**Heating Churches with wood-burning masonry stoves**

**- Masonry stoves for buildings and rooms of large volume**

Igor Kuznetsov

This article concerns church heating by the stoves built on the principle of free gas movement that possess many remarkable features which I described in the article "Basics for Stove Construction".

Let me remind you of these features:

- The bell can have any form and volume.
- The heat energy is carried by nature forces.
- Turbulent gas movement takes place inside the bell.
- The hottest gases are accumulated in the upper part of the bell.
- The coldest and heaviest gases are taken to the upper bell.
- Excessive pressure is generated inside the bell with temperature rise.
- The bell walls are equally heated in each horizontal section but they are more heated with each higher located section.
- The heat energy source can be located in any place of the bell lower zone whereas the heating character is preserved.
- There can be several heat sources.
- The hood arrangement in series one above another ensures a uniform heating in each horizontal section of the system, the lower bell takes up more hot gases energy than the upper one. The flue damper in stoves with forced gas movement shall be closed in proper time, otherwise it will lead to a significant heat loss. In our stoves in this case, the heat loss is insignificant.

- When more time is spent for the stove heating the temperature of chimney walls increases and they take up less heat from smoke fumes due to decrease of smoke fumes and chimney walls temperature difference. In this case the temperature of the exhaust gases increases, in other words, the stove efficiency decreases. During operation in practice the time for stove heating is not regulated, therefore the efficiency loss in the stoves with forced gas movement
- (including the system of counterflow) is inevitable. In the stoves of the "double bell" type the decrease of stove efficiency is insignificant when the stove burning time is increased as the heat excess is taken by the upper bell.

- Can be electrically operated.

Depending on size and design requirements, a church can be heated by masonry stoves several ways:

1. **Single-storey stoves of periodic action which may have various forms and volume.**

As a rule, such stoves heat one to four rooms. The heat transfer of such stoves includes heat radiation and heat convection from a large surface. Several churches are heated by such kind of stoves in Monastery built at the place where the remains of the tsar family have been hidden, Yekaterinburg, Ganina Yama. For example, the Derzhavny church is heated by two

stoves of 10 $m^3$ each. The active heat transfer surface of such stove is equal to 23.4 $m^2$, and the average heat transfer per hour is about 12.9 kWt,
if heated twice during 24 hours. The stoves built on the principle of free gas movement may have a much greater volume.

**2. Multi-storey stoves of periodic action with separate fireboxes on each storey or a single firebox for the whole stove.**

These stoves can heat 1 to 4 rooms. They may also have a very large volume and capacity.
The Sergiy Radonezhsky Church in the above mentioned monastery is heated by two three-storey stoves.

**3. Single-storey stoves with a built-in boiler of hot-water heating.**

These stoves are intended to be used for the water heating. To keep maximum heat inside the stove, these stoves have insulation cover on the outside. If no insulation to be used, the stove will also heat the room in which it is located. This is a stove of a periodic action. It is characterized together with water volume in the water-heating system by big thermal mass (accumulating capability).
The heat exchanger in such stoves is separated from the firebox. Therefore, the burning process is always taking place at the high temperatures, which ensures complete combustion of fuel and, consequently, a high efficiency. Typical wood-burning boilers cannot accumulate heat and should be constantly heated. Besides, in such boilers a heat exchanger is located directly in the firebox. In this case, combustion takes place at lower temperatures, the combustion of fuel is not complete, and the efficiency is reduced.

**4. Òwo three-storey stoves with built-in boilers in lower stoves.**

These stoves with built-in boilers of lower decks are similar to stoves described in item 3, and can be used for heating of the room in which they are installed (due to the heat-transfer of the stove walls) as well as heating by radiators of the room located higher.

