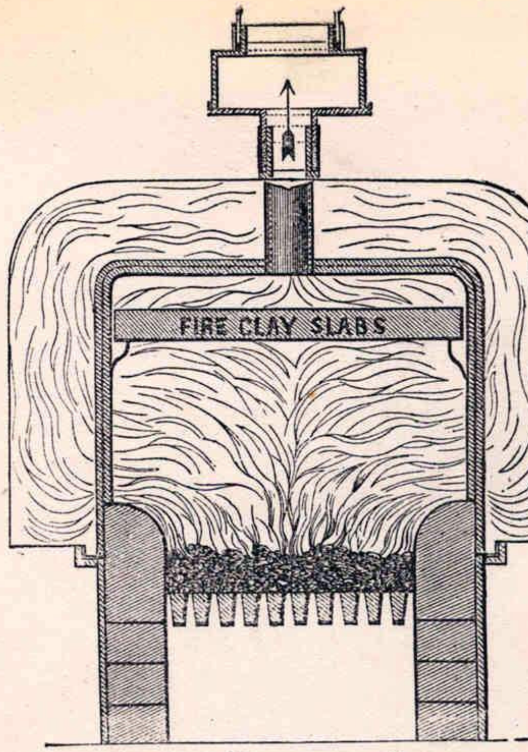


Fig. 46. — HORIZONTAL SECTION.

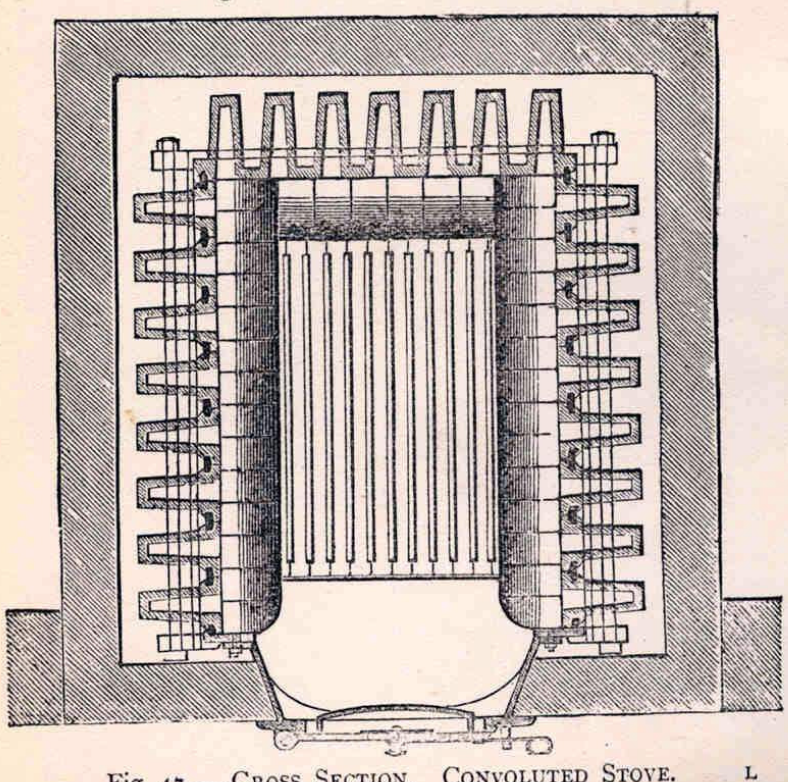
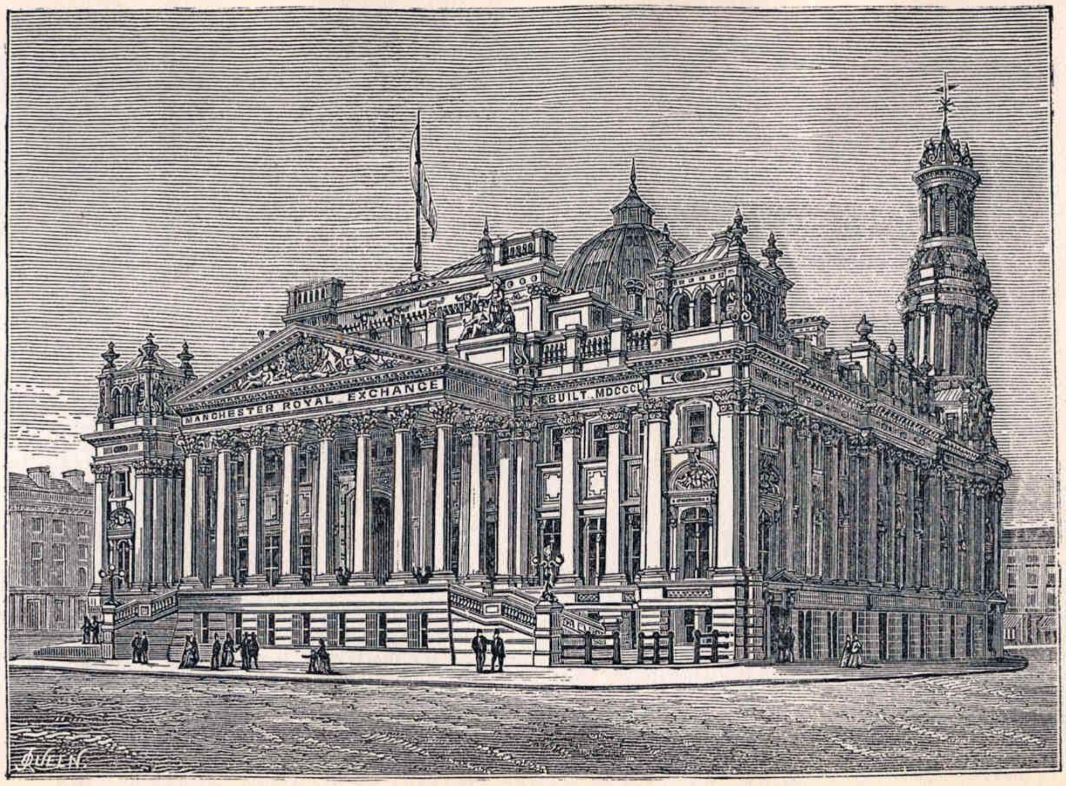


Fig. 47. — CROSS SECTION. CONVOLUTED STOVE. L

In the Convoluted Stove with the fire-clay slab running through and filling the upper part of the fire-box, and which throws the flame into the convolutes, the greatest radiation is obtained. The following scale is the result of experience, and may be relied upon for efficient warming without any forcing of the fire, which always means waste of fuel.

