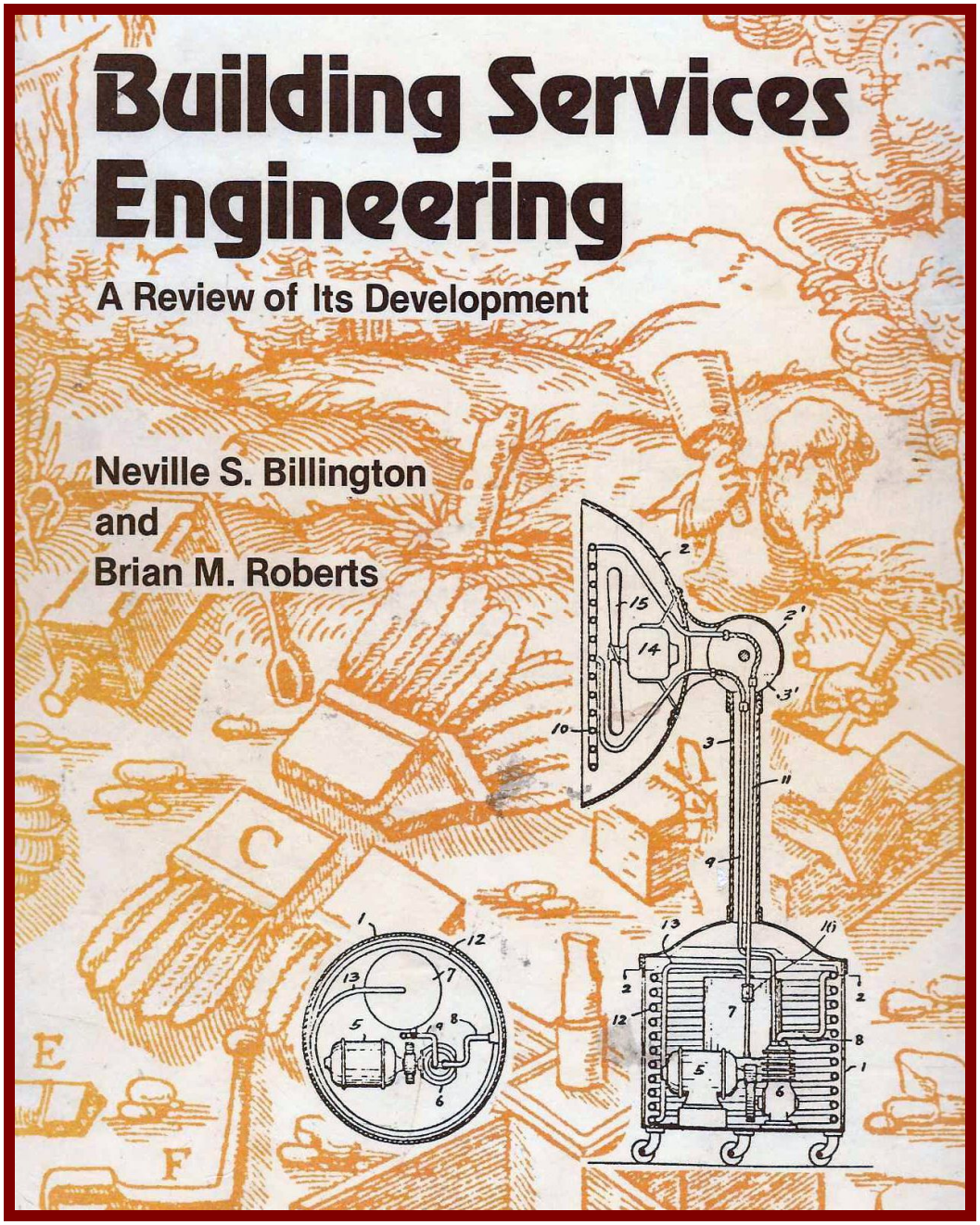
Heating Stoves 800-1930

Stove History



1982

3.2 THE STOVE

A. Faber gives a detailed account of the history of the stove in Europe, and particularly in Germany.(35)

A forerunner of the stove was the brazier used by the Romans. Such braziers seem to have been common in most countries, especially where fuel was scarce. Merely covering the brazier with a lid (a "couvre-feu" or curfew) and providing a pipe to carry off the smoke and fumes was probably the first step in the evolution of the free-standing stove. Early hearths, with stone surrounds, and covered with a couvre-feu, possibly led to the development of the built-in stove, made of brick, tile or stone.*

