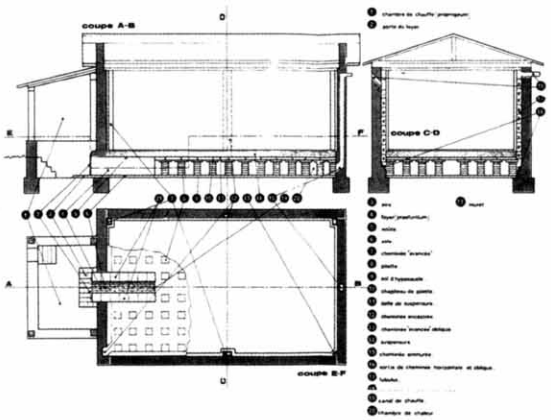
Modern Movement Architecture and Heating Innovations in France 1900-1939

by Emmanuelle Gallo

Modern Architecture is usually associated with technical innovations that resulted in a new set of aesthetics. The radical revolution of heating systems had already occurred during the previous century. But the beginning of the 20th C. was not an uninteresting period; on the heating issue, several significant improvements occurred and these will be discussed here.

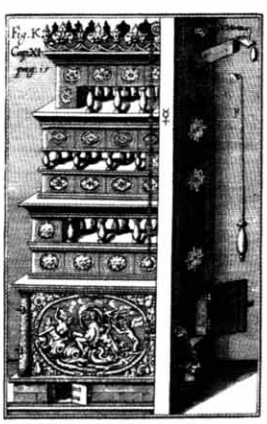


Example of a roman hypocaustus. Drawing by Jean-Marie Degbomon, in Jean-Marie Degbomon, *Le chauffage par hypocauste dans l'habitat privé de la place St-Lambert à Liège et l'aula Palatina de Trêves*, Etudes et recherches archéologiques, Liège 1984, 240 p.

A brief history of heating

The first interesting period in the history of heating is the Roman Empire. At that time was invented the *hypocaustus* which spread throughout the North of Europe, in bath houses and important villas.

The next heating revolution came between the 10th and 13th C. with chimneys standing against a wall and the first stoves made of baked clay in the Alemanic area (with Alsace in France).



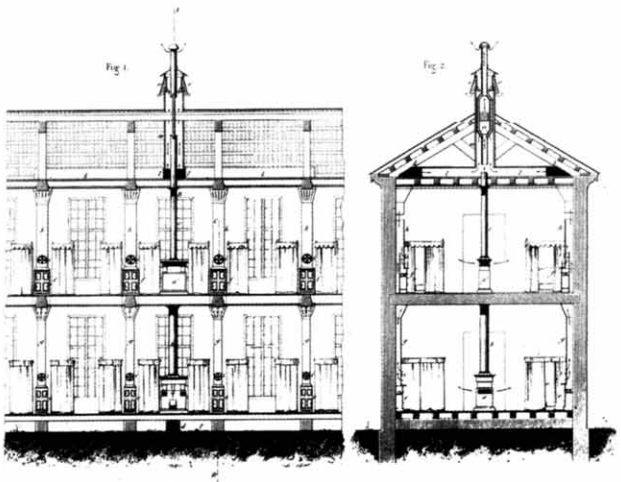
Iron and ceramic stove. Georg Andreas Böckler, *Furnologia oder Haushältliche Oefen Kunst*, Georg Müller, Franckfurt 1666, p.15.

During the second half of the 18th C. and first part of the 19th C., were developed new ways of building chimneys, with smaller fireplaces and radiant angles. Stoves were also developed by that time from short series to industrial manufacturing. Different kinds of central heating were tested, using hot air, hot water or steam and also combined solutions. The use of coal or coke, more common in Britain, came also to France.

By the second part the 18th C. all these changes were experimental, but during the 19th C. the different systems were developed, first for collective programmes such as: prisons, hospitals, theatres, university amphitheatres, textile mills (to facilitate production), or glass houses (to grow exotic fruits), but rarely for lodgings.