Weight of Metal.	Area of Heating Surface.		Area capable of Warming.	Area per Cwt.
cwt.	sq. ft.		cubic feet.	cubic ft.
14	35	=	26,000	1,857
20	55	=	40,000	2,000
22	69	=	50,000	2,275
34	119	=	86,000	2,529
36	139	=	100,000	2,777
45	280	=	140,000	3,111
50	231	=	175,000	3,500
56	296	=	22,000	3,928

It will be seen by the figures on the scale that with the small stove one hundredweight of metal warms an area of 1,857 cubic feet, and that as the stove increases in size a greater result per hundredweight is obtained. The last figures show that one hundredweight warms an area of 3,928 cubic feet. This must not be taken as the minimum weight of metal in each case, but an average.



MANCHESTER ROYAL EXCHANGE.

The cockle stove continued to be used in Britain for many years. Constantine (who was a manufacturer of warm-air stoves) used a cast-iron stove with a highly ribbed surface — the "Convoluted" stove — in the 1880's though they were largely confined to churches and schools at that time. He expressed a curious belief, in the words:

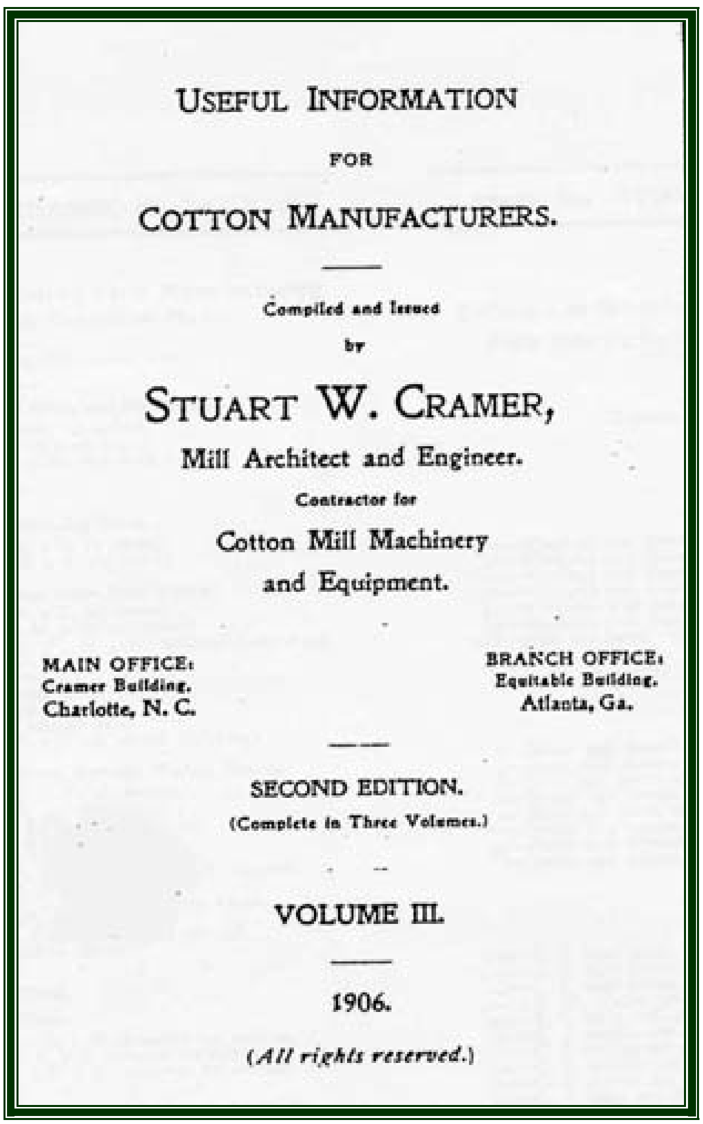
> "A cockle stove weighing 14 cwt (700 kg) was taken out of a church which had an area (*sic*) of 180,000 cubic feet (5100 m^3); it was replaced by a Convoluted stove of 50 cwt (2500 kg). The difference in weight gives the difference in heating power. Every pound of metal has a certain capacity for radiating heat and no more, and the heating power of an apparatus may be readily ascertained in this manner."

He bemoaned the lack of attention to warm-air heating:

> "During the 19th century, the progress made in air warming has been very small, while ingenuity has been very active in the improvement of apparatus for heating water and generating steam. The necessity for a powerful boiler for locomotive engines first stimulated invention in this direction."(15)

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

STUART W CRAMER
1867-1940



USEFUL INFORMATION

FOR

COTTON MANUFACTURERS.

Compiled and Issued

by

STUART W. CRAMER,

Mill Architect and Engineer.

Contractor for

Cotton Mill Machinery

and Equipment.

MAIN OFFICE:
Cramer Building,
Charlotte, N. C.

BRANCH OFFICE:
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SECOND EDITION.

