RAKVERE CASTLE ESTONIA

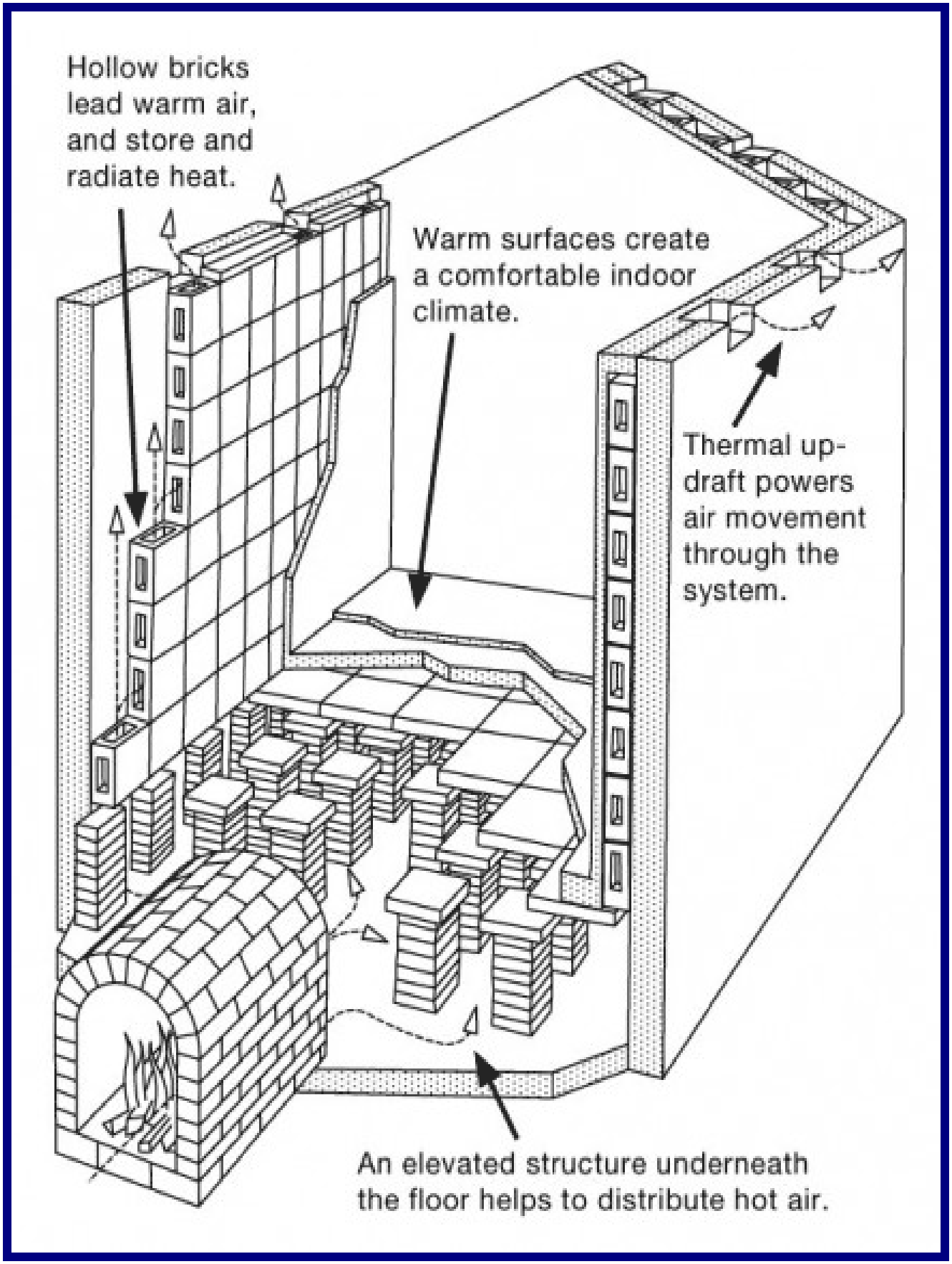
HEATING HISTORY

THE HYPOCAUST
PART TWO

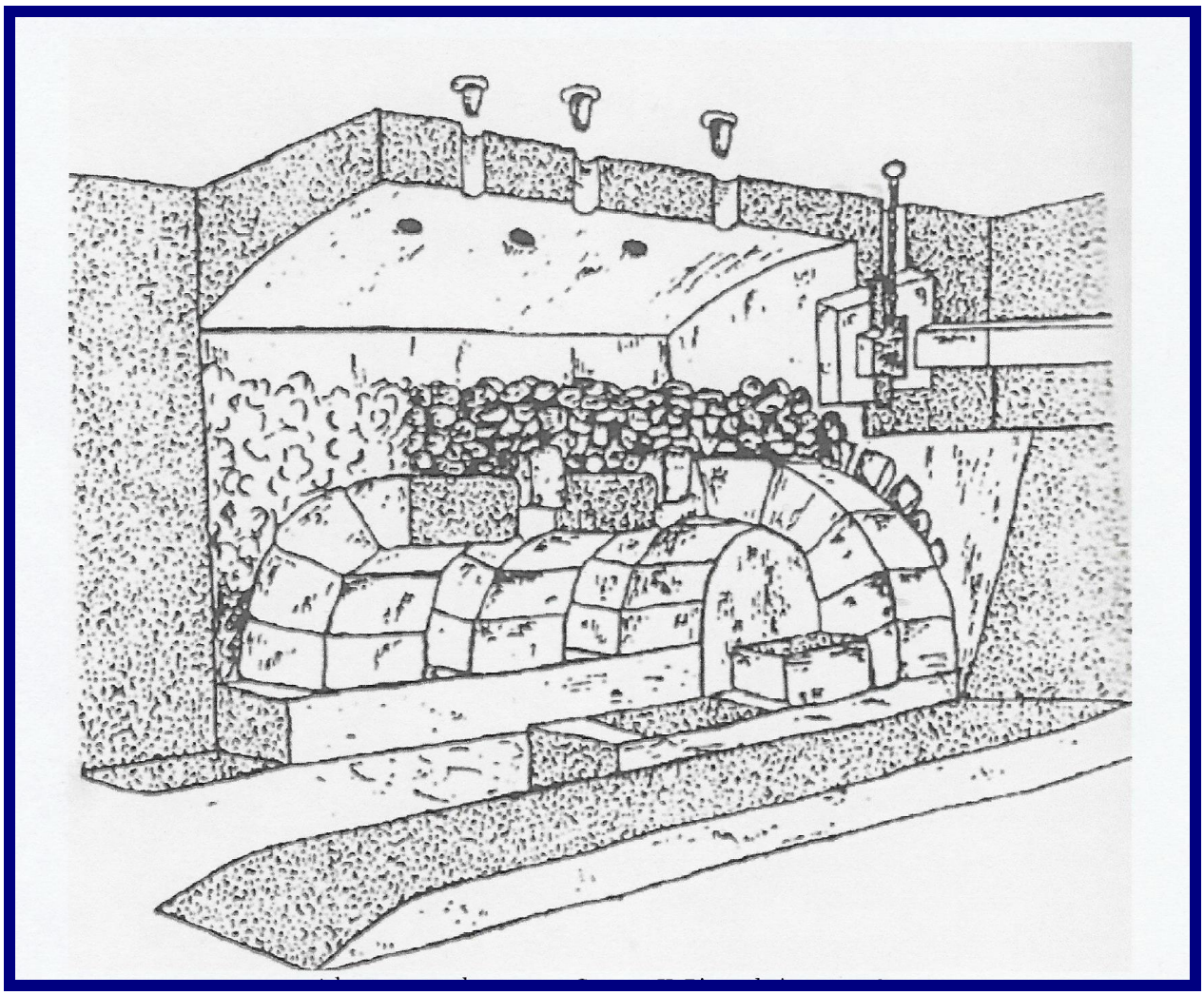
HEAT STORAGE AND TILED STOVES

BRIAN ROBERTS

THE CONVENTIONAL ROMAN HYPOCAUST



THE HYPOCAUST HEAT STORAGE SYSTEM MALBORK CASTLE POLAND

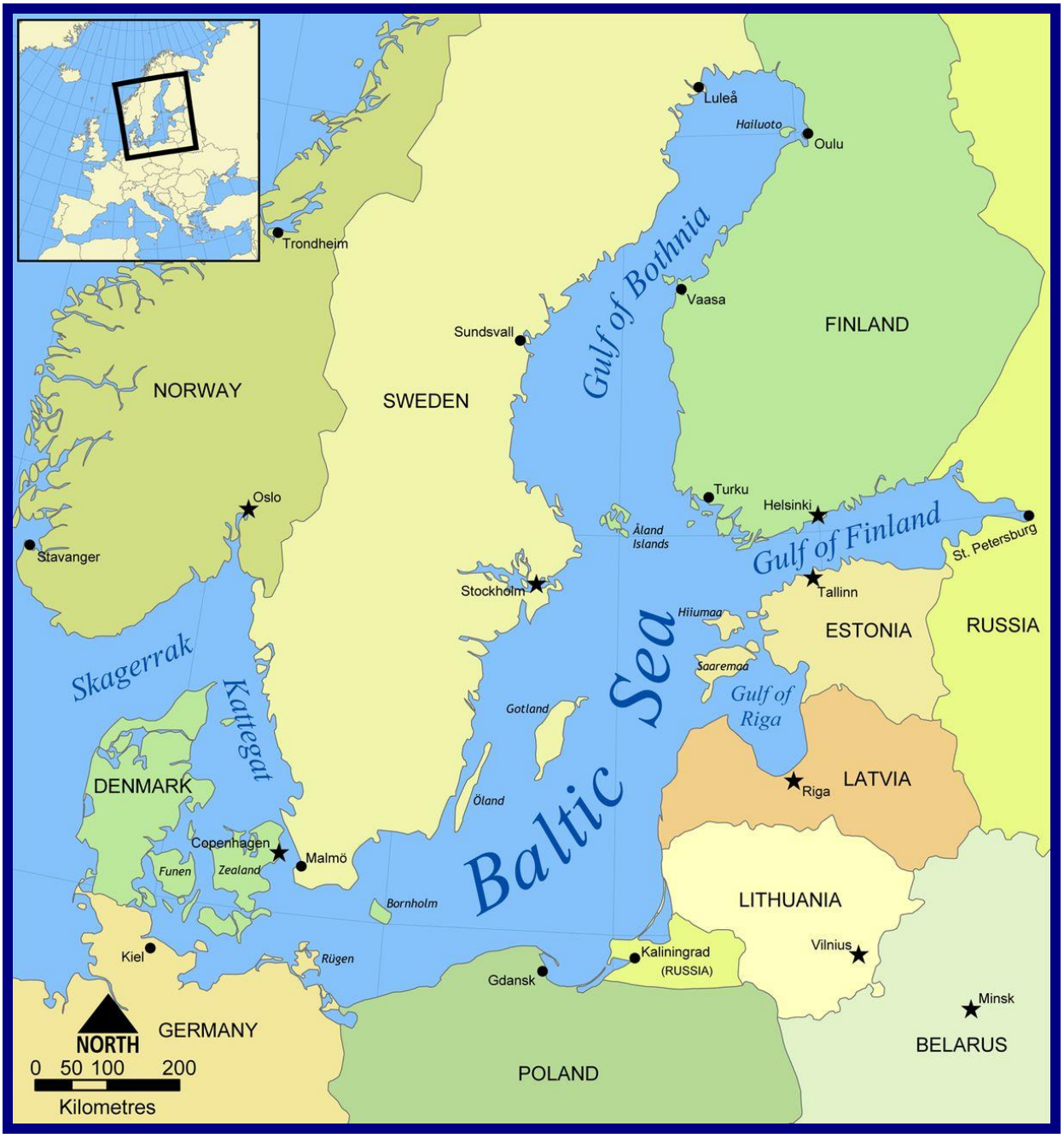


The heat storage hypocaust was used in medieval monasteries, castles and civic buildings in Baltic States. Many of these buildings date from the 13th and 14th centuries. Some although open to visitors are now in ruins. In 18th century Sweden the heat storage hypocaust was largely replaced by the tiled stove.

HEAT STORAGE SYSTEMS pages

Note: The location of examples is Estonia unless otherwise indicated.