In France, hot water systems became more popular (except for large scale buildings) because they imposed less of a restraint on the settlement, the boilers did not need the same level of control and users were less alarmed. These systems usually functioned without pump and were named *thermosiphon*.[1]

The 19th C. architectural press surveyed the developments in heating technology, especially in the *Revue Générale de l'Architecturale et des Travaux Publics*, which publishes articles by René Duvoir, a heating systems manufacturer[2].



Heating and ventilation of an hospital. René Duvoir, *Chauffage et ventilation d'hopital*, Revue générale d'architecture et des travaux publics, n°5, 1844, pl.27.

The context at the beginning of the 20th C.

At the end of the 19th C., the idea of using central heating for domestic purposes has become more acceptable even if it is not generalized, like it will become after the Second

Standard radiator. Compagnie Nationale des radiateurs, *Radiateurs chaudières Idéal – triple orné avec chapiteaux et bac d'évaporation*. 1911, p.34.

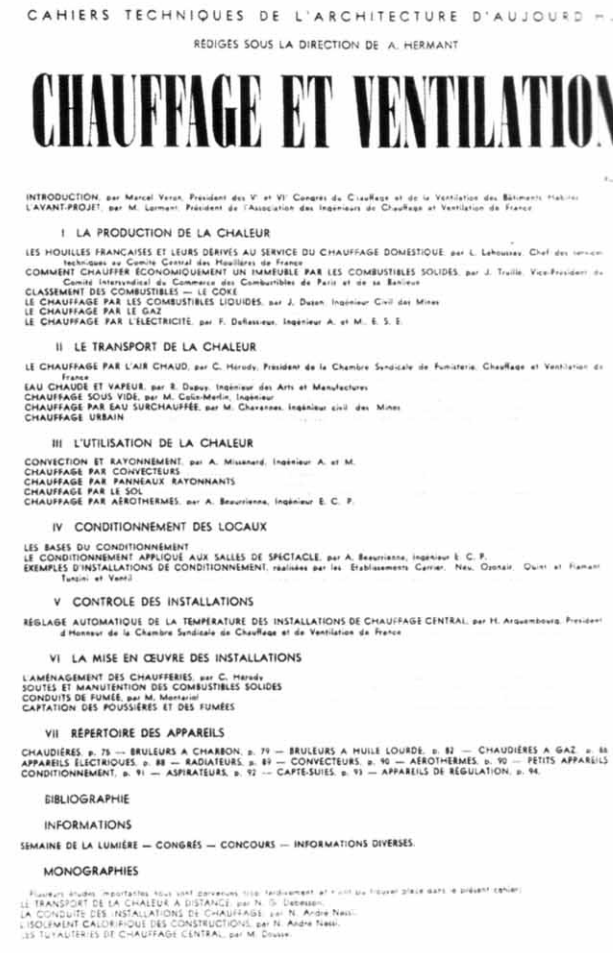
World War. Standardized radiators, the patents of which came from the USA, have replaced the old heat exchangers, as standardized furnaces become more common. Steam boilers bursted less frequently, the legal regulation becomes stable. Meters, clocks, valves, expansion coils, joints and pressure gauges were properly settled.

Important towns installed gas and then electric networks, first for lighting streets and then indoor spaces.

There are no books on heating technology published in France at that time that are written for architects, but there are quite a lot of books, mostly textbooks, for engineers. There exist also papers, or parts of papers, in the architectural press. These sources will be used to present the different innovations developed during the period: the use of fuel oil, the first French district heating networks, the introduction of electric pumps, the heating by radiant floors, the forced air heaters for plants. Several important engineers worked and published during our period, most of them trained at the École Centrale, Henri Arquembourg, Auguste Baurrienne, André Nessi, Victor Kammerer[3]. André Missenard (1901-1989), trained at the *École Polytechnique*, familiarly linked to an important heating manufacturer, also published a textbook on heating and ventilating. He received the Ernst Rietschel price in 1928 for his research on ambiance temperatures[4].

