Aug. 26, 1969 D. P. SHELLEY 3,463,469

KILNS WITH ATMOSPHERE PROPULSION

Filed Nov. 16, 1967 2 Sheets-Sheet 1

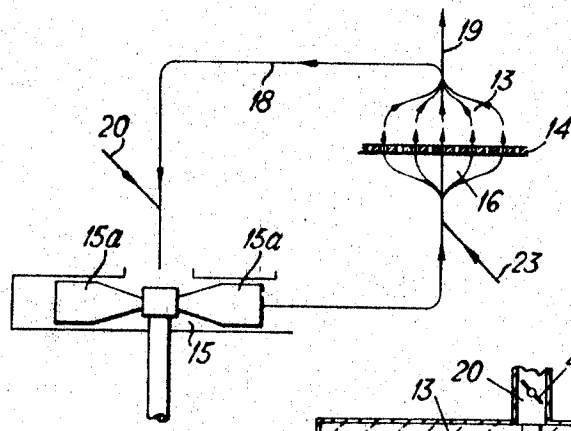


Fig. 1.

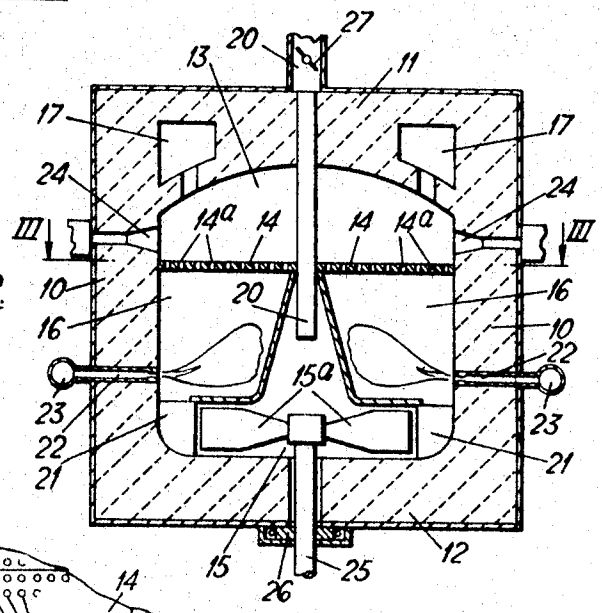


Fig. 2.

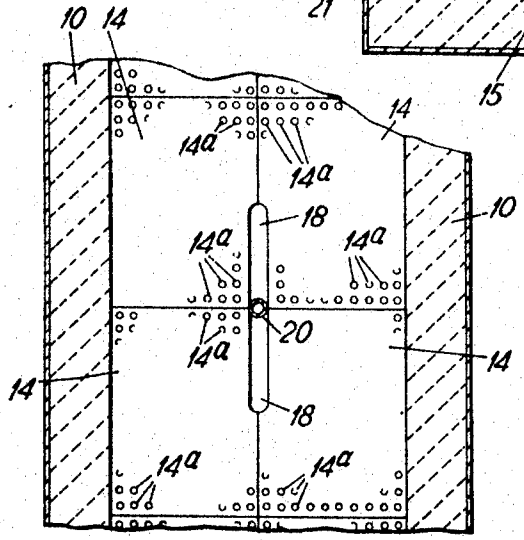


Fig. 3.

