Aug. 7, 1962 W. SCHMIDT 3,048,686

TUNNEL FURNACE WITH VERY HIGH FREQUENCIES TO HEAT SUBSTANCES, FOR EXAMPLE, FOODSTUFFS

Filed Oct. 14, 1959 2 Sheets-Sheet 1

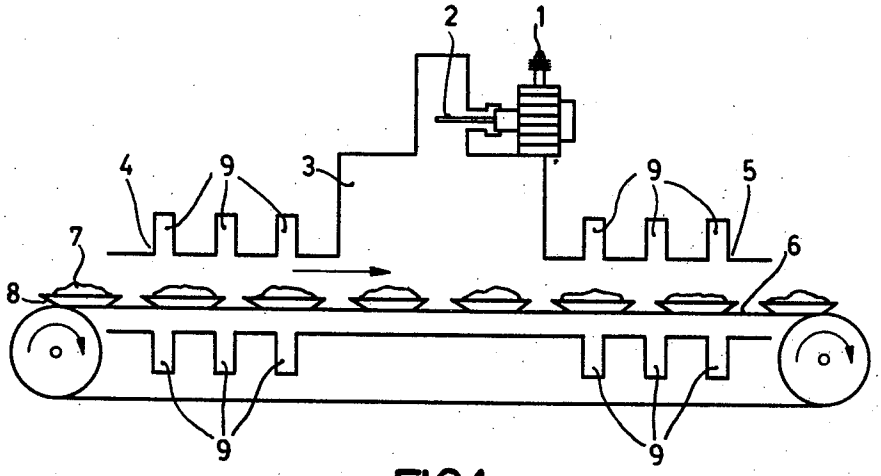


FIG.1

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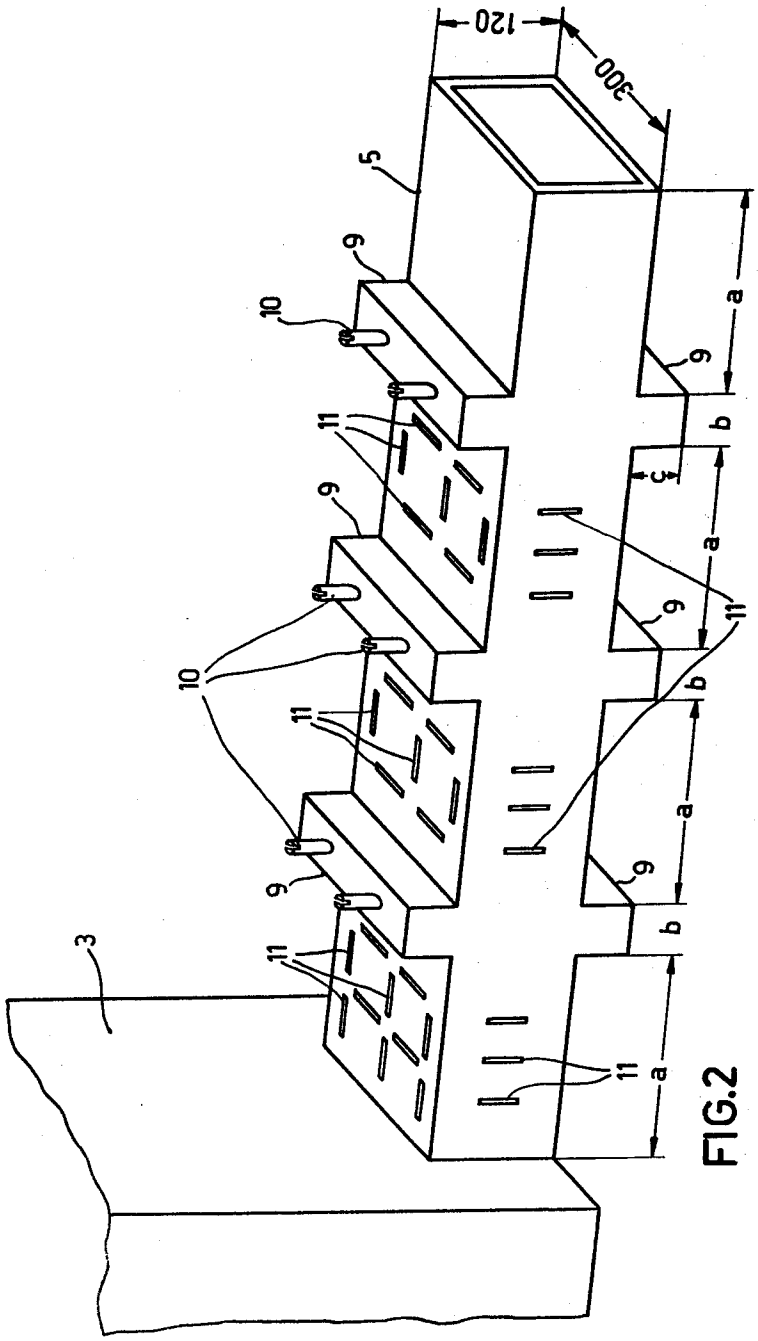


FIG.2

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TUNNEL FURNACE WITH VERY HIGH FREQUENCIES TO HEAT SUBSTANCES, FOR EXAMPLE, FOODSTUFFS

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10 Claims. (Cl. 219—10.55)

The invention relates to a tunnel furnace for very high frequencies to heat substances, for example, foodstuffs which furnace is suitable for use in large kitchens or in industry as a drying device for powdery or solid substances.

With such furnaces difficulties arise in that on the one hand the inlet and outlet openings must be sufficiently large to transport the substance to be heated, as the case may be with the containers thereof, through the treating space proper, whereas on the other hand these openings must be provided with means to prevent stray radiation from being emitted.