The part played by *L'Architecture d'Aujourd'hui*

When the new architectural journal *L'Architecture d'Aujourd'hui*, first published in 1930, presented the architecture of the modern movement, the technical questions became more prominent. During a couple of years, the technical topics got a special section. Here they were treated as part of the presentation texts of individual buildings. The journal also published in 1933/1934 a technical supplement named *Chantiers,* which means 'building sites', in which they opted for the same solution[5]. In 1935, the journal was restructured and one number a year was dedicated to a technical topic. Number 5, dated May 1935, focused entirely on "Heating and Ventilation". The different chapters were: heat production (fuel and energy), heat carrying fluids, heat transmission means, air conditioning, control and regulation. The papers, presenting the most recent and interesting heating systems, were written mostly by engineers involved in the field[6]



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BIBLIOGRAPHIE

INFORMATIONS

SEMAINE DE LA LUMIÈRE — CONGRÈS — CONCOURS — INFORMATIONS DIVERSES.

MONOGRAPHIES

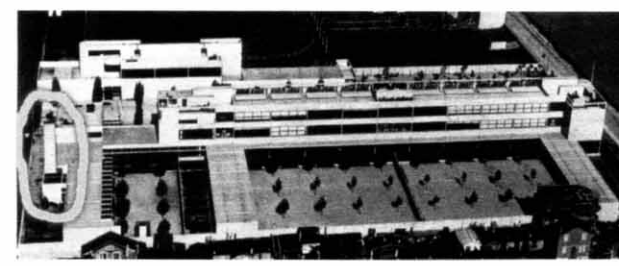
Plusieurs études importantes nous sont parvenues trop tardivement et n'ont pu trouver place dans le présent cahier:
LE TRANSPORT DE LA CHALEUR A DISTANCE, par N. G. Lazarieff.
LA CONDUITE DES INSTALLATIONS DE CHAUFFAGE, par N. André Nessi.
L'ISOLEMENT CALORIFIQUE DES CONSTRUCTIONS, par N. André Nessi.
LES TUYAUTERIES DE CHAUFFAGE CENTRAL, par M. Dousse.

L'Architecture d'Aujourd'hui n° 5, May 1935

The introduction of fuel oil for heating systems

One of the relative novelties is the use of fuel oil in combination with, or instead of, coal. Often it is possible to simply change the burners from coal to oil. Moving from coal to oil reduced the importance of the workforce since the feeding of the furnaces could be done automatically. Even if the cost of this new energy was higher, there was no more the income of the stoker to pay. The calorific power of oil varied from 10,400 to 10,800 calories per kilo, which is higher than that of solid fuel. Oil was especially convenient where there was no gas network.

The "Karl Marx" primary school in Villejuif by André Lurçat (1931-1933) used oil for heating as well as electric pumps[7]. The boiler room was isolated from the other buildings[8].



Karl Marx school, Villejuif, André Lurçat (1931-1933). Boiler room encircled. Pierre et Robert Joly, *L'architecte André Lurçat*, Picard. 1995, p.104-105.

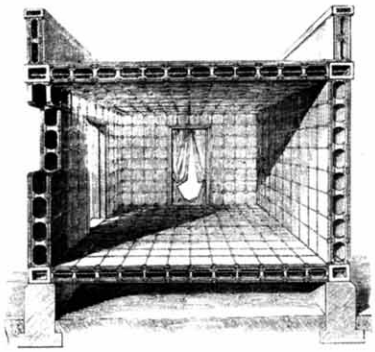
For safety, the furnaces could be fitted with different burners for oil or coal, with appropriate storage units for each. Hot water was sent to radiators with electric pumps but could also function without propulsion by using "thermosiphons". Tests showed that all the building's radiators were sufficiently heated after twenty minutes. Both fuels were tested with similar results. Oil was considered as the most convenient fuel, with coal used as a secondary supply.

Oil was not common in France. The magazine *Chantiers* (n°4, 1934) devoted a full page to the addresses of oil refineries in France[9]. In a suburban context, the luxurious Villa Cavrois in Croix designed by Rob Mallet Stevens in 1932 was also heated with oil[10].