**5. Stove and air-heating radiator combination**

The stoves of this type heat all the rooms of the building from one location in which air is heated and then transported through the air ducts due to the gravity force or a fan. In this case the air circulation design should be created, which is the task for the experts. The stove heat output should be sufficient to cover the building's heat losses. Otherwise in some rooms it will be cold, in other rooms it will be hot. -
These stoves can be made in the following variants:

- **With the heat exchanger inside the stove;**
- **With a stove or a heating system in ventilation chamber;**
- **With a stove, in which the heat exchanger is installed, to be installed in the ventilation chamber.**

These stoves could be of continuos or periodic combustion possessing big capability.
The stoves built on the principle of free gas movement may be of any form or volume. In the first case, an air exchanger (air-heating radiator) can be made of various metals or heat accumulating solid, e.g. soap stone. The hot gases that come out of the firebox come into the bell where they heat the air exchanger. This makes it possible to heat the room quickly and to

increase significantly the inertia of the heating system. Such a stove ensures a direct heating of the room in which it is installed and air-heating in the adjacent rooms.
The air heat exchanger can be made of metal and lined with brick.

In the second case, the stove is installed in the ventilation chamber, which is located in a basement, or on the ground floor. The stove incorporates high heat-transfer surface.

When the ventilation chamber is arranged on the ground floor, the stove's walls shall be made thin and in a metal case to ensure an increased heating of stove walls and the air in the ventilation chamber. The walls of the ventilation chamber shall be made detachable in order to be able to perform repair of the stove and to provide the heat transfer.
The firebox and smoke damper shall be installed beyond the ventilation chamber. In this case the stove transfers heat through the walls of the ventilation chamber and hot air in the adjacent rooms. When the ventilation chamber is installed in the basement, the air-heating radiator chamber shall be of the size allowing a man who is in charge of observing the stove operation to enter it. The intake duct is installed to ensure air flow into the air-heating radiator chamber. The heated air comes out to special channels or air ducts.

At present archeological excavations of a stove that served to heat the church in the past take place in a village Resantsy near Moscow . A picture of stove heating is shown in Figure 1

**Figure 1**

I have developed a detail design for stoves built on the principle of free gas movement, which can be used to heat as churches as the buildings of a significant volume.
These are stoves of periodic action, and they can be made of different volume and capability.
Parts of boilers " Universal", "Energy" and "HP" can be used in these stoves .
(The delineations look)
Inside, the stoves incorporate an air heat exchanger made of metal that ensures quick heating of air in thermal chamber. The air supply regulation is performed by means of closing or opening the door on the backside of the firebox. This has a good impact on combustion reaction and serves to increase the efficiency.

These stoves are capable of heating the room in short time. They can accumulate heat and gradually return it due to their big thermal mass. It is possible to perform automatic

temperature adjustment inside the room depending on the temperature outside as well to supply the necessary amount of  air which is needed for combustion at different stages of fuel combustion depending on the content of exhaust gases. With the help of wood pellets a complete automation of house heating is possible.