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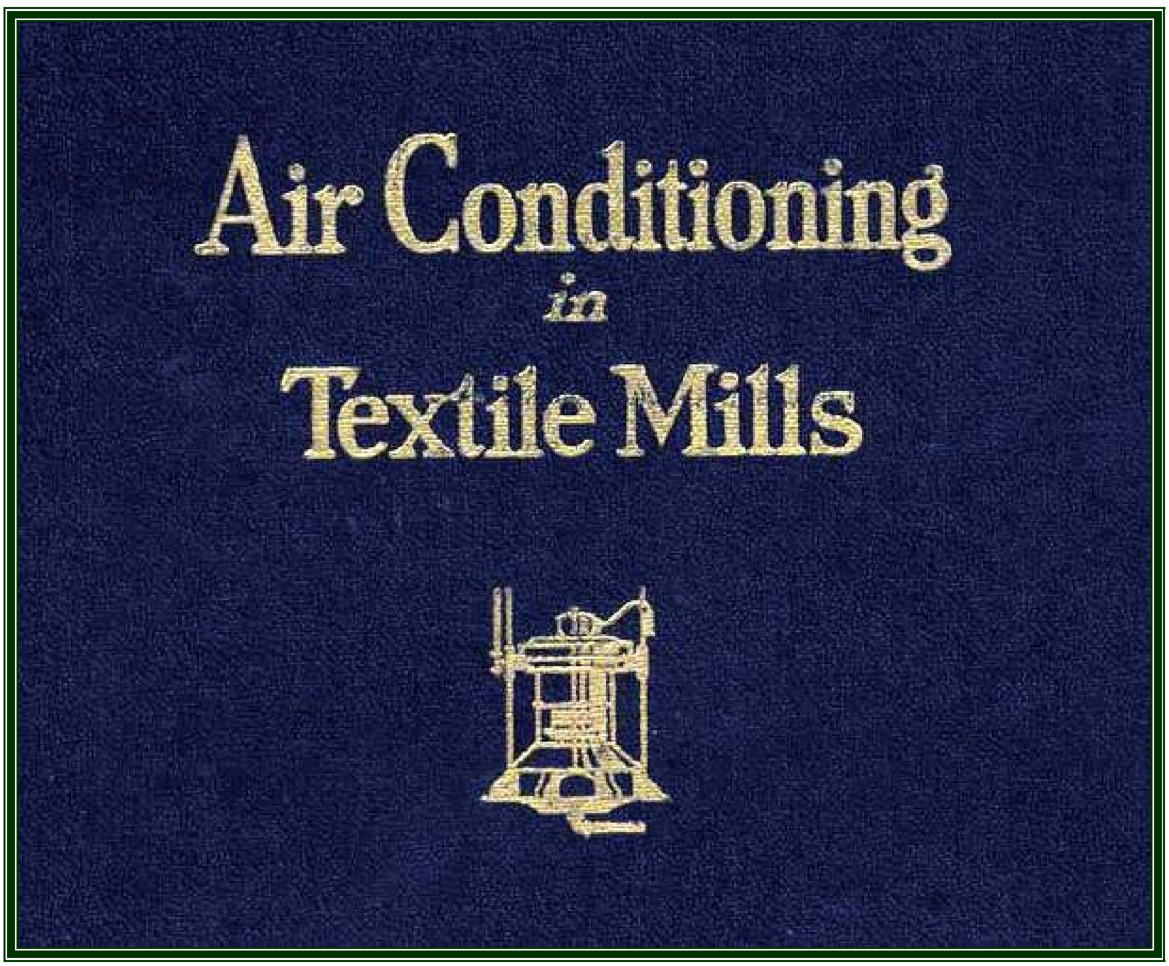
VOLUME III.

1906.

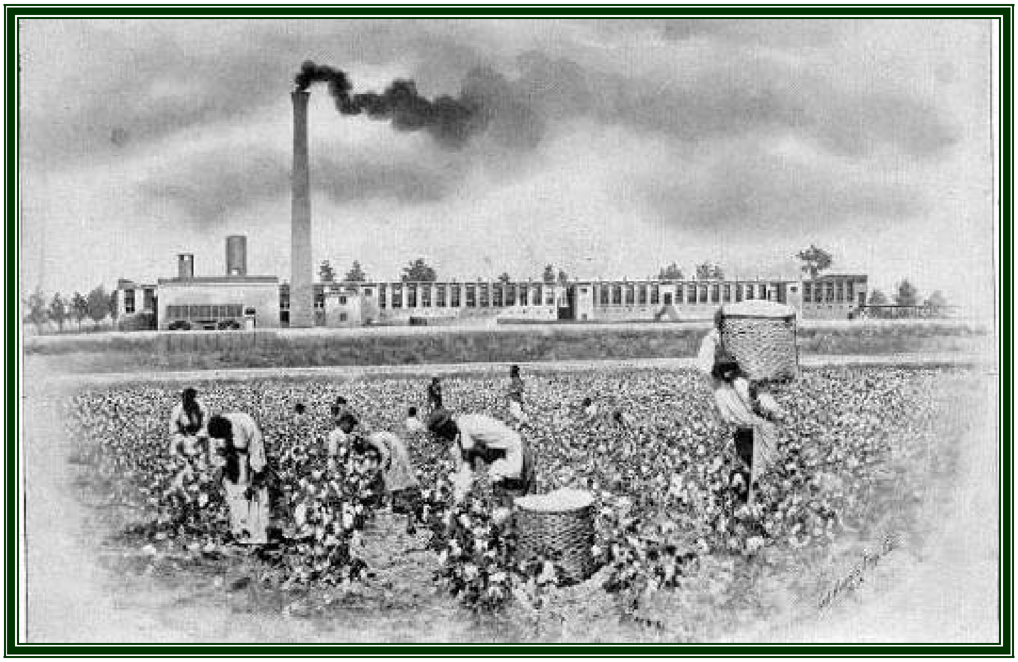
No portrait of Cramer has so far been discovered