THE BALTIC STATES

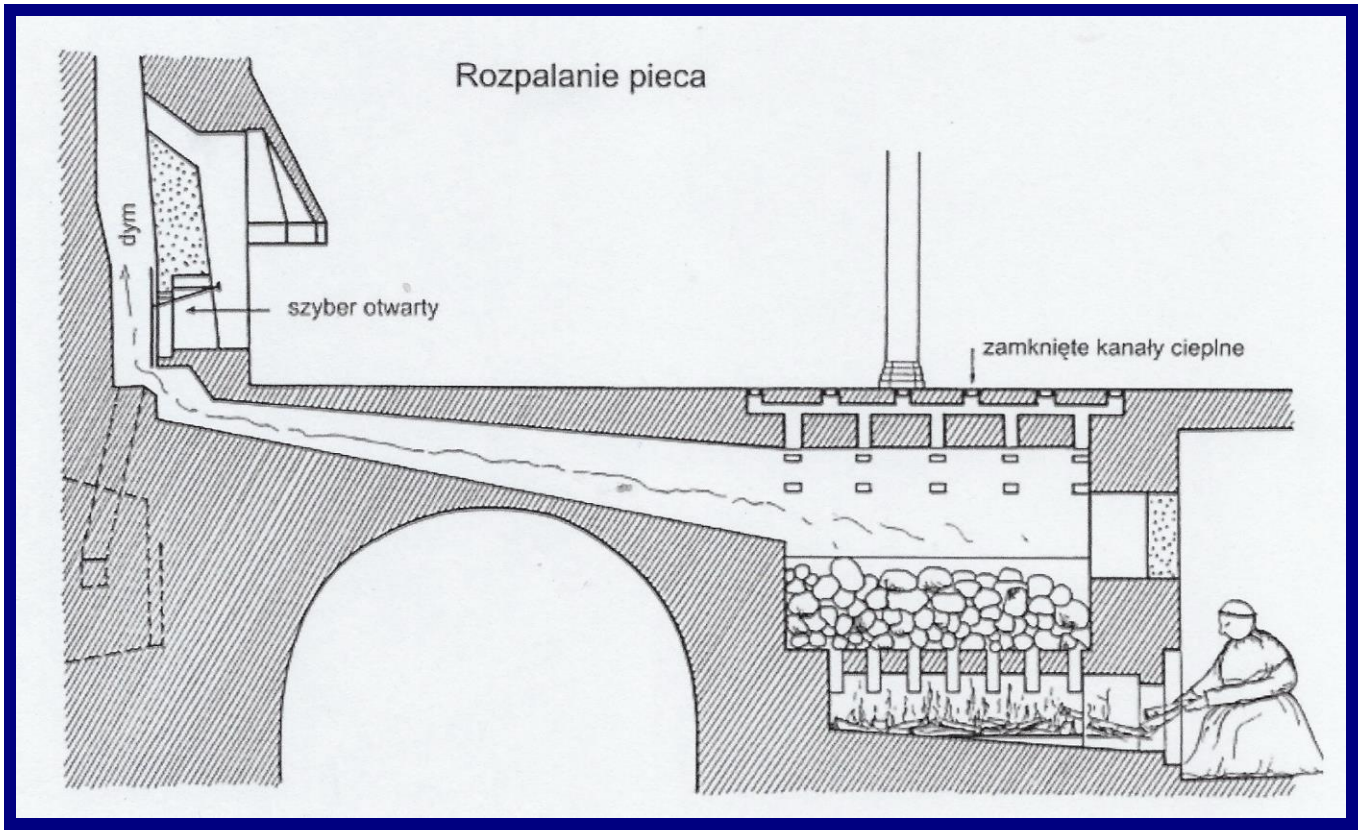


The heat storage hypocaust was used mainly in the Baltic Region: Denmark, Estonia, Finland, Latvia, Lithuania, Northern Germany, Poland and Sweden. Very little information in the English language has been found and this E-Book concentrates on Estonia, Latvia and Lithuania. One report states around 500 heat storage systems in the Baltic Region have been documented, many in castles and monasteries. Just a few examples are shown in the following pages.

THE HYPOCAUST HEAT STORAGE SYSTEM

The **Hypocaust** is a system providing central heating in a building. It works by heating the air in a solid-fuel furnace and circulating this warm air below the floor of the room. The Roman furnace, or stoke hole, was fed with wood as fuel by a slave or attendant. Hot air and smoke from the furnace would circulate through this below-floor space, the hypocaust, the ceiling of which was raised above the ground by pillars. These supported a layer of tiles, followed by a layer of concrete, then the floor tiles of the rooms above. Hot air and smoke from the furnace would circulate through this enclosed space and then up through clay or tile flues in the walls of the rooms above to outlets in the roof. This arrangement could also be used to warm upper rooms. Rooms intended to be the warmest were located nearest to the furnace below. Heat output was regulated by adjusting the quantity of wood fed to the fire. This was a labour-intensive and time-consuming operation, requiring constant attention and large amounts of wood as fuel.

As Christianity and its monasteries spread to the colder climate in Northern Europe, the Roman hypocaust was found to provide insufficient heating. The output temperatures were too low and the hypocaust had to be fired continuously. The original Roman system was developed into the heat storage hypocaust, an underground furnace on top of which granite stones would be piled, to then release hot air through vents in the floor. This method enabled a room to be kept warm for days with just one firing of the furnace.



THE HYPOCAUST HEAT STORAGE SYSTEM

The heat storage hypocaust was a large furnace with a pile of stones for the retention of heat and with a connection between the heat-accumulating pile and the heated room. The heated room had a perforated hot plate above the furnace. The openings were closed while the furnace was heated while the smoke escaped into the chimney through the stone pile. When heating was completed, the smoke flue damper was closed and the holes in the hot plate were opened. Then hot air then rose from the pile and through the stones into the room to be heated. The furnace itself was of massive construction having to resist the pressure exerted on its side walls by the hot stones in the pile.

More details of the construction of these furnaces and the hot plates and their control, with information on those parts remaining is given in the 30-page paper by Andres Tvauri.

Test on a Heat Storage Hypocaust.