It seems that the monasteries played a significant part in the evolution of heating equipment. In the early centuries A.D., only the monasteries had any warmth. Later, the orders returned to a more spartan regime, until the 11th or 12th centuries, when new foundations again had some heating. Warming spread to the castles and manors, and then to civic buildings, and only later to more ordinary buildings during the next centuries.

3.2.1 Masonry stoves

The first stoves were made of small clay bricks. A stove of this kind, of cylindrical form and standing in the corner of a room, was used at Klosters St. Gallen in about 820 A.D. It appears that rather later, these stoves were used only for heating bathrooms, and it was not until 1000 A.D. in southern Germany that they were brought back into the living spaces. During the 9th century, the clay bricks were replaced by "kacheln" in Switzerland, and by the 13th century, the kachelofen had spread throughout northern Germany also.

The absence of cast-iron in Scandinavia would encourage the use of masonry materials, and the stoves became known as Swedish or Russian stoves. The massive nature of these appliances, and hence their ability to give almost continuous heat output, was peculiarly suitable for the cold northern climates. The stove was built into the corner of a room, and it frequently served to warm more than one room of the house. These massive stoves became common in Hungary, Poland and Russia in the 16th century (Fig. 3.7).

In the early days of the stove, people were often uncomfortable since the stoves did not give out the expected amount of heat. The true reason for this not then being known, men sought to improve matters by enlarging the stove. At the middle of the 15th century, the erroneous construction of the chimney was recognised as the prime cause of the failure of contemporary stoves. The chimney was too large, had poor draught, and led, often, not above the roof, but only to ceiling level; it was, too, often made of wood.

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*Faber believes that in contrast to the fireplace and the iron stove (which originated in castle and monastery) the tile stove came from the country, being built by the peasants themselves.