American textile engineer from Charlotte, North Carolina. Credited with coining the term *air conditioning* in his paper, *Recent Developments in Air Conditioning* (1906), read before a convention of the American Cotton Manufacturers' Association. It is believed the term was suggested by the use of the term *conditioning* in the treatment of yarn, cloth, or raw materials before manufacture. Cramer also used the term in a patent (USP 852,823: 1906). He independently discovered some of the relationships used by Carrier [101] to arrive at his rational psychrometric formulae. Carrier used the term when he convinced Buffalo Forge to establish the subsidiary Carrier Air Conditioning Co. (1907). Cramer wrote *Useful Information for Cotton Manufacturers* (1909), which dealt with humidifying practice "based upon sound theory and actual field experience." Obtained a patent for an air-conditioning (humidifying) apparatus (USP: 1,073,475: 1913). After his retirement (1918), the Parks-Cramer Co. published (1924) the classic textbook *Air Conditioning in Textile Mills* based on his work.

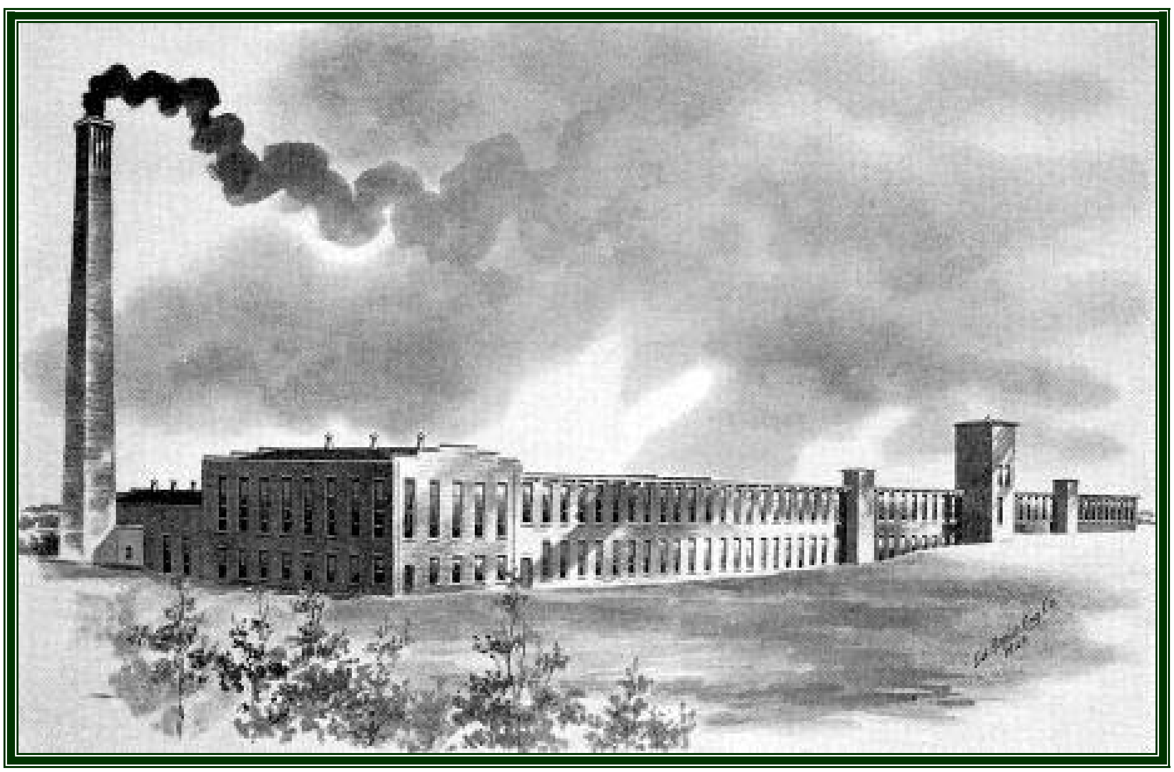
(Mini-biography from "The Comfort Makers," Brian Roberts, ASHRAE, 2000)



Cover title block 1924 (CIBSE Heritage Group Collection)



Atherton Mill, Dilworth, opened 1893



Highland Park Mill No. 2, Charlotte, opened 1893

STUART CRAMER

At roughly the same time that Wolff pioneered air conditioning for comfort among the New York elite, Stuart Cramer developed air conditioning as an aid to processing in the growing textile industry of the American South. Industry provided a larger market for air conditioning than luxury residences and expensive commercial buildings, and it was this larger market that sustained the early technical innovations and their developers. In industry as well as in commercial buildings, humidity control was combined with heating and ventilating equipment to produce a new system that had a greater range of functions along with much more complex technology.

Process air conditioning—the term used for these industrial applications—began with the effort to add moisture to dry factory environments. Humidification was especially important in factories that processed hygroscopic materials—that is, materials that absorb moisture from the air, which changes their shape and working properties. For example, manufacturers took advantage of the natural tendency of cotton and wool to absorb moisture, for damp fibers were more elastic and tough, easier to card, spin, and weave. Atmospheric humidification had the additional advantage of keeping static electricity levels low. Older methods of atmospheric humidification included dampening the factory floor or adding steam to the atmosphere. These methods were supplemented in the 1870s by commercial humidification systems, which used compressed air to atomize water over the looms.

No one gave more thought to the problems of humidification in textile mills than Cramer. A textile mill engineer from Charlotte, North Carolina, he coined the term *air conditioning* in a paper read before the National Cotton Manufacturers Association in May 1906, using it to describe his recent development of a new kind of textile mill humidification. Cramer recalled how "when entering this field, several years ago, I was puzzled to find a word that would embrace this whole subject. In casting about, I finally hit upon the compound word, 'Air Conditioning,' which seems to have been a happy enough choice to have been generally adopted."[23] The term was suggested by the use of *yarn conditioning*, which referred to the practice of exposing the textile fibers to moist atmospheric conditions in storage rooms before processing. Rather than condition the materials, Cramer proposed conditioning the air to which they were exposed as they were worked.