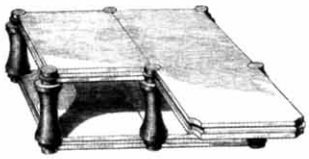
The development of radiant heating

Radiant heating had a long history; already in the Roman time, with the *hypocaustus* system, the rooms were warmed with smoke tunnels located under the floors. The ceramic stove way also used radiant heating in a more localized manner. During the 19th C. several specialists such as Emile Trélat promoted radiant heating for large surfaces, since it could be associated with cool air, a system which he considered healthy[11]. Two proposals for floor radiant heating were presented by Edwin Chadwick in the *Revue Générale de l'Architecture* (1872).

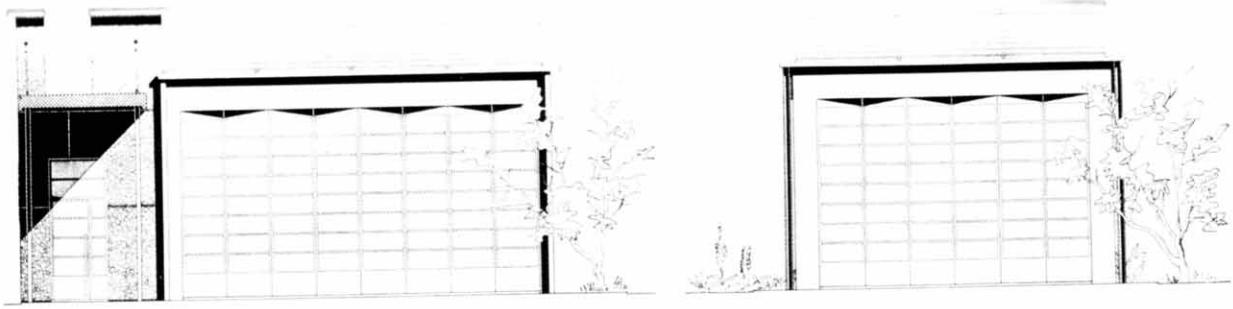
The first proposal involved the heating of a field hospital located in a tent, the other concerned a house built with double-skin walls with smoke in between[12]. These examples show the interest for radiant heating but also the difficulties of making such a system practical at reasonable costs.



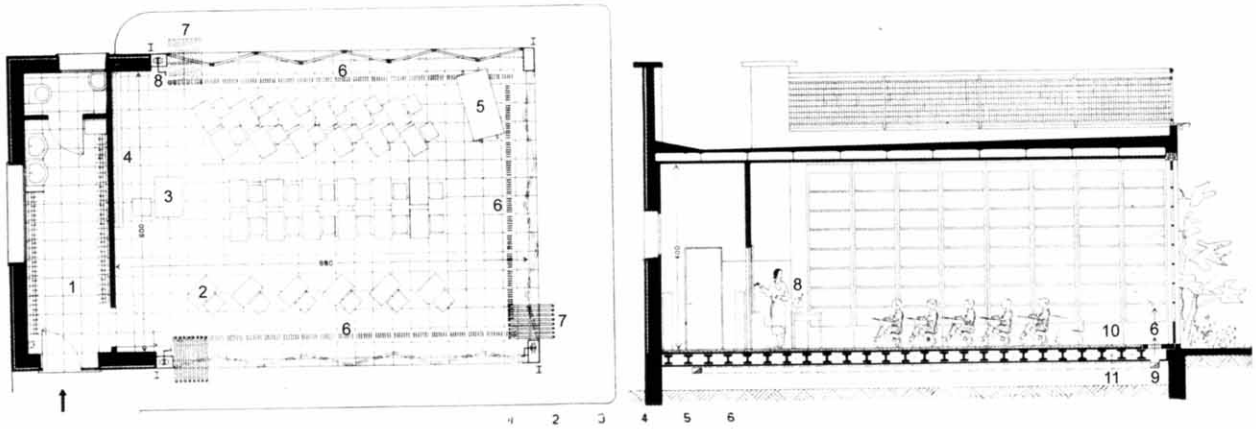
Radiant heating system by Edwin Chadwick. Lavézarri E., *"Traité pratique du chauffage", Revue générale d'architecture et des travaux publics*, n°29, 1844, col.155.