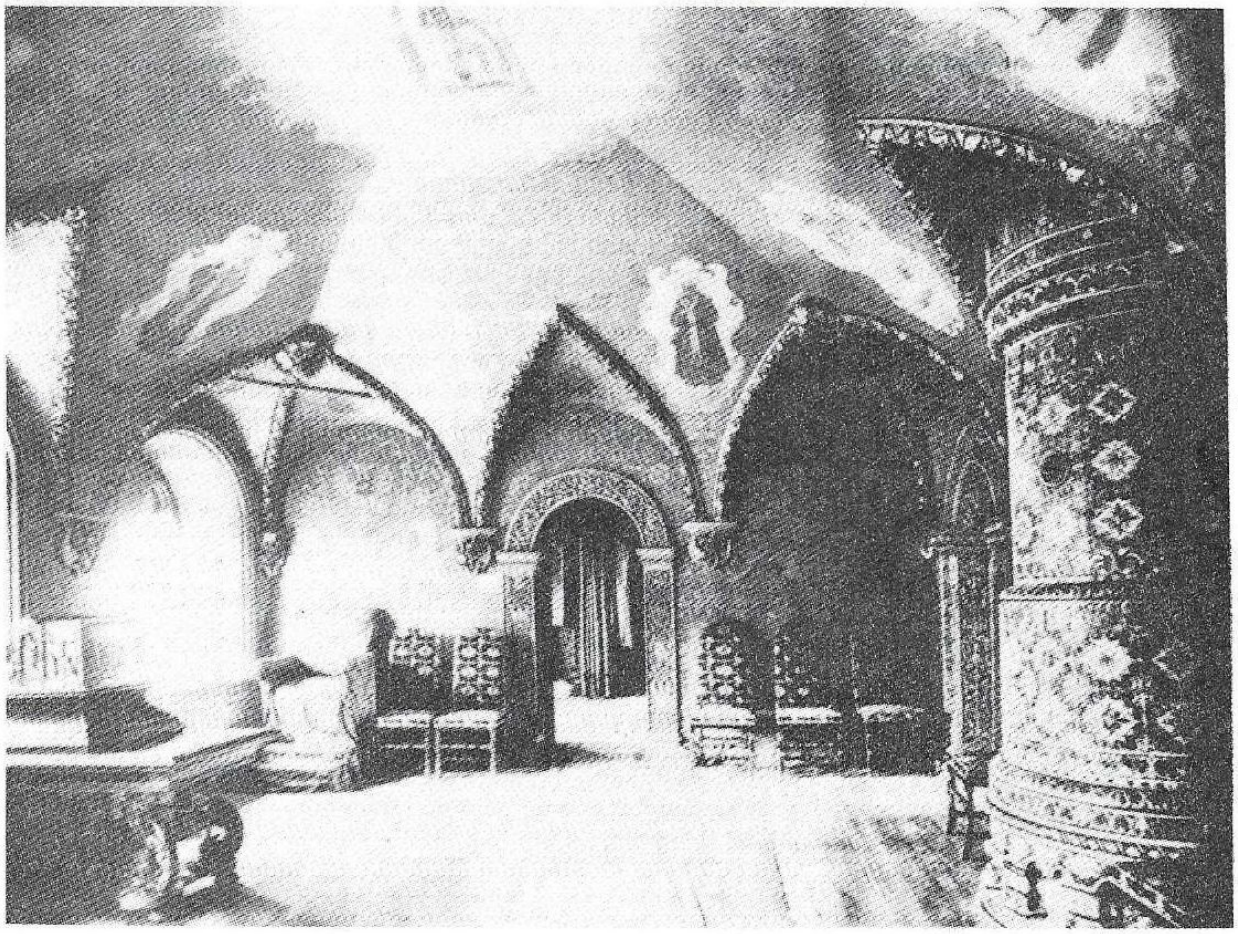

Fig. 3.7 A room in a Moscow palace, showing a large heating stove built into one wall and serving two adjacent rooms. (Courtesy Shell-Mex)

The earliest attempts to improve the stove are probably those of Kesslar of Frankfurt, in 1618. He designed a round metal stove, with a separate fire-box, a zig-zag flue way within the stove body, and controls for the inlet air and a chimney damper. He also described a sinuous flue pipe to be suspended above a fire on a central hearth. Many stove designers adopted Kesslar's ideas (Böckler 1666; Sturm 1700; Schübler 1728; and others) for both masonry and metal stoves, by providing extra heating surface. Some used extended flueways; others passed the flue gases into boxes or domes before they entered the chimney (and so obtained a greater area); yet others used simple heat exchangers. One at least used a spiral flue; and Parrot (1795) sought to increase heat transfer by putting a metal spiral in the flue itself.[35] Some kachel stoves had sizeable openings in them, through which air could pass; and this considerably increased the heating surface. Glazed earthenware stoves were used in France in 1520; but their success dates from the 17th century and was consolidated in the eighteenth.[18][29] Many patterns were designed to allow cooking to be done on them. Some included warm-air heating pipes, either within the fire-pot or outside the body of the stove, to allow of extra convection heating (this was an adaptation of Savot's invention for open fires).

One noteworthy invention is that of Dalesme in France, and exhibited at a fair at St. Germain in Paris in 1680.[15] He combined downward combustion with secondary air provision, and was the first to attempt smokeless burning. To light the stove, the flue-pipe was warmed by a lamp to induce a current of air, and the top of the fuel in the firepot was then ignited by a burning brand. Much later, American stove-builders (e.g. Nott, 1830) made stoves using downward combustion, combined with an extended flue, to burn anthracite. These stoves had windows through which the fire could be seen, and a magazine of fuel. This type of stove was introduced to Europe in about 1879.

3.2.2 Metal stoves

In the rest of Europe (and later in America) the metal stove achieved dominance. Tomlinson notes that the stove "is a common article of furniture in Northern Europe" and its "popularity" is attributed to the scarcity and cost of fuel. The development of the iron stove owes something to improvement in metal working techniques, and also to the replacement of wood as fuel by coal.