Cramer's term *air conditioning* emphasized atmospheric humidification over direct methods of moistening. He was groping for a new word because his equipment differed from existing systems of humidification, both direct and atmospheric. Rather than striving for the simple goal of adding moisture to the air, he hoped to maintain a predetermined relative humidity. Cramer aimed to substitute a precise numerical percentage of relative humidity for rough quantitative values, such as "more." Textile workers did not always agree on the optimum humidity level for a specific task. However, the ability to control the factory at a given percentage of humidity allowed the manufacturers to avoid large swings in humidity levels that often characterized older systems. Cramer's air-conditioning system maximized control and consistency.

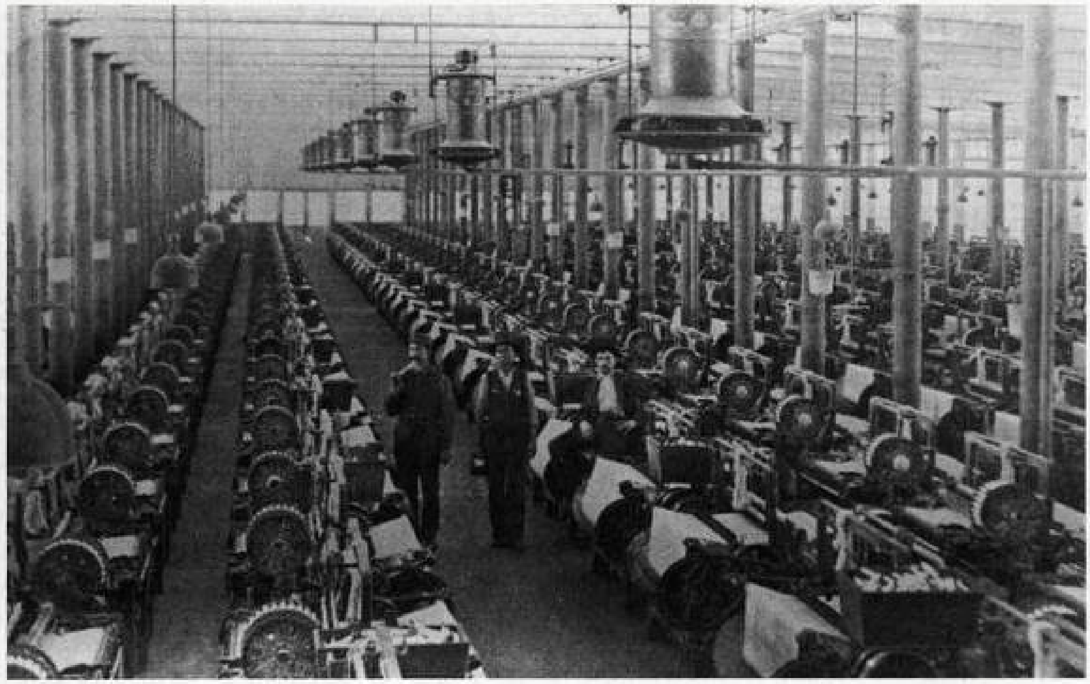
Cramer was born in 1867 in Thomasville, North Carolina, and graduated from the U.S. Naval Academy at Annapolis, Maryland, in 1888. He resigned from the navy that year and attended Columbia University School of Mines from 1888 to 1889. For the next four years he worked at the U.S. Assay Office at Charlotte. In 1893 Cramer began his career in textile engineering, joining the office of D. A. Thompkins Company in Charlotte as engineer and manager. When one of Thompkins's clients, the Whitin Machinery Works, became discontented with the company's handling of their account, Cramer left Thompkins to become Whitin's southern sales agent. He eventually represented several textile machinery manufacturers of which Whitin was one.[24] He also established several independent businesses, including the Cramer Furniture Company and the Cramer Air Conditioning Company.

The Cramer Air Conditioning Company grew out of Stuart Cramer's long involvement with the problems of textile manufacturing. From his position as the agent of several textile machinery companies, he designed or equipped nearly one-third of the South's cotton mills from 1895 to 1918.[25] This deep engagement with the problems of textile manufacturing led him to cast about for ways to improve factory humidification. Changes in mechanized weaving only increased the importance of atmospheric humidification. Increased machinery speeds led to hotter rooms and more highly stiffened yarns. In 1911 the *Southern Textile Bulletin* noted that "in these days of automatic high speed looms, it is necessary to size heavily" and that "unless the room is heavily moistened, it is impossible to soften up a hard sized warp" in the short time that it was exposed to the atmosphere on the frame.[26]

In 1904 Cramer applied for his first patent in air conditioning, a control instrument for regulating humidifiers automatically. It was the first of many inventions; at the time of his death in 1940, he held sixty patents that reflected the broad range of his interests.[27]

Cramer's 1904 control instrument, a hygrometer, was based upon the principle of a constant wet-bulb depression. Ventilating engineers ordinarily used two kinds of thermometers. One, a dry-bulb thermometer, was the kind commonly found in homes to measure heat. The second, a wet-bulb thermometer, measured the temperature of the air when cooled to saturation. It thus reflected not only heat but also the relative humidity of the atmosphere. A fabric wick covered the bulb of the wet-bulb thermometer, and was kept constantly wet by submerging one end in a small reservoir of water. The evaporation of the moisture from the wick cooled the thermometer so that the wet-bulb temperature was always below the dry-bulb temperature unless the air was completely saturated.