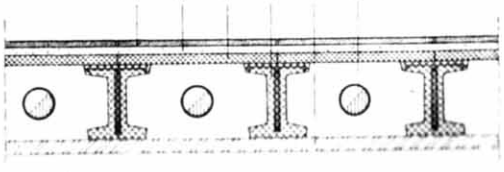
The early 20th C. saw the commercial development of radiant heating. The building presented here is the open air primary school in Suresnes by Eugène Beaudouin (1898-1983) and Marcel Lods (1935-1936)[13]. This experimental school was designed according to the



Suresnes open air school, Eugène Beaudouin, Marcel Lods (1935-36). A. Roth, *La nouvelle architecture 1930-1940*, Engelbach. 1939, p.124



1 entrance, clothes
2 tables
3 teacher's table
4 blackboard
5 rolling cupboard
6 grid for hot air
7 glass folding door
8 crank handle
9 hot air channel
10 heating tube
11 natural stone slabs



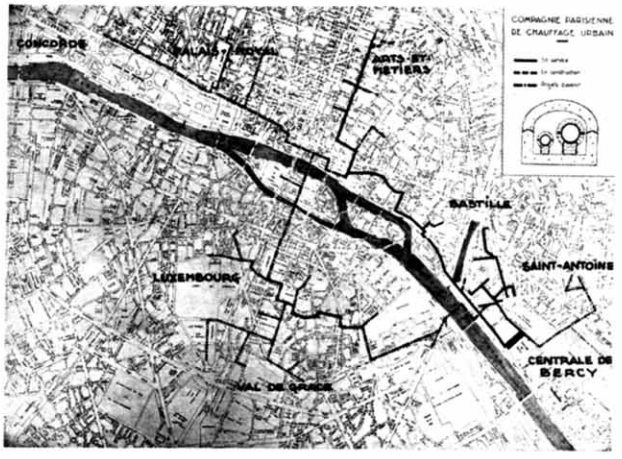
1 natural stone slabs (quartzite)
2 sand bed
3 prefabricated concrete slabs
4 prefabricated concrete beam
5 "Isoplac" (magnesium bound wood fibre)
6 heating tube

principles of *hygiénisme* with classes spread out in a garden, three walls made of folding doors and sundecks on the roof. The floors of the classrooms were made of natural stone slabs, and the heating consisted of steel pipes embedded in the floor void. To offset the cold produced by the huge windows, in addition to the radiant heating, they used warm air rising from ducts along the length of the moving wall, when necessary. The heating plant was a low pressure steam system, eliminating all danger of damage by frost during the holidays. Radiant heating was promoted by André Missenard, who wrote a paper on the topic for a special number of *Architecture d'Aujourd'hui*, Missenard conceived such heating at a huge scale during the sixties[14]. Patents were registered by Deriaz and distributed by several firms in Paris: Boeringer, Chaussidière, Gandillot, Albert Hatry and Tunzini[15].

The introduction of district heating in France

District heating networks appeared in the state of New York around 1880[16]. The first European network was installed in 1900 in Dresden[17]. Only in 1928 were they introduced in France, even if Augustin Roy (1864-1934), an architect and vigorous hygienist, had already promoted the idea of heating social housings from a central station in 1905[18].

Two networks were created at the time, one in Paris, and the other in Villeurbanne, near Lyon. One of the advantages of district heating is the reduction and the control of smoke nuisance. The extensive use of coal in towns was the cause of dangerous air pollution denounced by many, one being the modern architect Marcel Lods[19].