A close stove was constructed from the cast iron plates then used as firebacks about 1475; an iron master from the Moselle showed an iron stove at the Frankfurt fair in 1490. The use of cast iron for building stoves spread from Germany to Scandinavia in the next century, and German immigrants to N. America in 18th century carried their techniques with them.

5-plate stoves (so-called because five rectangular plates were used to make them) were placed against the wall of a room; 6-plate stoves were free-standing, and became the pattern of the American stove. This was designed primarily for use with wood fuel, and the fire-pot was a rectangular box of metal, supported on legs. There was a charging door at one end, and at the other there was a flue outlet.

Portable stoves were in use in Switzerland in the 18th century. An example in the Landes museum was constructed of sheet iron, and was intended for burning charcoal. It was 150mm high and 190mm broad, and had a carrying handle. Another, for burning wood, was of faience, 475mm high, and was mounted on castors. Holes at the base admitted combustion air; the fumes escaped from the mouths of lions' heads on the corners.

Trevithick devised a portable stove (BP 6083 of 1831), supposedly to overcome some of the disadvantages.

> "The fire is situated in the centre of a metallic vessel, capable of containing a considerable quantity of water, which surrounds the fire receptacle, except at the doorway and at an opening provided for the escape of the smoke into the chimney. The vessel is made steam-tight and when the water boils the door over the fire is tightly closed to shut off the supply of air; the smoke flue is then removed and the machine wheeled into the place or room requiring to be warmed, where it will continue to give out heat for several hours without any of the disagreeable odours arising from stoves heated by an enclosed fire."

It was clearly not a very practical device.

Werner in 1797 was a keen protagonist of the metal stove. He set down the requirements for a satisfactory design:

To be made of iron
Use little fuel
Warm the room quickly
Controllable output
Easy to operate, durable and cheap, and taking up little space
It should take the combustion air from outside.

On the basis of a decade of study of household stoves, he gave three constructional "musts" — a grate with controllable air supply, an ashcan, and extended flueways (the length to be such as to avoid condensation) with cleaning eyes.(35)

At the beginning of the 18th century, iron-founding had improved sufficiently to permit more complicated shapes to be cast, and the "round" cast iron stove came into being. The early Dutch stoves were referred to by Rietschel as "cannon" stoves, from a superficial resemblance to a gun barrel. The fire-pot was never filled to the top with fuel; much of the surface of the stove was heated by radiation from the burning fuel and by contact with the hot gases. It was this type of stove to which Arnott fitted a primitive thermostat (his thermometer stove) to control the primary air supply, in about 1840. These simple stoves were inefficient, since the flue gases were discharged at a high temperature. During the 18th and 19th centuries, many types of stove were manufactured in Europe. Many of these incorporated the earlier ideas to improve efficiency, and to reduce the risks from leakage of combustion products. Some had gills or ribs cast in the surface. The "Gurney" stove, which was of this kind, was used at the end of the 19th century to heat St. Paul's, Chichester and Ely cathedrals. The surface of the stove was often enclosed, both to reduce the surface temperature, and to allow of convection heating.

The Convoluted stove, due to Constantine, was of this type. It was constructed of ribbed sections bolted together, and enclosed in a brick setting through which air could pass. A noteworthy feature, shown in the drawing, is the arch of fireclay slabs over the combustion chamber — presumably to ensure efficient and complete combustion. These stoves were used to warm the Free Trade Hall in Manchester (Fig. 3.8).