Cramer's control consisted of a wet-bulb and a dry-bulb thermometer wired electrically in such a manner as to maintain a constant difference between the wet-bulb and dry-bulb temperatures. That constant difference, or *wet-bulb depression,* maintained the relative humidity of the atmosphere at a nearly constant percentage. A 6-degree wet-bulb depression at a temperature of 70 degrees produces 69 percent relative humidity, while the same depression at 90 degrees produces 73 percent relative humidity. Thus, the variation in humidity was only 4 percent over a range of 20 degrees. "In practice," Cramer wrote, "it is found that within ranges of temperature ordinarily encountered in a textile factory a regular and uniform depression of the 'wet bulb' (as it is termed) corresponds with a practically-uniform relative humidity."[28] In addition, Cramer patented an electrically controlled compressed-air valve that provided automatic regulation of a humidifier when linked to the hygrometer.[29] Between June 1905 and April 1906 he filed patents on four humidifiers as well.[30]



Textile mill. Bell-shaped air conditioners designed and installed by Stuart Cramer hang from the ceiling in the weaving room of a textile mill. They resemble the humidifiers that they replaced. (Cramer Air Conditioning Company, *Equipment* [n.d., n.p.])

Not only did Cramer's system provide automatic control of humidity, increasingly he merged ventilation and humidification into one system. The humidifiers that preceded Cramer's air conditioner were canister-shaped devices that hung from the ceiling every few feet and aspirated a fine mist of water that mixed with the air of the workshop more or less effectively, leaving any excess to settle on the equipment. Such a constant wetting of the machinery promoted rust. Cramer's first air conditioners were similar in appearance and were mounted on the ceiling in great numbers. However, in these devices the air of the factory was drawn inside the housing, conditioned, and then released to the atmosphere of the shop, thus eliminating excess moisture that fell on the machinery.

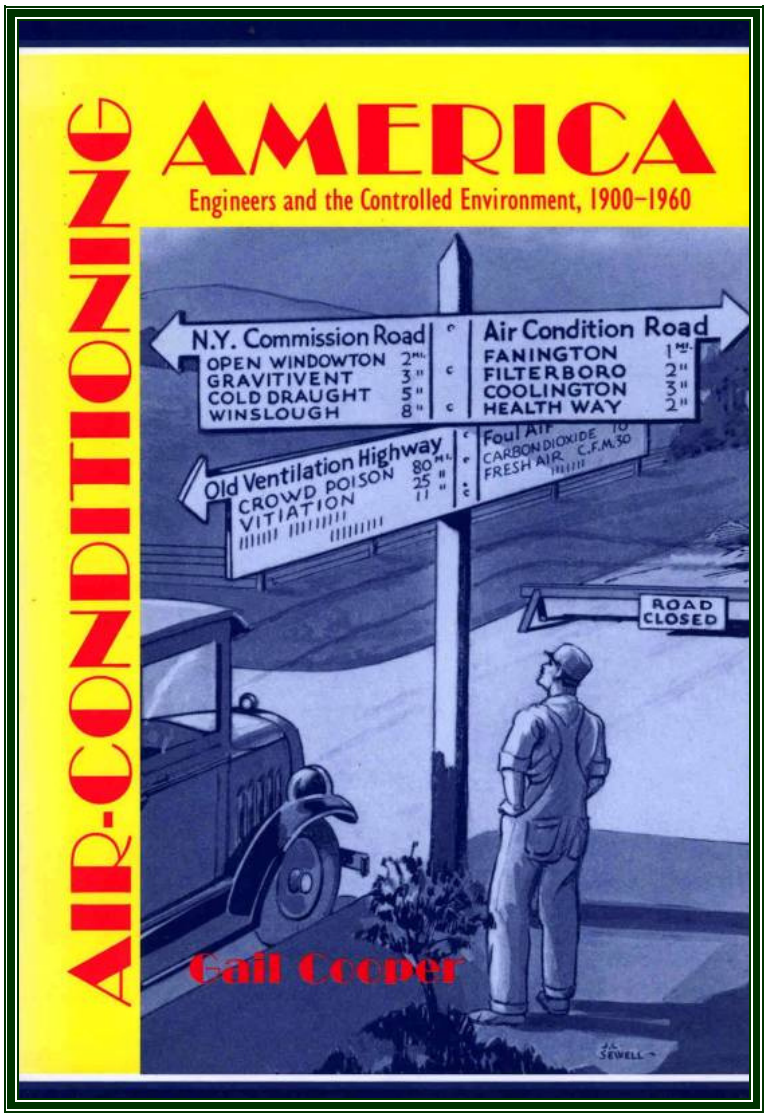
In this fashion Cramer made the switch from providing moisture to providing conditioned air. This new approach to an old problem led him to manufacture a new air conditioner that could be mounted on the wall to draw in fresh air and condition it before circulating it within the factory. This model, unlike previous humidifiers, was designed to perform the functions of both ventilation and humidification. It was placed against an outside wall or window and equipped with a fresh-air intake. Air was drawn both from the outdoors and from the factory and pulled through a fine water spray and then through a cloth filter before being discharged. Cramer claimed his air conditioner both cleaned and humidified the air.

Although the device was clearly aimed at solving the problem of maintaining an adequate humidity by adding moisture, the patent application claimed that it would also act as a condensing or cooling tower to lower the humidity in some cases. On those days when the humidity rose to a "very high percentage," Cramer expected a portion of the moisture to precipitate onto the cold surfaces of the cloth filter. Whether it would actually dehumidify in any effective fashion is unclear, but within a limited range, his April 1906 air conditioner cleaned, humidified, and distributed the entire air supply for the inside of a factory, doing so automatically when coupled with his humidity control instruments. This combination of functions was what Cramer termed "air conditioning," and together with temperature control, it remained the basic definition of the technology.