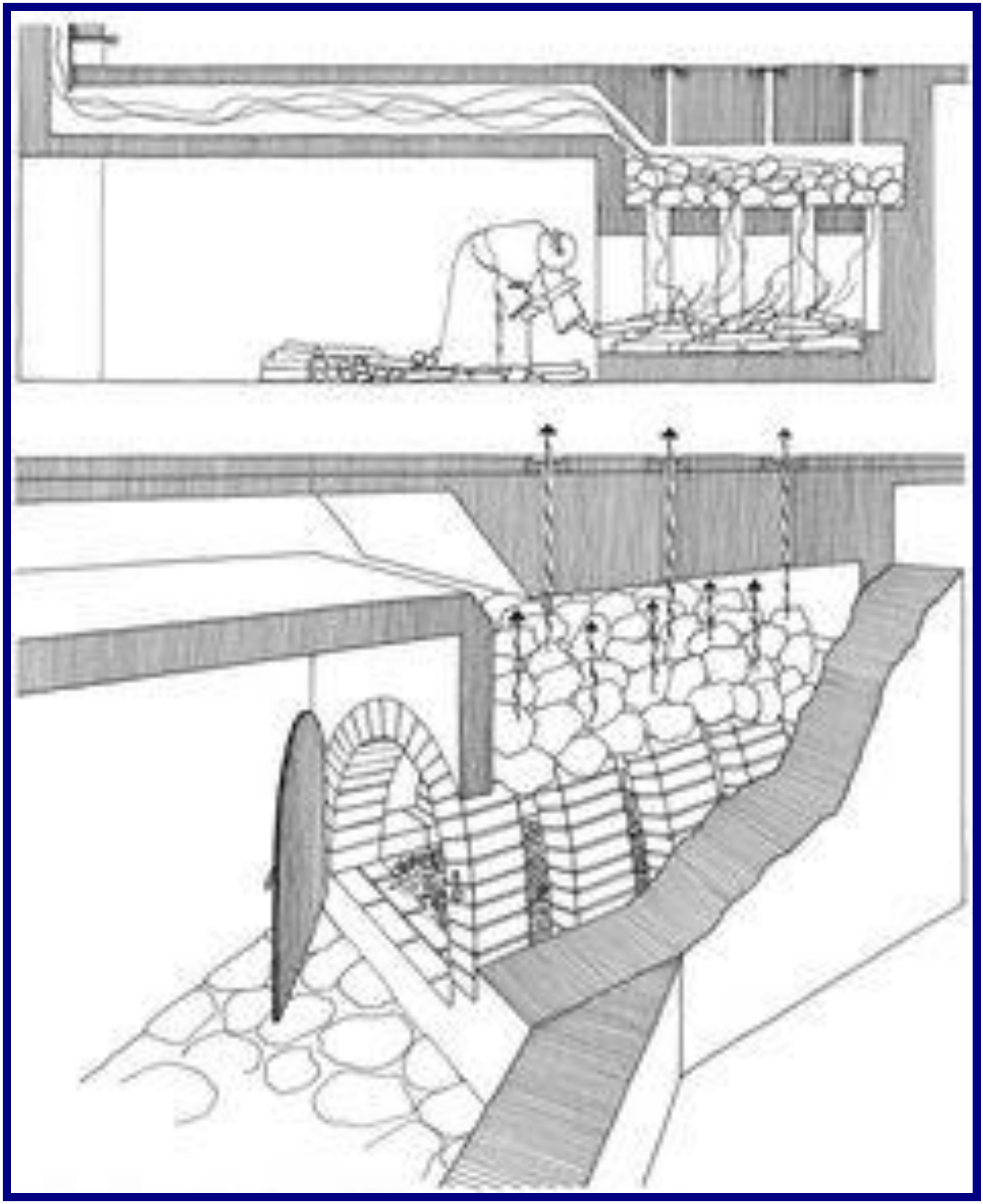
In 1822, a number of experiments were conducted to establish the effectiveness of a then 400 year-old heat storage hypocaust in Poland's Malbork Castle. One such experiment involved heating the castle's 850 square-metre banqueting hall.

On 3 April, a cold furnace was lit for three and a half hours using 0.7 cubic metres of spruce wood. When the vents in the hot plate were opened, hot (200 degC) air rushed into the banqueting hall, raising its temperature from 6 to 22.5 degC in just 20 minutes. The air vents were then closed. By the following morning (4 April), the room's air temperature had fallen to 14 degC. The air vents were opened and the temperature rose to 19 degC in one hour without any additional fuel being lit.

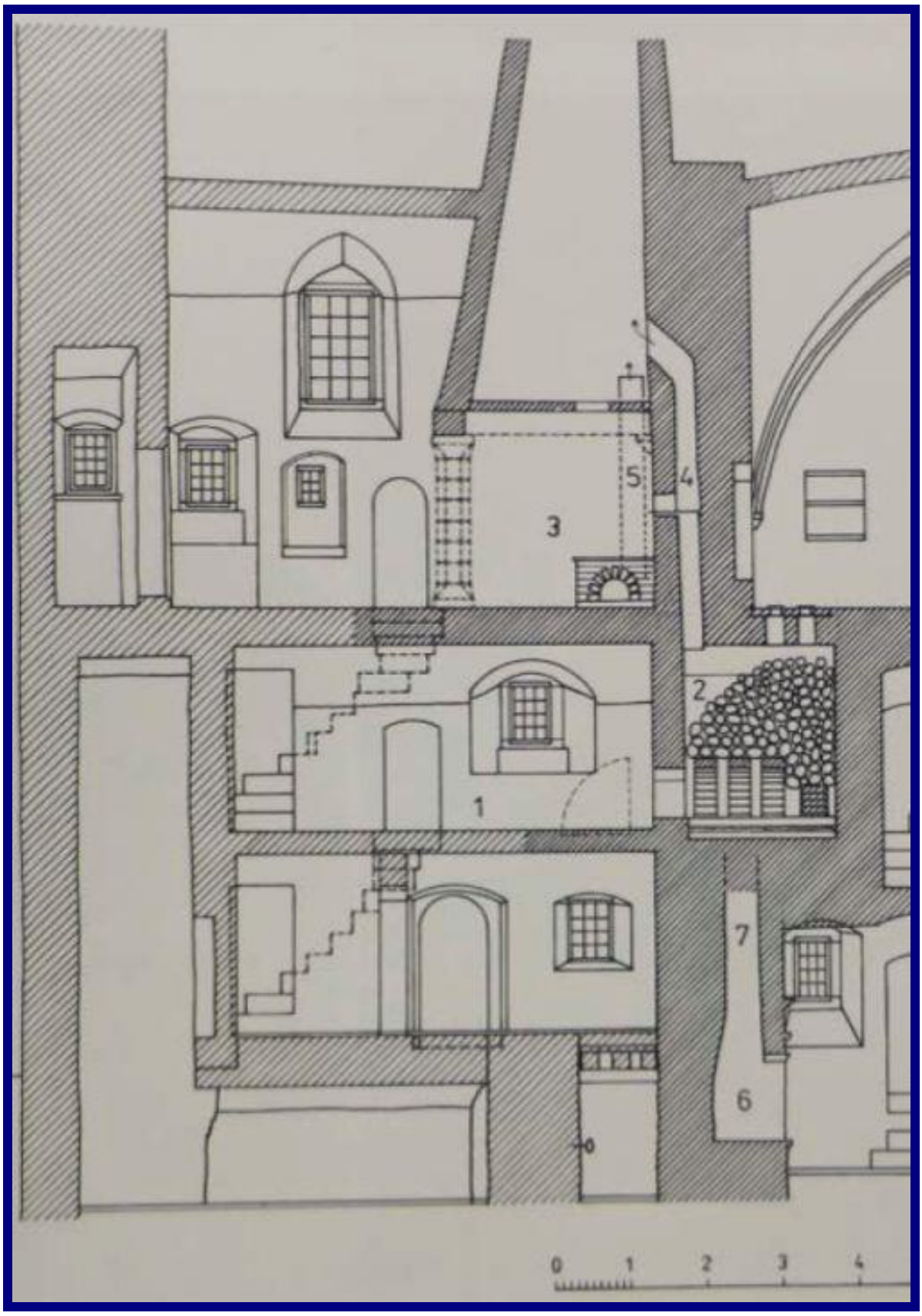
On 5 April, the temperature of the air escaping through the vents was 94 degC and the room temperature rose from 10 to 16 degC in half an hour. On 6 April, three days after the fire was extinguished, the air was still hot enough to raise the room's temperature from 10 to 12 degC. Even on 9 April, a full six days later, the warm (46 degC) air rising from the vents managed to lift the temperature in the hall from 8 to 10 degC."