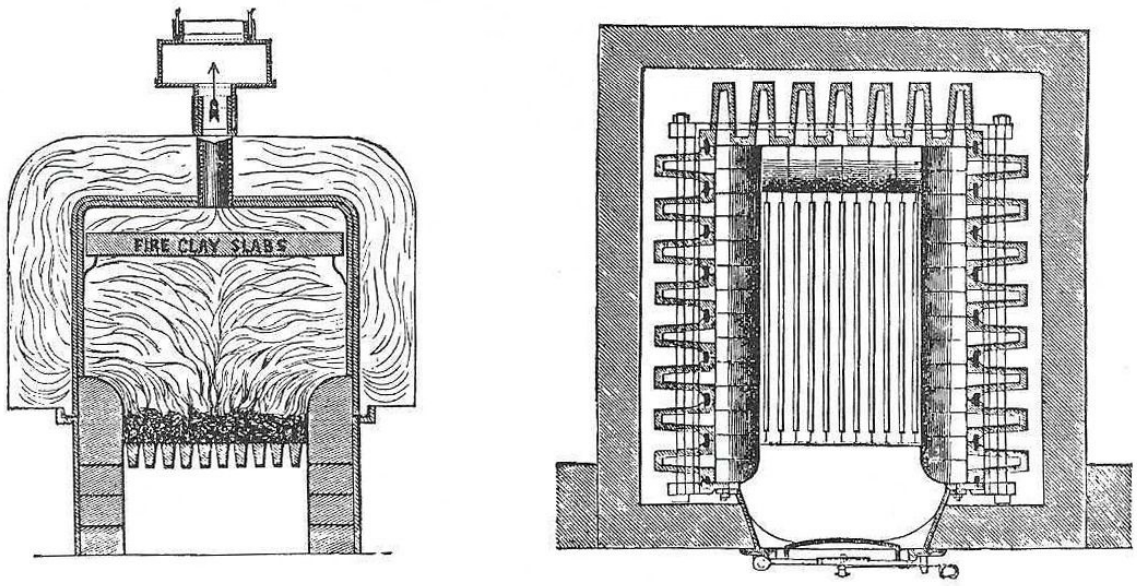

Fig. 3.8. Cross-section, Convoluted stove.(25)

The rating of these stoves was declared by Constantine to depend on the weight of metal, and he gives the following table for his products:[25]

Weight of metal (cwt)	Area of heating surface (ft^2)	Volume of space to be heated (ft^3)	Volume per cwt of metal (ft^3/cwt)
14	35	26000	1857
22	69	50000	2275
34	119	86000	2529
45	280	140000	3111
56 (the largest)	296	220000	3928

The Frenchman, Le Bon, devised his "thermolampe" in 1799. A retort was placed in the firebox of a stove, and filled with a charge of wood. The distilled gases were used to heat and light Lebon's house. In later stoves using the distillation principle, the gases were fed back into the combustion chamber, giving smokeless combustion. Some of the stoves described by Debesson worked on this principle.

In most designs, a magazine of fuel was provided (the "Irish" stove ("Belfast" or Musgrave, 1857-8)), and the firepot was lined with a refractory material. This served both to improve the combustion and to prevent the outer surface from becoming too hot. In the Musgrave stove, the flue gases made two passes through a heat exchanger before discharge. Fresh air warmed by passage through the exchanger was fed into the room (Fig. 3.9).

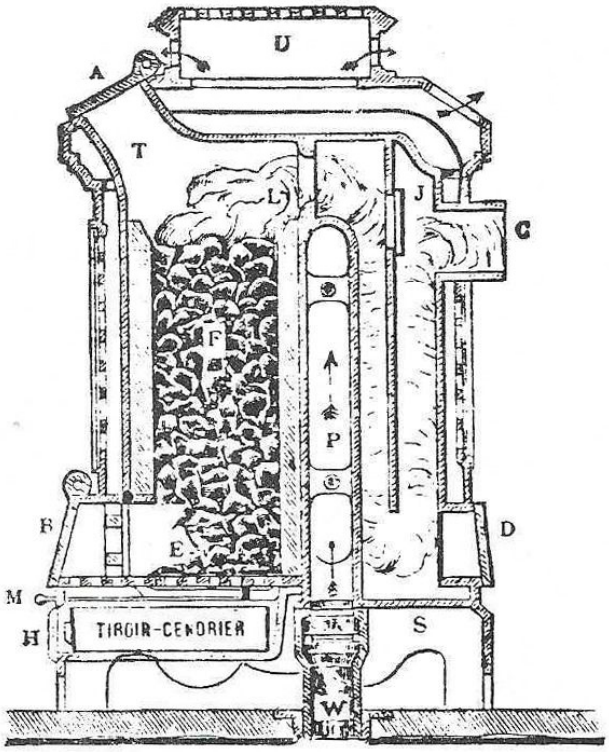

Fig. 3.9. Musgrave stove (Ireland)(1857).[29]

Inlet air controls, usually in the form of ashpit dampers, were also provided. Shaking grates to aid the removal of ash were frequently used. Special flueways were eliminated, the fuel bed itself serving to scrub the heat from the flue gases instead. The Brabo stove probably represents the most modern development of this particular form of stove.