Cramer argued that the air conditioner offered manufacturers greater control over atmospheric conditions. The combination of ventilation and humidification in one apparatus permitted the replacement of window ventilation with a mechanical system. Manufacturers could now keep factory windows closed. Windows produced adequate ventilation only at the risk of creating drafty conditions. In his 1906 patent application Cramer asserted that "it is a well-known fact that ventilating textile factory buildings by opening windows or doors is not only injurious from a manufacturing standpoint interfering with the proper running of work, but also positively disarranges and disturbs the normal conditions of the fibers of the material which are required for the most favorable conditions to manufacturing."[31] By 1906 he arrived at a closed-window strategy for manufacturers of hygroscopic materials. His combination of humidity control and mechanical ventilation systems was the beginning of the separation and isolation of the factory interior from outside conditions, for the purpose of maintaining a precisely controlled indoor climate. With the adoption of this system, Cramer worked toward an ideal that he expressed as "the most favorable conditions to manufacturing," rather than the older goal of the improvement of existing conditions.

Air conditioning thus developed from two different sources: a concern for human comfort and an aid to industrial production. While comfort air conditioning preceded process air conditioning, it had a limited market. Both, however, involved the effort to control humidity, in addition to concerns of the temperature, cleanliness, and distribution of air. The emphasis on dehumidification for comfort led Wolff to adopt a fan-coil system with full refrigeration equipment, while Cramer's concern with humidification led to the use of a spray chamber. Both engineers went beyond the current engineering practice of their day in attempting to design a comprehensive system of environmental control using both existing and innovative equipment. Attempts to match technical equipment to these increasingly elaborate notions of environmental control absorbed the energies of the industry for years.

(Text extract from "Air Conditioning America," Gail Cooper, 1998)



"Air Conditioning America," Gail Cooper, 1998
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Air Conditioning

in

Textile Mills

A Handbook on Humidification

for

Textile Manufacturers
Engineers and Students

Edited by

Albert W. Thompson
Vice-President
Parks-Cramer Company

Price $5.00

Parks-Cramer Company
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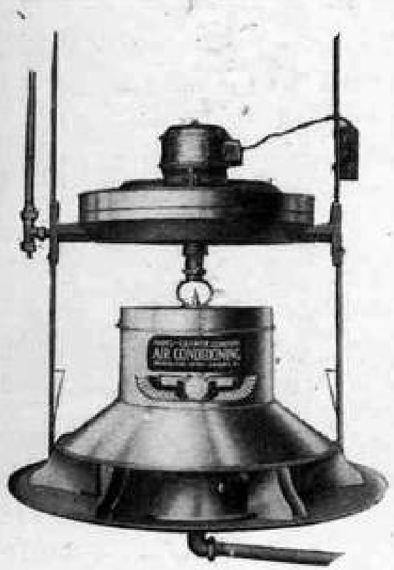
Industrial Piping and Air Conditioning
Fitchburg **Boston** **Charlotte**

1924



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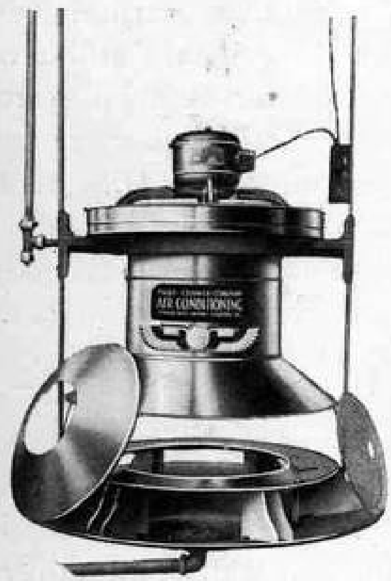
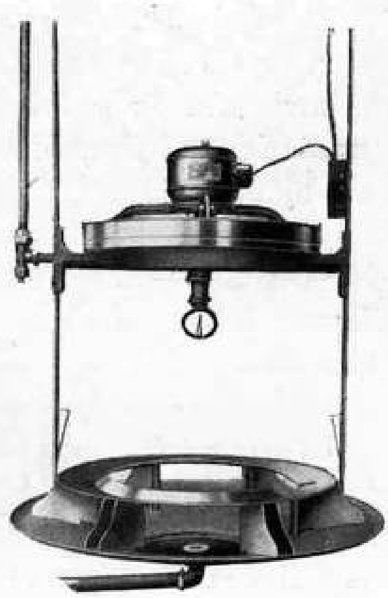
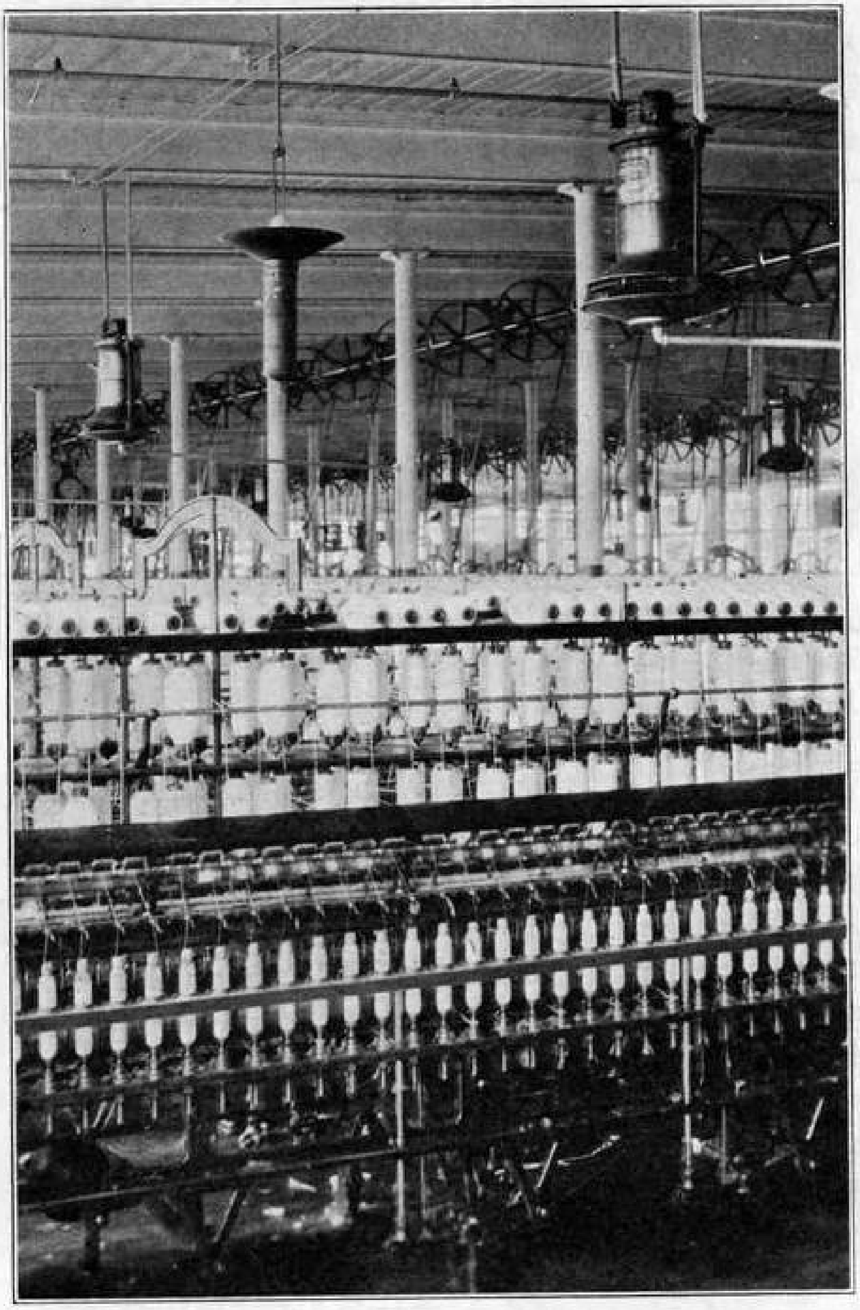