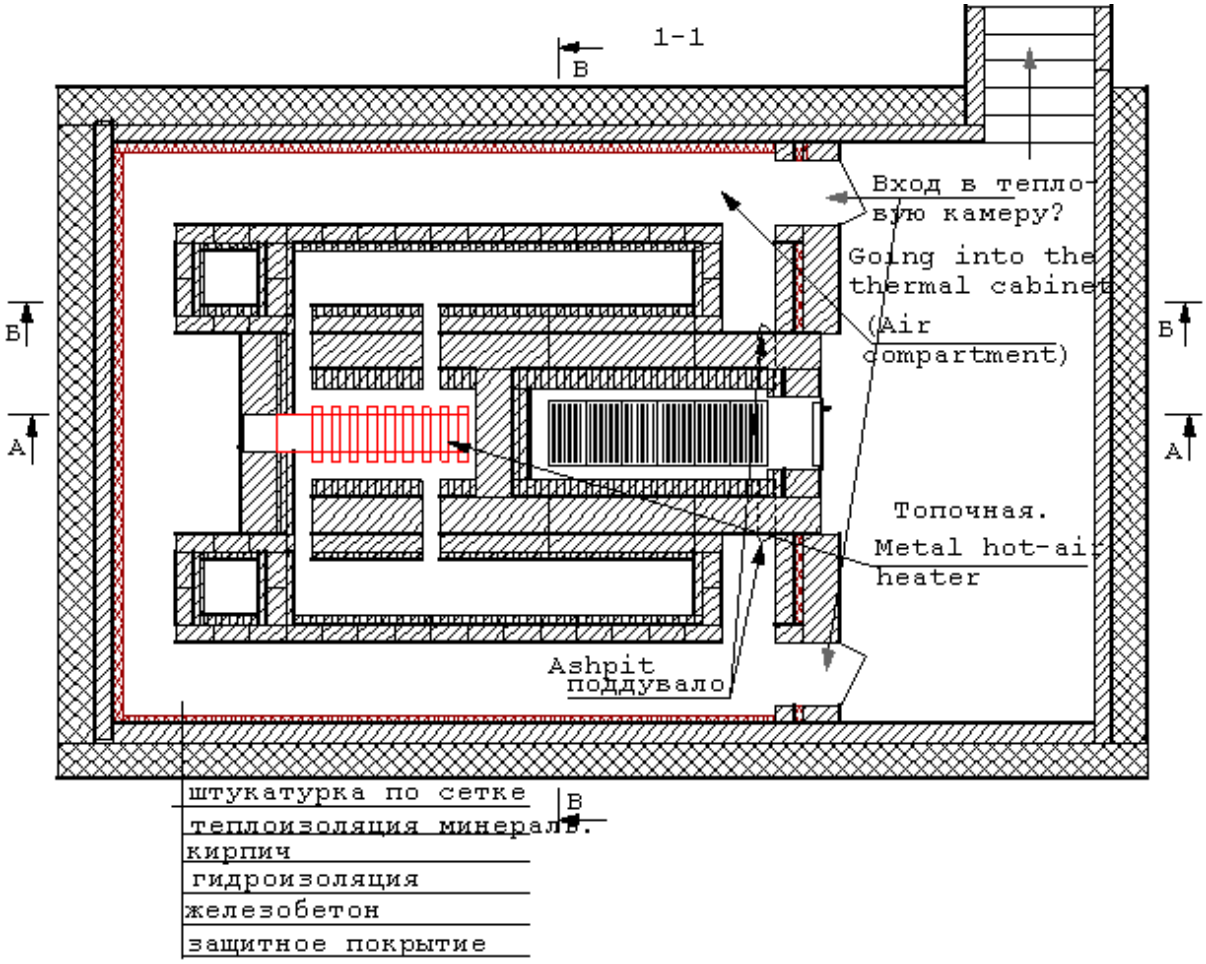


**Figure 2**

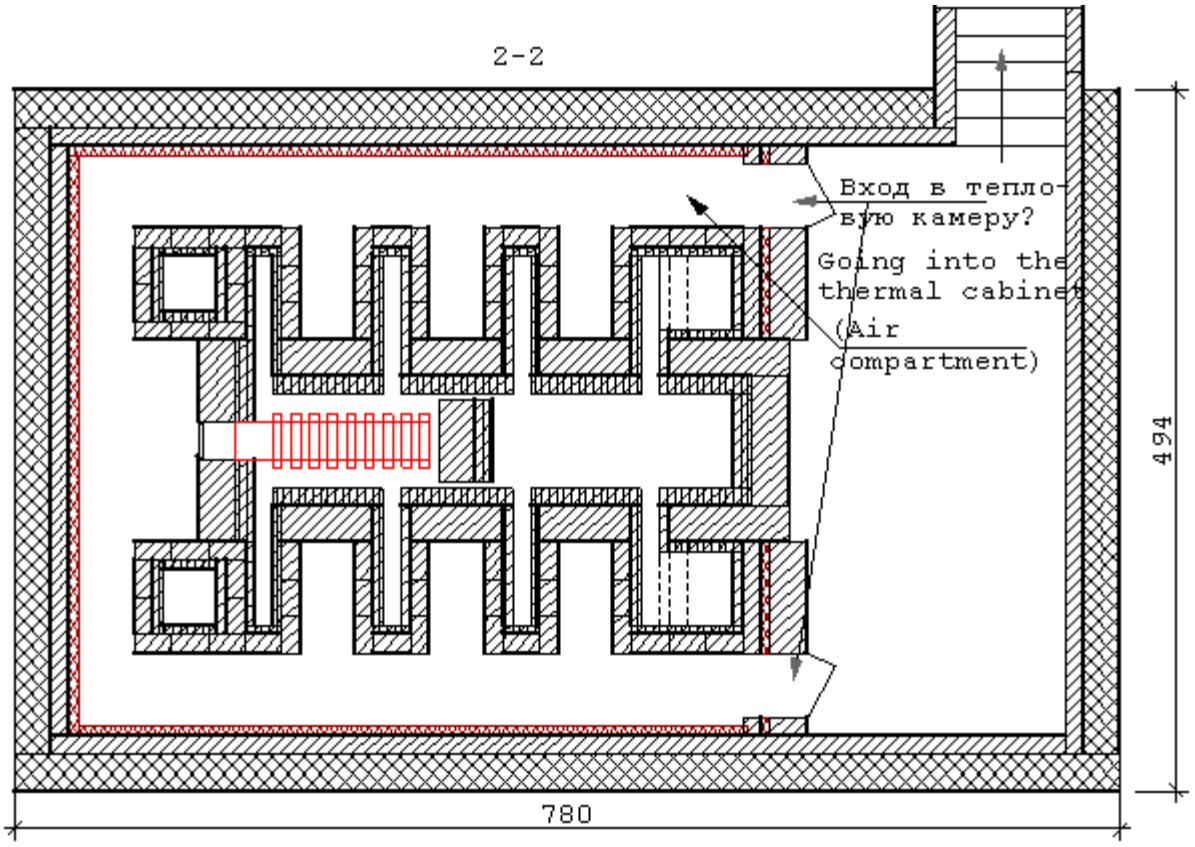


**Figure 3**

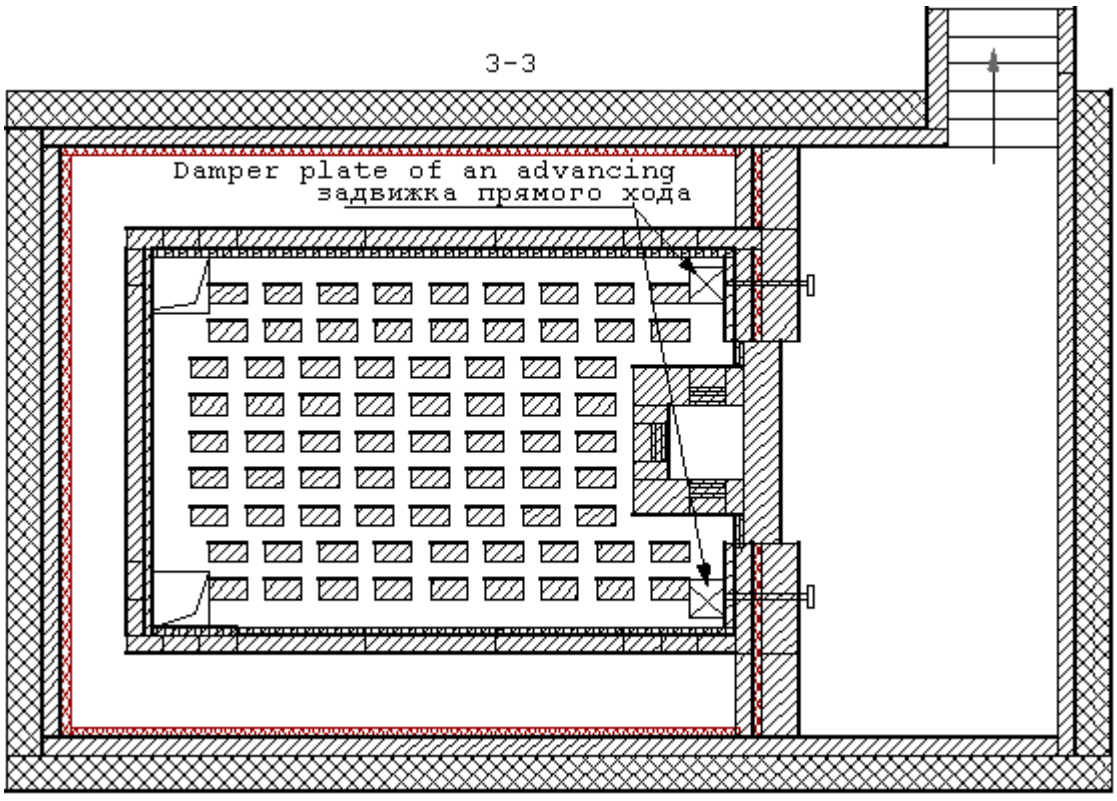