From: Heat Storage Hypocausts: Air Heating in the Middle Ages.

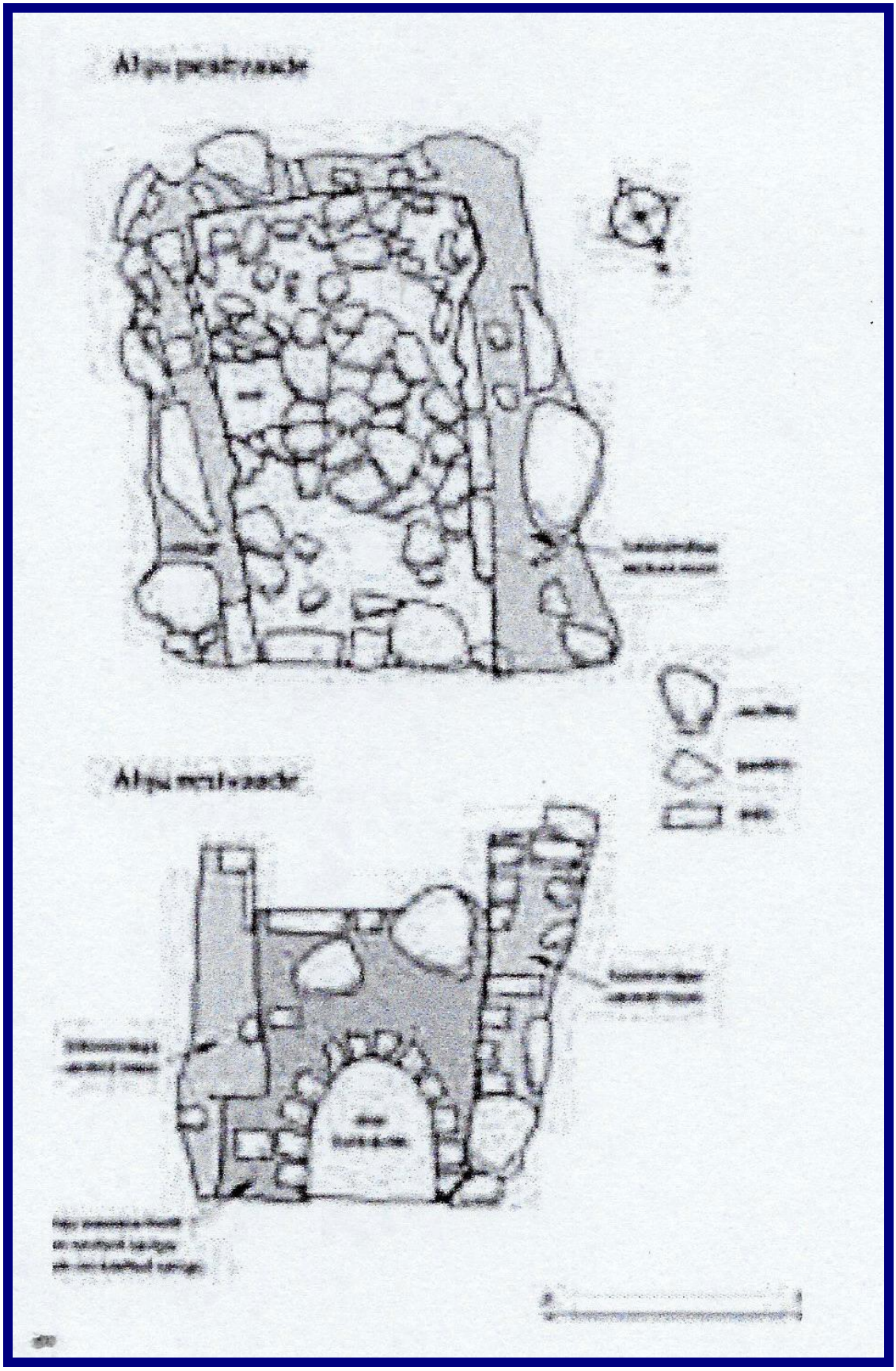
THE HYPOCAUST HEAT STORAGE SYSTEM