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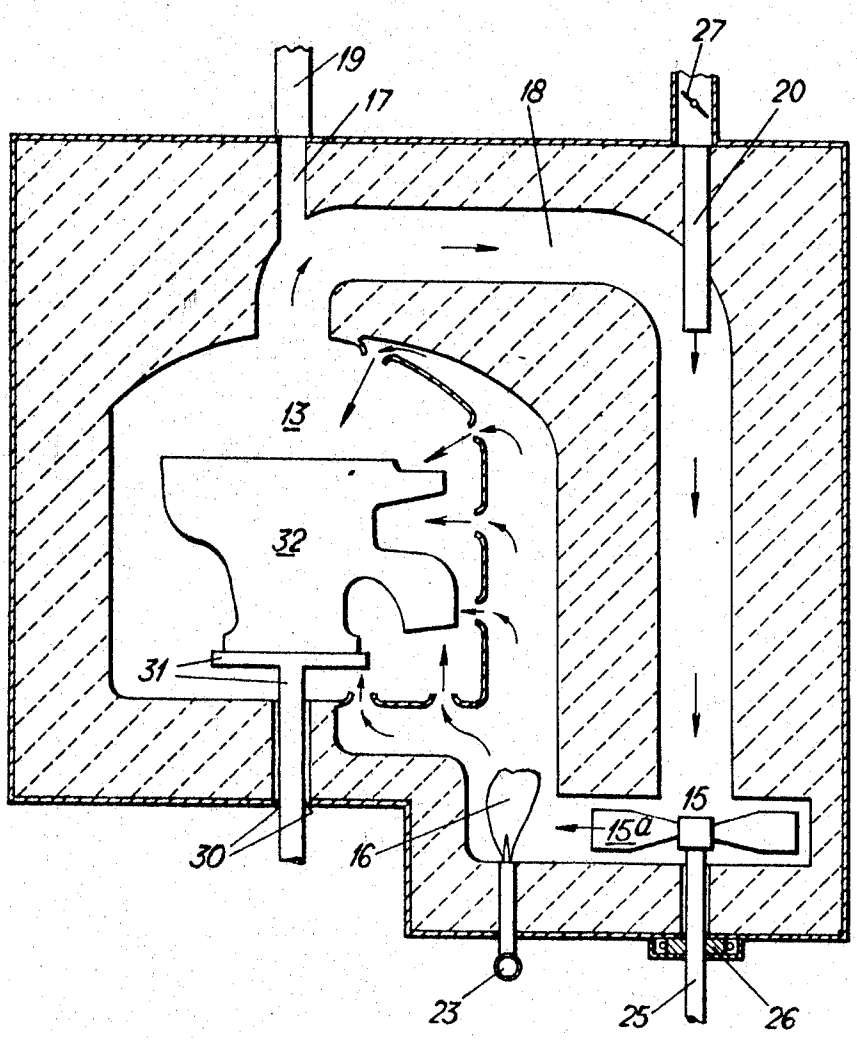
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KILNS WITH ATMOSPHERE PROPULSION

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Fig. 4.



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KILNS WITH ATMOSPHERE PROPULSION

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U.S. Cl. 263—40 11 Claims

ABSTRACT OF THE DISCLOSURE

In a kiln having propulsion means for creating circulation of hot atmosphere through the kiln, a quantity of cool air is admitted into the circulating system immediately ahead of the propulsion means so that the air acts to maintain the propulsion means at a lower temperature than the highest operating temperature of the kiln, the higher temperature being restored by the consumption of fuel in a combustion zone between the propulsion means and the kiln chamber in which the goods are fired.

BRIEF SUMMARY OF THE INVENTION

A kiln is provided with a chamber in which goods are to be fired, and a fan or similar means for promoting a circulation of hot atmosphere through the kiln chamber, a cool air inlet being arranged ahead of the fan to cool the fan so that it is not subjected to the high temperatures in the kiln chamber, inlet means for combustion gases or fuels being arranged between the fan and the kiln chamber so that combustion raises the temperature to the desired extent, some or all of the hot atmosphere from the kiln chamber being recirculated back to the fan.

This invention relates to kilns, especially but not exclusively kilns suitable for use in the firing of ceramic goods.

In kilns it is usually desirable to provide some form of propulsion means for creating additional circulation of hot atmosphere through the kiln to that obtained from the burning of fuel in air, either under pressure or natural convection. For the sake of convenience the atmosphere propulsion means will be herein referred to broadly as a fan.

In many types of kiln the temperatures involved are higher than ordinary fans can withstand. Kilns for firing ceramic goods, for instance, may require firing temperatures of the order of 1300° C. and this is higher than even heat-resisting metal fans are designed to experience. As a consequence various special types of fans are available, but these are costly and need replacement at frequent intervals. It would therefore be a great advantage to be able to use fans made of ordinary heat-resisting metals which will operate satisfactorily at temperatures up to about 1000° C.

This invention comprises a method of effecting the circulation of hot atmosphere in a kiln which will maintain such a lowered temperature in the region of the fan: the invention also includes kilns incorporating such a circulation system.

According to the present invention a method of effecting the circulation of hot atmosphere in a kiln includes the steps of admitting cool air into the circulation system ahead of the fan, thereby maintaining the fan at a lower temperature than the operating temperature in the kiln chamber, and admitting combustion gases or fuels into the system between the fan and an inlet to the kiln chamber, so that by combustion the temperature of the circulating atmosphere after it has left the fan is increased to the maximum firing temperature required before it enters the kiln chamber in which the goods are fired.