**Figure 4**

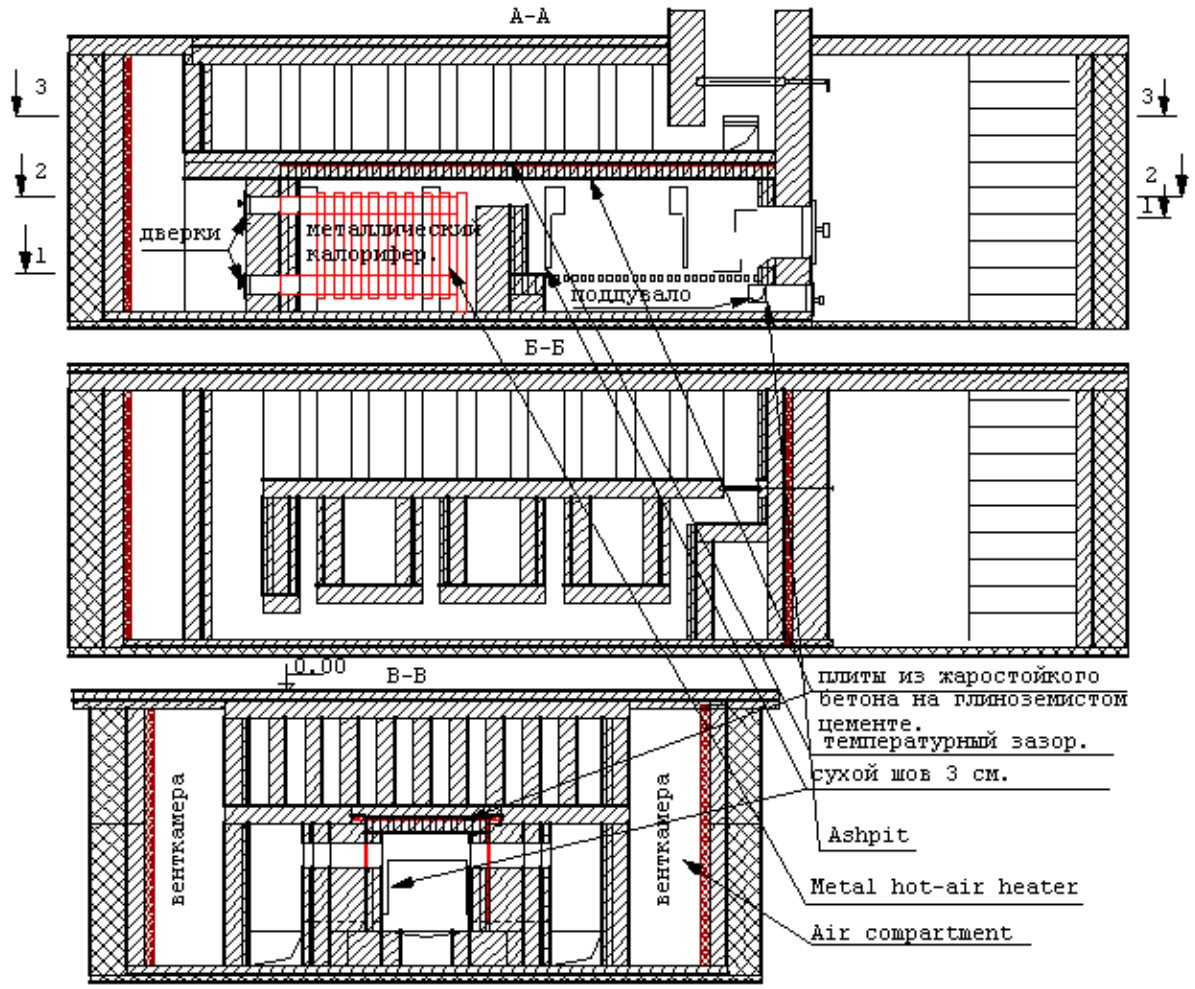
А-А
3
2
1
дверки
металлический
калорифер.
подцувало
Б-Б
0.00
В-В
венткамера
вентканера
плиты из жаростойкого
бетона на глиноземистом
цементе.
температурный зазор.
сухой шов 3 см.
Ashpit
Metal hot-air heater
Air compartment

**Figure 5**