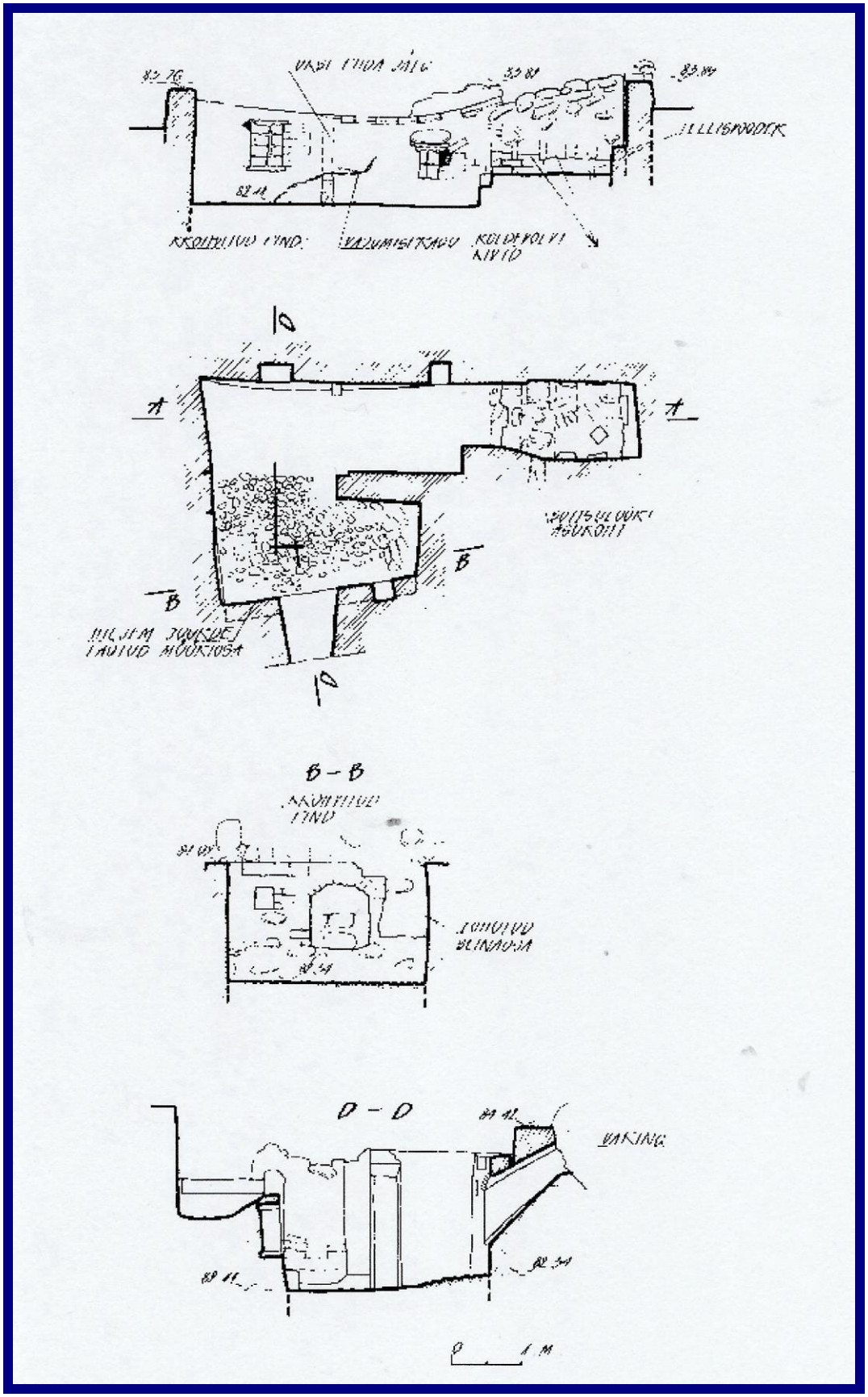
TALLINN TOWN HALL ESTONIA HEAT STORAGE HYPOCAUST



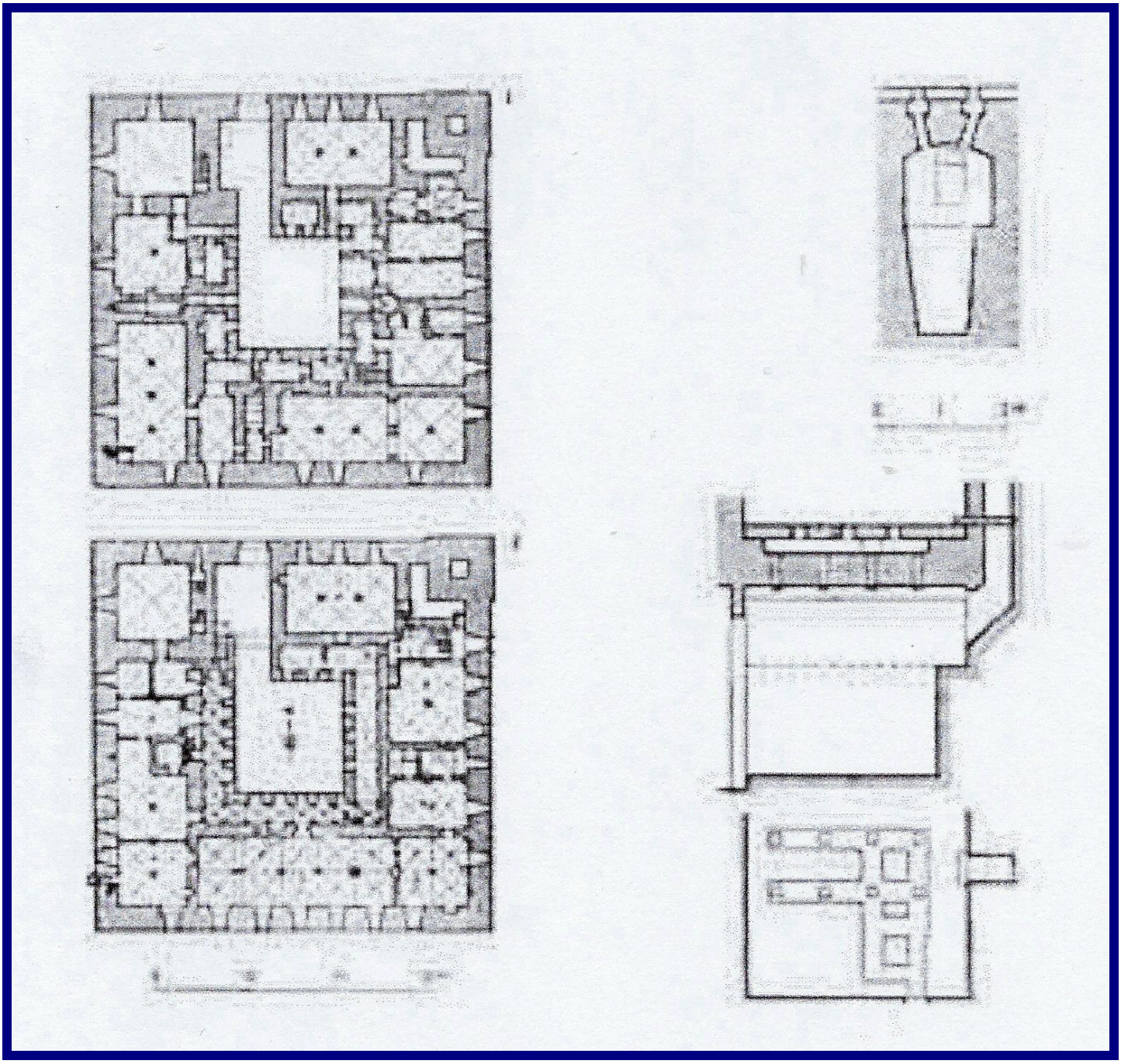
VIJANDI CASTLE ESTONIA HEAT STORAGE HYPOCAUST