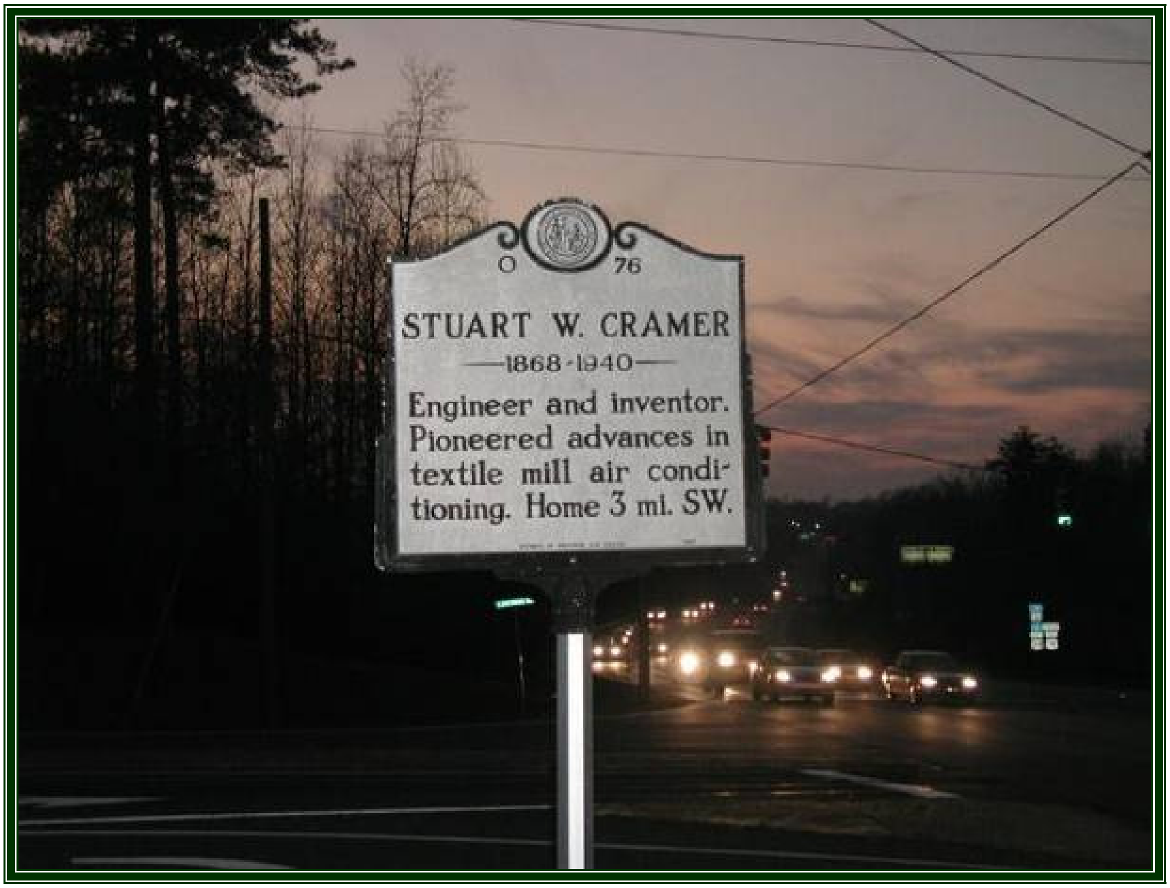
High Duty Humidifier—showing accessibility for cleaning

From Parks-Cramer 1924



Ring Spinning

From Parks-Cramer 1924 (Note ceiling-mounted humidifiers)



Marker at Gaston, North Carolina
(Note this gives his date of birth as 1868)