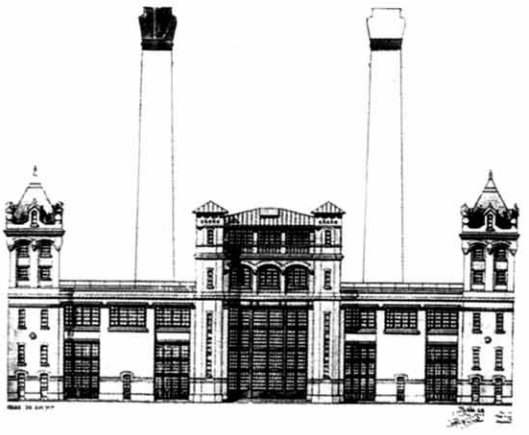


PLAN DU RÉSEAU ACTUEL DE CHAUFFAGE URBAIN DE PARIS.

Paris steam network and heating station. André Hermann, *Chauffage urbain*, *L'Architecture d'Aujourd'hui*, n°5, 1934, p.33.

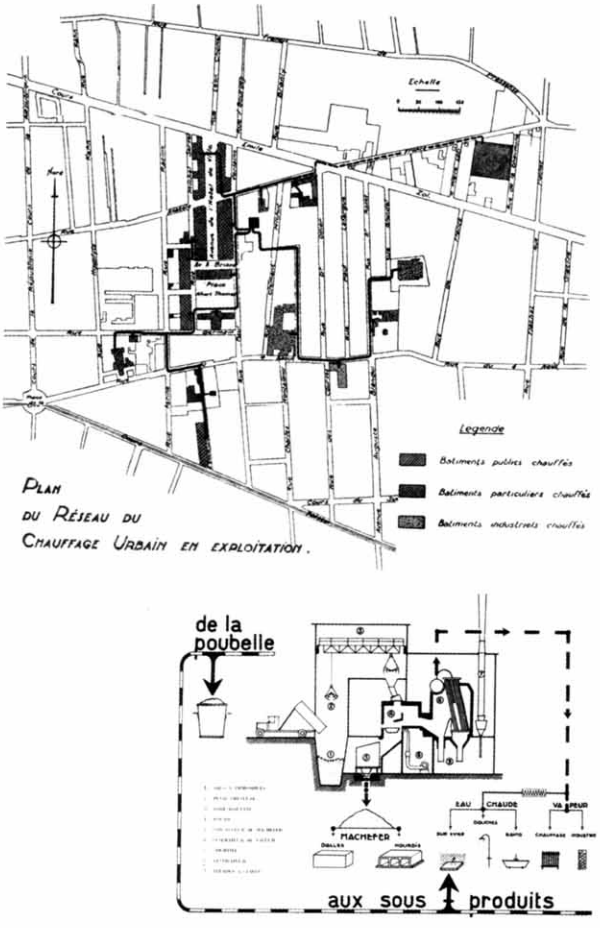
In Paris, this steam network was funded privately. It consisted of an obsolete electric plant designed originally for the subway by the Seine near the Gare de Lyon. The network was extended in the neighbourhood and westwards to the town centre[20]. The city of Paris gave the concession to the *Compagnie Parisienne de Chauffage Urbain*, and prescribed the connection first to public buildings[21].

That is why all the public buildings (owned by the town or by the state) nearby the network were connected: the



Compagnie Parisienne de Chauffage Urbain. André Hermann, "*Chauffage urbain*", *L'Architecture d'Aujourd'hui*, n°5, 1934, p.33.

railway station *Gare de Lyon*, the main town hall, primary schools, the National library, the town hall of the fourth district, the *Palais-Royal* and the *Comédie Française* theatre, the *Conservatoire des Arts et Metiers*, the Turgot high school, but also hotels, cinemas, offices, and Haussmanian residential housings.



Villeurbanne District, Lyon, heating network and the circulation system of the refuse incinerator. Lazare Goujon, *Villeurbanne 1924-1934 ou 10 ans d'administration*, Association typographique (1935, p.370).

From the beginning, the idea was to created a network with several interconnected production units, located in suburbs, producing electricity and burning household refuse, but with the monetary crisis and the war the interconnection had to wait until the 1950s.