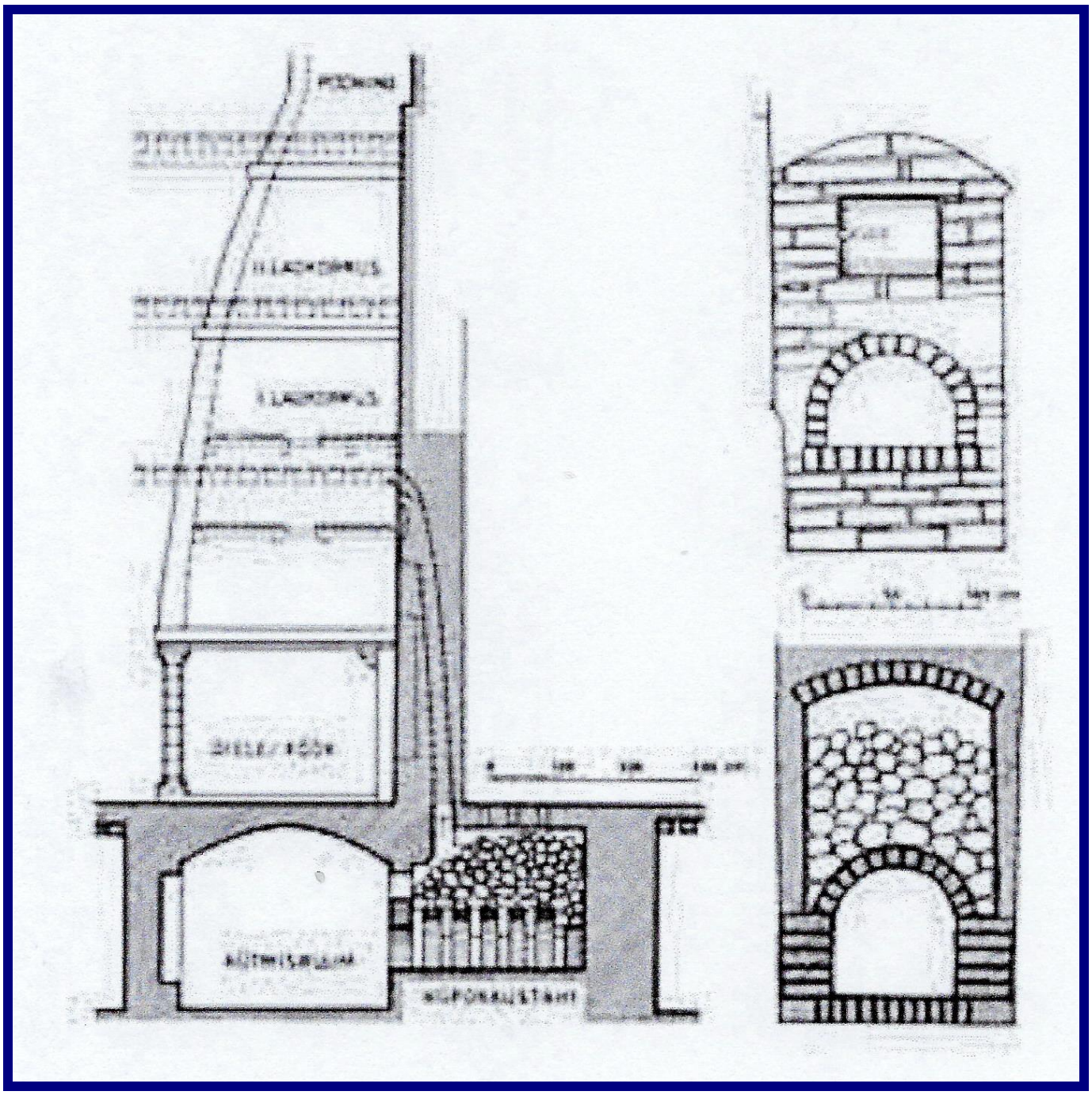
FRANSICAN MONASTERY VIJANDI ESTONIA: HEAT STORAGE HYPOCAUSTS



KURESSAARE CASTLE ESTONIA HEAT STORAGE HYPOCAUST



MERCHANTS HOUSE TALLINN ESTONIA HOT AIR STORAGE HEATING SYSTEM



DWELLNGS TALLINN ESTONIA HEAT STORAGE HYPOCAUSTS

MAULBRONN MONASTERY GERMANY HOT AIR VENTS IN THE FLOOR

<15>

ALTENE CASTLE LATVIA

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HAAPSALU CASTLE

MALBORK MONASTERY POLAND

KOLUVERE BISHOPS CASTLE

<19>

KURESSAARE CASTLE

NARVA CASTLE

OTEPAA BISHOPS CASTLE

PAIDE CASTLE

PERITA CONVENT LATVIA

TALLINN TOWN HALL

TALLINN GREAT GUILD HOUSE

TALLINN ST. MICHAELS CONVENT

TALLINN TOMPEA CASTLE

THE SWEDISH TILED STOVE

History of the Swedish Tiled Stove.

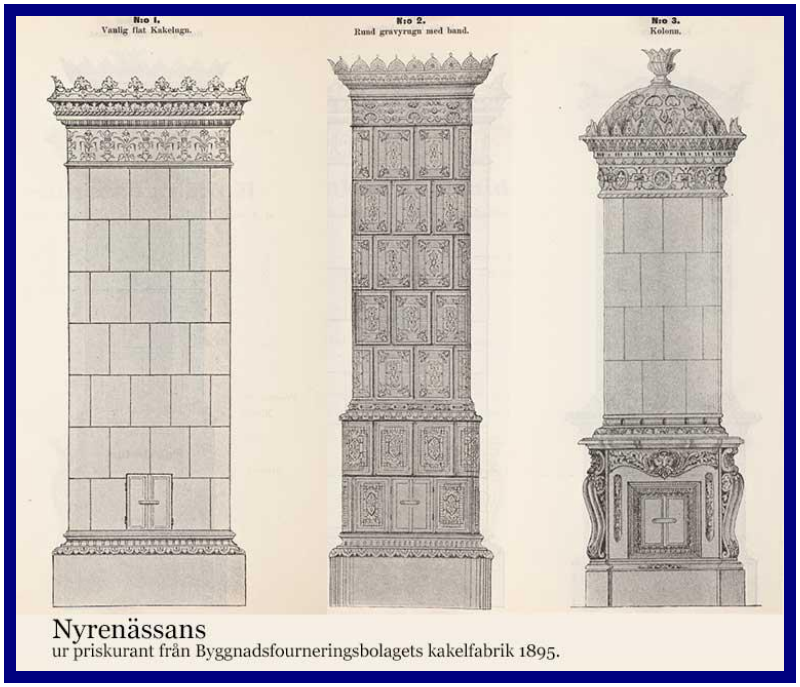
An edited extract of the paper by Annika Svensson.