The invention also consists in a kiln having a fan chamber for promoting a circulation of hot atmosphere through the kiln, a kiln chamber in which the goods are fired, a cool air inlet ahead of the fan chamber so that the cool air acts to cool the fan, and an inlet duct for combustion gases or fuels between the fan and the kiln chamber, acting to raise the temperature of the circulating atmosphere after it has left the fan but before it enters the kiln chamber.

It will therefore be possible for the fan to be situated at a relatively cool region in the circulating system, and the special demands of very high temperatures on the design of the fans are avoided. For example the atmosphere temperature in the region of the fan may well be maintained some 400° C. lower than the maximum temperature in the combustion zone and firing chamber.

A method and means of carrying the invention into effect will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic diagram illustrating a circulation system.

FIGURE 2 is a transverse section through the hottest part of a tunnel kiln.

FIGURE 3 is a sectional plan on line III—III of FIGURE 2.

FIGURE 4 is a similar view to FIGURE 2 showing a modification.

The kiln structure comprises side walls **10**, a roof **11** and a base **12**, defining a tunnel-like enclosure. The enclosure comprises a kiln chamber **13** in which the goods are to be fired, a hearth **14** for supporting the goods, the hearth being constructed of refractory slabs having perforations **14***a* to allow hot air and radiant heat to pass upwards through them, a fan chamber **15** containing a fan **15***a*, and a combustion zone **16** below the hearth.

Hot atmosphere from the kiln chamber **13** is led off along a recirculation duct **18**, some proportion of the gases being rejected and allowed to escape through waste gas flues **17** to atmosphere at **19**. The duct **18** is of elongated cross-section and leads downwards through the hearth **14** into the fan chamber **15**. Before it reaches the fan, however, the recirculating gases receive an admixture of cool air from an intake duct **20** that is to say air at ambient room temperature. From the fan chamber the atmosphere is conducted by way of radial baffles or deflectors **21** to the combustion zone **16**. Injectors **22** inject gaseous or other fuel into the combustion zone from a fuel line **23**. The atmosphere is thus raised to the maximum operating temperature desired and enters the kiln chamber **13** by way of the perforations in the hearth. Additional fuel burners **24** are provided in the chamber **13**. The fan **16** is of a heat resisting type and is mounted on a heat resisting driving shaft **25** which passes through a heat-resisting gland, which may be packed with graphite,

indicated at **26**. The quantity of cool air admitted by way of the intake duct **20** is controlled by a valve **27**. Thermocouples are inserted in the kiln chamber **13** and in the combustion zone **16** for controlling the temperatures and the lower combustion zone controller may be fitted with an additional control point so that the burners in the combustion zone are automatically shut off if the combustion zone is at such a tempearture that combustion will not take place automatically.

Calculations have been made for a kiln on the lines illustrated. Hot atmosphere coming from the kiln chamber **13** is delivered along the recirculation duct **18** at a temperature of about 1100° C. the flow being about 5.84 pounds weight per minute; all the flows will be given in these units. Cool air is admitted through the intake duct **20** at about 2.4 pounds per minute. The temperature of the mixture is thus reduced to about 818° C. and the fan receives about 8.24 pounds per minute. The delivery from the fan is taken to the combustion zone **16** where the mixture receives combustion gas at about 0.16 pound per minute. The combustion raises the temperature to about 1300° C. per minute and about 8.4 pounds per minute at this temperature is delivered to the kiln chamber **13** by way of the perforations in the hearth **14**. Atmosphere leaves the chamber **13** after acting on the charge or load at a temperature of about 1100° C. and about 5.84 pounds per minute goes, as before-mentioned, back to the fan by way of the duct **18**, while about 2.56 pounds per minute is led off by way of the escape flue **17** leading to atmosphere **19**. If desired this waste may be fed to lower temperature zones of the kiln or may be diffused along the kiln towards the ends before being allowed to escape to atmosphere. The foregoing example shows that a circulation of 8.4 pounds per minute at any desired fan pressure may be obtained by this system compared with a flow of 2.56 pounds per minute burning the same fuel-air mixture in a conventional burner. In calculating the figures the slight variations which arise in practice due to radiation losses and gains from the brickwork or other structure of the kiln have been disregarded.