As the use of stoves extended, and casting techniques developed, they became more and more ornate. A list issued by the German firm of Werk Lauchhammer in 1786 gives prices for stoves with sculptures upon them:[35]

Pedestal stove with statuette of Ganymede	175 taler
Pedestal stove with bust of Socrates	95 taler
Altar stove with bust of Commodus	85 taler
Round stove with bust of Cristina	65 taler

An Austrian work of 1894 suggests, as a basis for the selection of a kachelofen, that each m^2 of stove surface will heat a space of 15 to 18 m^3 in 1 or 2 hours. It is added that the stove should be placed at least 2/3 m from any wood. A common cast-iron magazine stove, with fresh-air supply to a convection jacket, and capable of heating a room of 160 m^3, was priced at £3.8. Ordinary cast-iron stoves and cooking ovens cost between 10 shillings and £2.[53]

The early stoves had to be fuelled frequently; and if too much fuel was charged at one time, combustion was very rapid. Means of achieving slow continuous operation were sought. As early as 1666, Böckler placed a quantity of stones in the body of the stove, above the burning fuel, to be heated by the flue gases and thus to serve as a heat store.[35] As an alternative, the fuel would be mixed with ash, clay or other incombustible material, to make the fuel burn more slowly.

A prerequisite for continuous burning is a fuel capacity of sufficient size. Much ingenuity has been expended in designing stoves with large fuel reserves and yet preventing the whole stock from becoming alight. A well-known example is the Tortoise stove, in which the fuel is allowed to fall on to the firebed from the hopper. This stove also incorporates other interesting features — the clinker arch used later in the Earlymill and Janitor boilers, the thermostat control of secondary air supply, and the use of sized and graded fuel.

Both Picard (1897)[68] and Debesson (1908)[29] devote a good deal of space to the designs of stoves then available on the French market. Picard defined three classes of stove, viz.,

(a) the open brazier, without any flue
(b) the close stove with flue, but without any jacket
(c) the close stove with flue and with convection jacket (e.g. Kessler, Arnott and Musgrave).

Debesson's classification of slow-combustion stoves was on different lines, being based on the mode of combustion, namely,

(i) the mass of fuel is traversed by the flue gases on their way to the chimney (Musgrave)
(ii) the fuel is held in a magazine, and is fed automatically to the grate. The magazine is surrounded by the hot flue gases (Phare)
(iii) the fuel is held in a magazine, and feeds to the grate by gravity; the flue gases do not pass through the magazine (Cade) (Fig. 3.10)
(iv) smoke-consuming stoves, where the gases are burned in excess air after leaving the fire (Excelsior).