The first Swedish tiled stoves were based on German models found in royal castles in the 16th centuries. In 1767, a system with five internal flues created by the architect Carl-Johan Cronstedt and the General Fabian Wrede, turned the tiled stove into the exceptionally efficient energy repositories that they remain today.

The tiled stoves had their heydays during the 19th century, and during this time the stoves were both amazing sculptures as well as markers of social status. However, during 1950-60, most tiled stoves were torn down. Since the 1990s however, these sources of warmth and comfort have made their comeback, on the basis of their energy smart qualities.

The tiled stove is made to extract the most possible heat out of the smallest amount of wood and effort of work. A tiled stove is constructed to keep the smoke as long as possible before it is conducted to a chimney. This is brought about by a stove maker who is building up vertical internal flues within the stove. The smoke is conducted close on ten metres, and therefore it can accumulate and heat the stove before it reaches the chimney. The heavier the stove is, the more it generally radiates. A smaller stove has a weight just over 300 kg, and a larger one has a weight of approximately 1200 kg.

The tiled area also affects the efficiency, so usually a squared stove provides more heat than a rounded one. The body of the smaller stove contains two internal flues that keep the heat for approximately four hours, compared to the larger stove containing five internal flues that keeps the heat for about twenty hours after the fire has died down. Older stoves are still being used since it is possible to rebuild the inner construction. even after thirty or more years of use.



Nyrenässans
ur priskurant från Byggnadsfourneringsbolagets kakelfabrik 1895.

THE SWEDISH TILED STOVE

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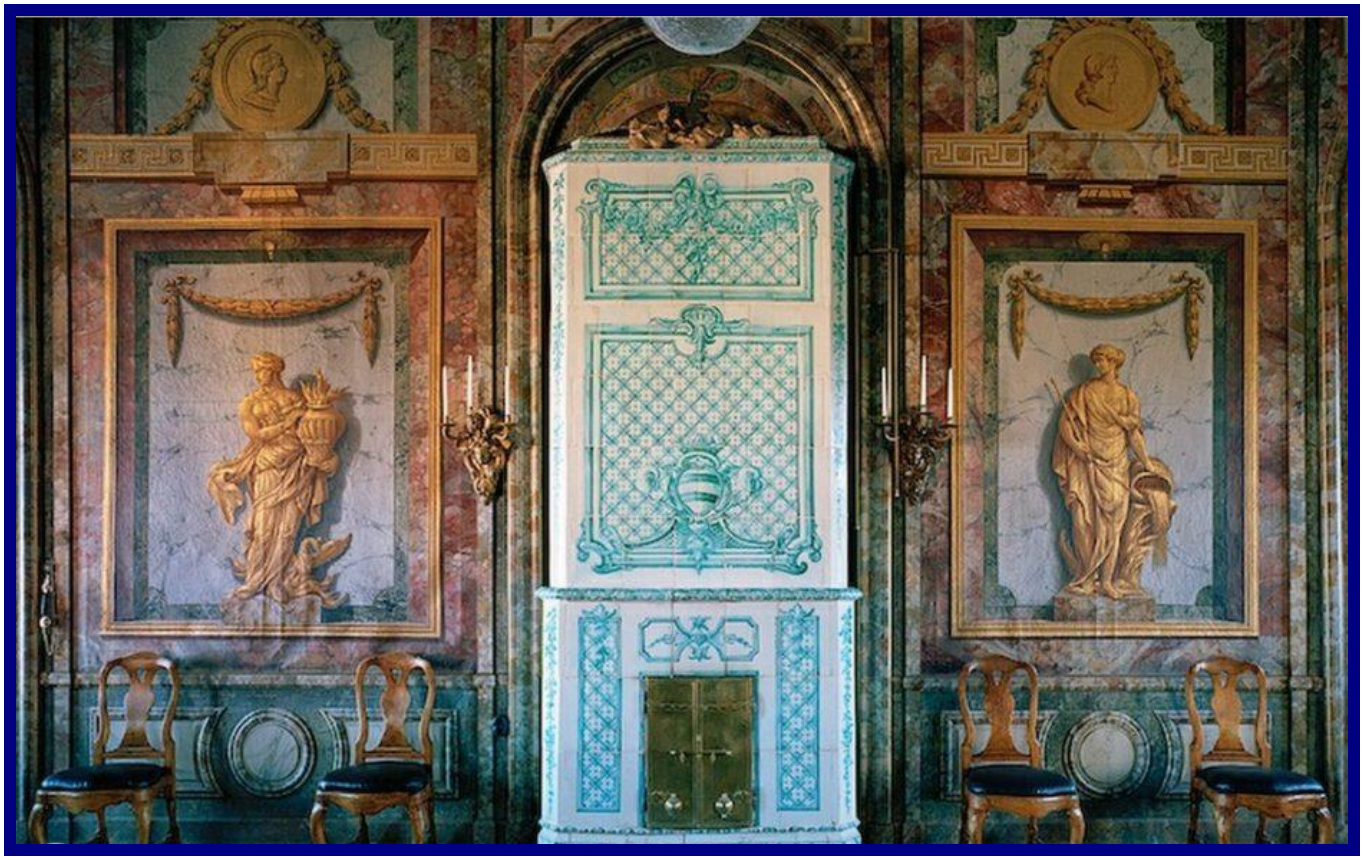

THE HEAT STORAGE HYPOCAUST

REFERENCES AND FURTHER READING

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2017 Heat Storage Hypocausts: Air Heating in the Middle Ages, Low-Tech Magazine.
2019 The Hypocaust: An Assessment of Non-Ancient Varieties, Sam Johnson*, Cardiff University SHARE eJournal. (*CIBSE Heritage Group).
2021 Heritage Revisited Part 10: Building Engineering Services, (see pages 6-7, 40-42), Frank Ferris, CIBSE Heritage Group.

For the conventional Roman Hypocaust see:
2022 The Hypocaust: Part One, Brian Roberts (E-Book), CIBSE Heritage Group website.

BRIAN ROBERTS, Budleigh Salterton, 2022