It will be evident that the general design of a kiln is not affected by the present improvements, and consequently this invention can be applied to many different types of kiln, enabling standard heat-resisting metal fans to be used in cases where hitherto this has been quite impracticable. For example the kiln illustrated has a hearth and it will be suitable for the goods to be made to travel through the kiln from one end to the other by supporting them on suitable bats or carriers. There will usually be several of the sections illustrated in the hottest zones of the kiln, but not in the cooler zones near the ends. In kilns suitable for the firing of large articles the goods may be carried through the kiln on a conveyor having supports extending upwards through a narrow slot **30** in the hearth of the kiln. The perforated hearth plate **14** may be omitted and a circulating atmosphere directed as required at the various parts of the articles. The supports **31** carrying the large articles such as **32** may be rotated by the support whilst the article is adjacent to the circulation inlet in order to heat the piece uniformly all over, rather than on the sides adjacent to the inlet, and the ware may move forward intermittently from one fan station to another so that for the major portion of the firing time it is being rotated whilst being heated by the circulating atmosphere.

The system may be fitted with an automatic temperature control to maintain the desired temperature of the atmosphere being admitted to the kiln chamber regardless of the temperature of the atmosphere being drawn from the kiln into the fan, the controller operating by regulation of the flow of fuel.

An automatic control may also be used to maintain a constant pressure of atmosphere flowing to the kiln chamber regardless of changes in operating conditions, and this controller may operate by controlling the fan speed.

When burning some fuels it may be necessary to mix a small proportion of the air required for combustion with the fuel before admission to the combustion chamber to assist flame propagation and to prevent cracking or carbonising in the burners. This will not affect the advantage to be gained from the system.

I claim:

1. The method of reducing the temperature in the atmosphere propulsion region of a kiln while maintaining a high temperature within and increasing the mass rate of atmosphere circulation through the firing chamber of the kiln, which comprises the steps of:

(a) discharging atmosphere from the propulsion region into the firing chamber,

(b) introducing fuel into the atmosphere discharged in (a) at a flow rate sufficient to raise the temperature of the atmosphere entering the firing chamber to a value substantially exceeding 1000° C.,

(c) recycling a major amount of the atmosphere discharged into the firing chamber back to the propulsion region, and

(d) introducing cool air into the propulsion region at a mass flow rate sufficient to burn the fuel introduced in (b) while maintaining the atmosphere temperature within the propulsion region substantially less than 1000° C.

2. The method as defined in claim **1** including the step of directing a minor amount of the atmosphere discharged into the firing chamber to waste, in which, the mass flow rate of said minor amount is substantially equal to the mass flow rate of cool air introduced in (d) plus the mass flow rate of fuel introduced in (b).

3. The method according to claim **2** wherein the cool air in (d) is introduced by gravity.

4. A kiln comprising in combination,

an enclosure divided into a firing chamber, a combustion chamber, and an atmosphere propulsion chamber, said atmosphere propulsion chamber having an inlet and having an outlet communicating with said combustion chamber, said combustion chamber communicating with said firing chamber,

atmosphere propulsion means including a bladed impeller located within said atmosphere propulsion chamber and constructed of material incapable of withstanding temperatures in excess of about 1000° C., said impeller being rotatable and positioned to induct gaseous atmosphere through said inlet and discharge it through said outlet into said combustion chamber,

means for introducing fuel into said combustion chamber at a mass flow rate sufficient to maintain a temperature of atmosphere entering said firing chamber substantially in excess of 1000° C.,

conduit means for recycling at least a major portion of the atmosphere entering said firing chamber back to said atmosphere propulsion chamber, and

means for introducing external cool air into said atmosphere propulsion chamber at a mass flow rate sufficient to maintain the atmosphere temperature within said atmosphere propulsion chamber substantially less than 1000° C.

5. The kiln according to claim **4** wherein said atmosphere propulsion chamber is located below said combustion chamber, the last mentioned means comprising a conduit extending downwardly to said atmosphere propulsion chamber to feed cool air by gravity thereto.

6. A kiln as claimed in claim **4** having a hearth in the kiln above the fan chamber, the hearth having perforations, the fan serving to deliver hot atmosphere through the perforations into the kiln chamber by way of the combustion zone.

7. A kiln as claimed in claim **6** having baffles positioned to direct the hot atmosphere from the fan chamber into the combustion zone.

8. A kiln as claimed in claim 4 which is of tunnel formation, at least two such circulation systems being arranged in the hottest part of the tunnel.

9. A kiln as claimed in claim 4 including means for controlling the temperature and pressure of the atmosphere admitted to the kiln chamber.

10. A kiln as claimed in claim 4 including means for controlling the quantity of cool air admitted to the recirculating atmosphere.

11. A kiln as claimed in claim 4 having a kiln hearth, the hearth having a narrow slot along it, and travelling supporting devices for articles to be fired extending upwards through the slot.

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U.S. Cl. X.R.

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