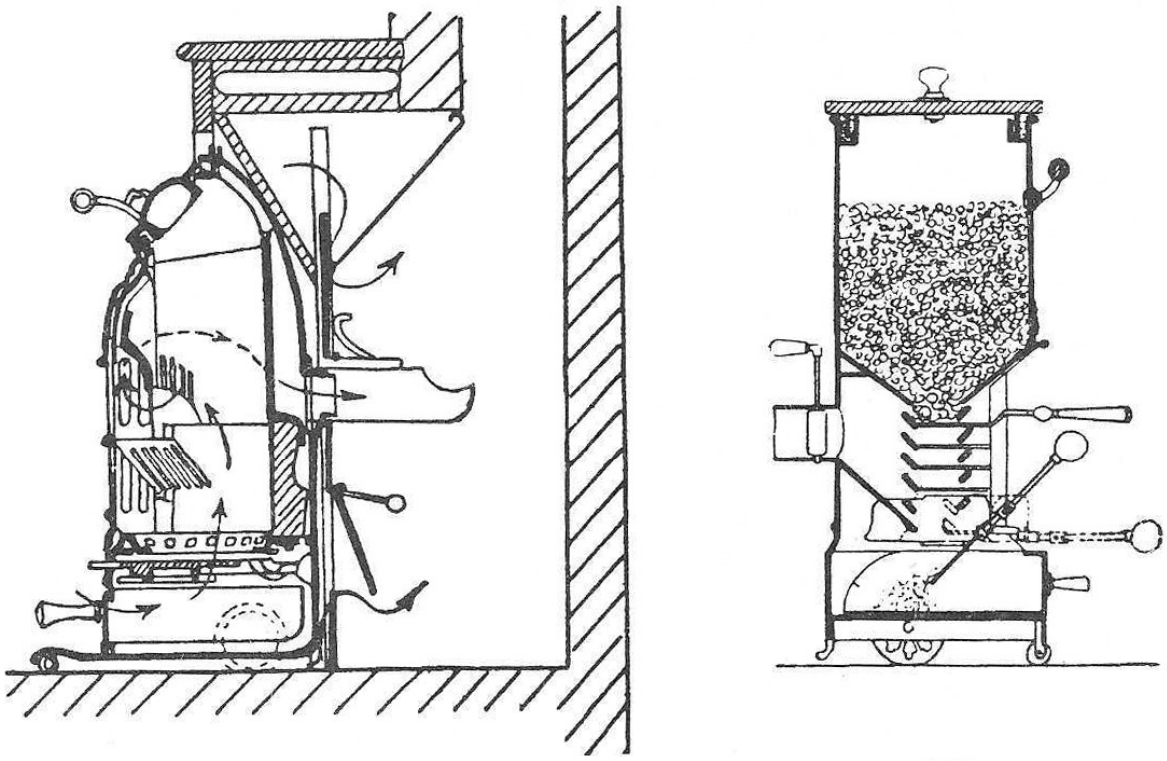

Fig. 3.10. Two portable stoves (slow combustion).[29]
Salamander (*left*) and Cade (*right*).

Although Debesson was aware of the disadvantages of stove-heating, he wrote:

> "Stoves are, and will remain for a long time, the heating appliance *par excellence* not only for the poor but also for the great majority of the population of the globe, of all those who cannot afford the luxury of living in houses with modern central heating."

He did not, however, approve of their use in schools, believing them to be unhygienic, nor in government offices:

> "Let us hasten to say that in Paris and in the country, almost all the schools are warmed by these odious stoves. When many of our provincial towns, and all foreign governments are proud to heat their schools by the hygienic steam or hot water, Paris, City of Light, remains as at the time of Franklin and heats its schools by stoves."

And:

> "One can however find them in Paris in many ministries and administrative offices, which still ignore the modern methods of heating. Let us not be too critical however. Since the winter of 1907-8, some of our ministry buildings are already being heated by low-pressure steam, and we may perhaps hope that before the century is over, all the other ministries will follow their example. What will the clerks and officials do when they can no longer pass the time poking up the fire, and when radiators, with their severe aspect, have taken the place of the joyous wood fire!"

The views of the 1857 Commissioners are of interest, for they point the way towards good design and use of stoves.(40)

> "We are led to the conclusions that the outer surface of the stove should be only moderately heated; and that both the heat of the stove and the temperature of the hot air should be under regulation and easy power of control; that there should be at all times a flue or pipe for the passage of the smoke and gases; that humidity and ventilation should be each specially promoted, the two latter independently of the heating action of the stove."

> "The effect (of closed stoves) is to dry the air to a more or less injurious and uncomfortable degree, and to render it indispensable that the humidity of the air be promoted by artificial means .. . ... The best practical method open to us therefore is the placing upon the top of the stove a vase or other vessel, either open or closed, with a perforated cover."