In Villeurbanne, the network was begun by the town with its mayor Lazare Goujon (1869-1960), in the context of a global urban and hygienic programme, with a new town hall, a Palace of Labour (*Palais du travail*), and large-scale social housing complexes shaped as skyscrapers[22]. The production station was centred on the refuse incinerator and was complemented with a coal furnace. The heat conducting fluid was hot water under pressure (180°C, 15 kg) and the German company *Caliqua* in charge of the network had a branch in Alsace.

The heat was delivered to the housing units, factories and public buildings, including a swimming pool located in the basement of the Palace of Labour. In this radical socialist town, directed by a doctor, the purpose was to democratize comfort and hygiene with the help of the engineer Jean Fleury.

Heating with gas and electricity

Heating with gas was possible through two ways: central heating or gas radiators designed and produced at the end of the 19th C. This type of heating involved numerous pieces of equipment necessary to heat individual rooms.

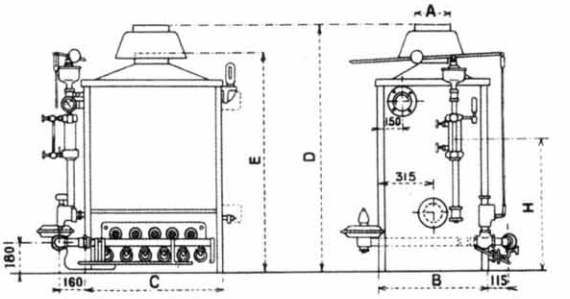
Central heating with gas could be installed for the entire residential building or just for one apartment. The energy efficiency was good (80%) and the regulation was convenient, but the entire system had to be properly and regularly controlled in order to be safe[23].

Calor electric radiator. Postcard, Union des arts décoratifs 1987, photo Sully-Jaulmes.

Gas radiator, photo Emmanuelle Gallo, author's collection, and gas boiler's description.

CHAUDIÈRES A GAZ " IDÉAL GAZINA "

TYPES " GW " ET " GS "

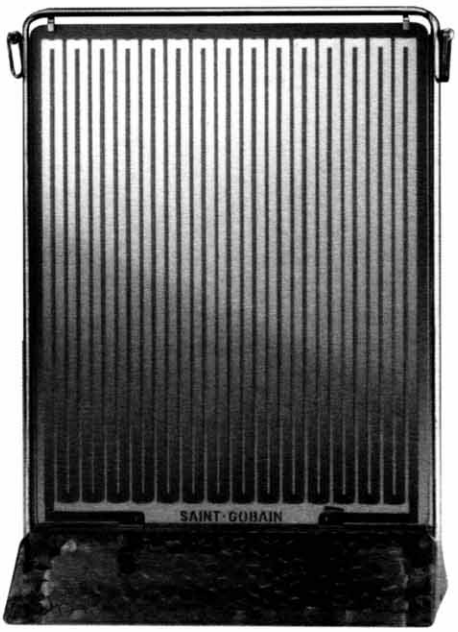


Numéros	Diamètre Raccord Régulateur de pression du gaz	Diamètre Raccord Vanne de réglage	Diamètre des tuyaux d'évacuation	Largeur de la Chaudière seule	Profondeur de la Chaudière seule	Hauteur avec antirefouleur	Hauteur sans antirefouleur	Hauteur des départs au-dessus du sol	Hauteur des retours au-dessus du sol	Hauteur de la ligne d'eau
	m/m	m/m	m/m	m/m	m/m	m/m	m/m	m/m	m/m	m/m
CHAUDIÈRES POUR EAU CHAUDE										
1-GW- 8	40 /49	40 /49	203	630	875	1405	1210	950	330	—
1-GW- 9	50 /60	40 /49	228	630	975	1480	1210	950	330	—
1-GW- 10	50 /60	40 /49	228	630	1075	1500	1210	950	330	—
1-GW- 11	50 /60	40 /49	254	630	1175	1500	1210	950	330	—
CHAUDIÈRES POUR VAPEUR A BASSE PRESSION										
0-GS- 40	20 /27	26 /34	102	470	350	1310	1220	1040	485	810
0-GS- 50	20 /27	26 /34	127	470	425	1310	1220	1040	485	810
0-GS- 60	26 /34	26 /34	152	470	500	1340	1220	1040	485	810
0-GS- 70	33 /42	26 /34	152	470	575	1340	1220	1040	485	810
1-GS- 40	33 /42	26 /34	152	630	475	1355	1210	950	330	760
1-GS- 50	33 /42	33 /42	173	630	575	1355	1210	950	330	760
1-GS- 60	33 /42	33 /42	203	630	675	1365	1210	950	330	760
1-GS- 70	40 /49	33 /42	203	630	775	1385	1210	950	330	760
1-GS- 80	40 /49	40 /49	203	630	875	1405	1210	950	330	760
1-GS- 90	50 /60	40 /49	228	630	975	1480	1210	950	330	760
1-GS- 100	50 /60	40 /49	228	630	1075	1500	1210	950	330	760
1-GS- 110	50 /60	40 /49	254	630	1175	1500	1210	950	330	760