There has long been a prejudice against the use of hot-air stoves. The air was said to be overheated, burnt and unwholesome. In the early 19th century, there were protracted and somewhat acrimonious arguments between the protagonists on both sides. Experimental evidence was adduced from the lethal effects of air which had been passed through a red-hot tube. Other fatalities were ascribed to the use of the stove, although it is possible that these were due in fact to carbon monoxide poisoning.*

The lack of ventilation afforded by a stove was known, and was an additional reason for discouragement, although Tomlinson notes that this was not considered a demerit in Russia. Bernan wrote:

> "It is essential for the economical effect of a stove that the room be nearly airtight... . In apartments with ill-fitted rickety doors and windows, and a large extent of ill-glazed surface, and thin heat absorbing walls, abounding in wind-chinks — or in general in all cases where the apartment approximates to the exposure of a field, as many English rooms do — an open fire is to be preferred."(15)

In modern stoves control of both primary and secondary air has been improved by the abandonment of crude inlets and the substitution of better fitting doors on the appliance. The greater control now possible has made continuous burning a practical proposition; and it is now universally adopted.

3.2.3 Openable stoves

Several factors have operated against the further development of the stove as a device for heating a room in which it is situated. These are the somewhat unsightly appearance (and bulk of the European stove), the desire to avoid refuelling in the room, the undesirability of a number of stoves in one house, and, in Britain, a marked preference for a visibly flaming fire. These factors have led on the one hand to the warm-air furnace and on the the other to the openable stove. Desarnod suggested the idea of an open stove, giving sight of the fire, in about 1750. This was accomplished in later designs by using mica windows.

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*Debesson supposed that all slow-combustion stoves produce carbon monoxide, and said they should never be used in bedrooms. No such stove should be fitted except to a metal chimney with sound joints.

Sir G. O. Paul devised a closeable fire, consisting of a common Bath grate with folding doors which could close the fireplace opening and the ashpit, and also a lid to cover the fuel in the grate. The "Venetian" boiler grate, of 1904, was an open fire with moveable front bars which could be rotated to close the front of the fire. A sliding plate closed the top of the fuel bed, when the appliance became, in effect, a closed stove. It was also fitted with a back boiler.(81)

The first commercially successful free-standing openable stove was the "Cosy", introduced by Smith and Wellstood in 1924.(81) It comprised a stove with a separate outer casing to permit room air to pass between the jacket and the main body of the stove. There were two front fire-doors, having mica windows; there was a shaking grate to facilitate the removal of ash.

In 1929, Richardson and Florence designed a stove in which the two fire-doors slid sideways. They were interlocked wtih the flue outlet so that when closed the flue gases went direct to the outlet over the fire, but when opened, the stove operated as a down-draught fire, the gases going to an outlet at the level of the grate. This invention does not seem to have survived.

Most openable stoves were designed to burn anthracite. Not until 1935 did manufacturers design stoves to burn gas-coke. Modern openable or closable stoves have a deep firebed, of which the lower part is enclosed by refractory materials. This enables coke as well as coal to be burned satisfactorily, and permits of a sufficiently low slumbering rate as to allow of over-night burning. The primary air supply is closely controlled by means of spinners. The front of the stove has doors which may be opened to give a sight of the burning fuel, and which often have panels of mica.

In most instances, the body of the stove is surrounded by an outer jacket. Air from the room circulates through the space so formed between the stove and its outer casing, becomes warmed in so doing, and is discharged to the room from a vent at the top of the jacket. Alternatively, the air may be led through an annular duct surrounding the flue pipe to warm other rooms in the house. A small back boiler is sometimes fitted to this type of stove, to make more effective use of the slumbering period.

The efficiency of this kind of stove is generally around 50% compared with a (radiant) efficiency of 25 to 35% for open fires and up to 80% for a true stove.

It is of some interest to note that Marcus Bull in America carried out a series of trials on stoves in a special test room early in the 19th century.(32) His test room comprised one room within another, air being circulated between the two. The inner room was heated by the appliance under test, the fuel required to keep it at a constant temperature being measured. The following are typical of his results:(15)

Appliance	Relative fuel consumption
open fireplace burning wood	1000
Franklin stove + 5 ft of 6-in flue	270
Cylinder stove + 5 ft of 2-in flue	149
Cylinder stove + 42 ft of 2-in flue	100