Accessoires pour les Chaudières à vapeur : Régulateur de pression du gaz, Rampe à gaz complète avec robinets, Vanne de réglage progressif du gaz, Regulateur de pression de la vapeur, Veilleuse thermostatique avec robinet, Antirefouleur, Jaquette isolante en tôle noire (émaillée blanc sur demande seulement), Robinet de vidange, Garniture de niveau d'eau, Soupape de sûreté, Manomètre.

Sur demande et moyennant un supplément de prix, l'Antirefouleur peut être remplacé par un Régulateur automatique de tirage.

The first introduction of electric heating in France took place in 1925, when electric wiring of appropriate size was developed[24]. This system gave a total liberty. By its high price the cost slowed its diffusion, especially in the case of direct electric heating. Storage heaters were more financially attractive.



Saint-Gobain electric radiator *Radiaver*.
Affiche George Fabre, Bibliothèque Forney.

For the period under study, electric heating remained insignificant even if beautiful radiators were designed, especially one by Saint-Gobain for the Paris International Exhibition of 1937.

Conclusion

This period 1900-1939, if not revolutionary when it came to heating, was still innovative. There are new types of energetic sources and networks available. New forms of heating passed from utopia to reality. The architects use more readily the novelties proposed by the engineers even in residential projects. The diffusion of thermal comfort is not yet democratic but it is during this period that everything was settled for a larger availability after the Second World War.

Notes

[1] All these general informations are collected for the author's Ph.D, in working prodress: *Modernité technique et valeur d'usage, le chauffage des bâtiments d'habitation en France*, Université de Paris I, directed by Gérard Monnier. See also: Gallo, E., *Jean Simon Bonnemain (1743-1830) and the Origins of Hot Water Central Heating, 2nd International Congress on Construction History,* Queens' College, Cambridge, UK, 29th March-2nd April 2006, edited by the Construction History Society, p. 1043-1060.

[2] René Duvoir, "*Chauffage par eau chaude*", *Revue générale d'architecture et des travaux publics*, n°7, 1847-1848, col. 509-515

[3] More details on heating of public buildings and *L'École Centrale*: Emmanuelle Gallo, Alice Thomine, *Chauffage et ventilation, Le Paris des centraliens, bâtisseurs et entrepreneurs*, Action Artistique de la ville de Paris, Paris (2004, pp. 199-201) directed by Jean-François Belhoste,

[4] André Missenard, *Cours supérieur de chauffage, ventilation et conditionnement de l'air*, Librairie de l'enseignement technique, Paris 1937-1943, 4 vol.

[5] Nathalie Rouleau-Simonot, *Les tentatives d'une revue à forte identité technique au travers de L'Architecture d'Aujourd'hui, puis de Techniques et Architecture (1930-1945), Les Avatars de la littérature technique*, CHTE, CNAM, INHA, (3,4, 5 March 2005) (in press).

[6] *Chauffage et ventilation, Architecture d'Aujourd'hui*, n°5, mai 1935,100 p.

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