With these furnaces it is known to use inlet and outlet ducts with a comparatively small inner diameter as compared with the wavelength of the oscillations employed, so that an irradiation of the high-frequency oscillations is avoided. It is obvious that only bodies of small dimensions can be heated in such furnaces.

There are furthermore known devices for automatically controlled dielectric heating of industrial products, the working space being formed by a hollow waveguide adapted to the operational frequency, of which the working space, the inlet and the outlet must be screened for the micro-wave energy by a pair of λ/4 closures each. If the cross sections of the inlet and the outlet are smaller than the operational wavelength, a partial screening may be expected, whereas otherwise, i.e. with larger sections of the inlet and outlet such a construction is not capable of providing an appreciable screening and in the no-load condition substantially no screening is obtained; moreover the screening bands are so narrow that frequency stabilisation is required.

The furnace according to the invention does not exhibit these disadvantages. It permits of using inlet and outlet ducts of which the sections are a multiple of the operational wavelength. Moreover, even in the no-load condition of the conveyor belt, a high-frequency screening can be realized in an adequately wide frequency range.

In accordance with the invention the inlet and outlet ducts for the substance to be heated in the tunnel furnace for heating substances, for example, foodstuffs, in which the diameter of the inlet and outlet ducts exceeds the operational wavelength constitute screenings for the waverange by providing, on two opposite walls of the ducts, a plurality of, for example, three pairs of λ/4-closures.

Further particulars of the invention will be evident from the following description of the embodiment shown in the figures.

FIG. 1 shows diagrammatically a sectional view of the device according to the invention and

FIG. 2 shows the outlet duct on an enlarged scale as compared with FIG. 1.

Referring to FIG. 1, the magnetron oscillator is designated by **1**. By way of radiator **2** the high frequency is introduced into the treating space **3** proper. At the treating space **3** are provided the inlet duct **4** and the outlet duct **5**. The conveyor belt **6** traverses the two ducts **4** and **5** and transports the substance **7** to be treated, which is supplied in this embodiment on dish-shaped supports **8**, into the treating space **3**. In the embodiment

shown in FIG. 1 the upper and lower walls of the ducts **4** and **5** are provided with duct portions **9**, the so-called λ/4 closures, operating as blocking filters.

FIG. 2 shows three pairs of λ/4 closures, provided on the upper side and on the lower side of the duct **5**. In this device both the width of the screened frequency band and the damping may be increased by using a larger number of these λ/4 closures. The λ/4 closures **9** may be considered as series-connected duct portions for a qualitative explanation of the operation. With correct tuning the tuning capacity, owing to transformation via these λ/4 closures, constitutes a resistance connected in series with the main conductor in the no-load state and hence an interruption of the conductor.

The λ/4 closures may, as an alternative, constitute parallel resistances on the two other walls of the ducts **4** and **5**.

A wide band is obtained particularly by relative detuning of the separate λ/4 closures; the said width must, however, owing to the high quality of microwave circuits, not exceed about 1% of the medium frequency of the band, i.e. the operational frequency of the oscillator.

The ducts **4** and **5** may be provided, in addition, on the inner sides with dissipating substances, such as graphite, so that any non-reflected, residual microwave energy is dissipated by damping in the form of heat in the damping layers.

The inlet and outlet ducts may, as an alternative, be provided with known grid rods, which produce an additional damping.

FIG. 2 shows, in a perspective view, on an enlarged scale, the outlet duct **5**. With an operational frequency of 2400 mc./s. the ducts may have the height and width of 120 and 300 mms. respectively, indicated in FIG. 2. The cross sectional area of these ducts may, however, amount to 150 x 300 or 50 x 500 mms.^{2}.

The further sizes indicated in FIG. 2, *a*, *b* and *c* are the following:

$$a = n\frac{\lambda}{2}$$

where n equals an intgeral multiple 1, 2, 3, . . . etc.

$$b = n\frac{\lambda}{4}$$

where *n* equals an integral odd multiple 1, 3, 5, . . . etc.

$$c = n\frac{\lambda}{4}$$

where *n* equals an integral odd multiple 1, 3, 5, . . . etc.

Reference **10** designates the adjusting screws provided at the λ/4 closures.

It is advisable to provide, in the walls of the ducts **4** and **5**, a few slots **11**, which are not essential, in principle, for the operation of the device and which provide that in the ducts, in spite of the inhomogeneity, only one type of wave, for example, the H_{30}-wave occurs, which is reflected in the working space **3** by correct tuning. In the case of a change-over to a different, possible wave type (for example H_{40}), the tuning to the H_{30}-wave would be inoperative in the hollow waveguide owing to the change in wavelength λ_H, so that an adjustment to the new wave type would be required.

In the embodiment shown in FIG. 2 the slots **11** may have a width of 3 mms. and a length of 40 mms.

The slots may be replaced by rods, which are arranged on the inner sides of the walls.

What is claimed is:

1. A microwave heating system comprising means for

providing therein an electromagnetic field for heating substances located therein, and access means disposed from the exterior of said system to said field adapted for passage of said substances, said access means comprising at least one waveguide member having a hollow cross-section with one inner dimension thereof greater than the operational wavelength of said system to provide said passage, and a plurality of substantially aligned quarter-wavelength enclosures having substantially a predetermined integral multiple of half-wavelength spacings therebetween associated with said waveguide member, said quarter-wavelength enclosures being disposed on each of two predetermined opposing surfaces of said waveguide member, the quarter-wavelength enclosures of one of said opposing surfaces being substantially aligned with the quarter-wavelength enclosures of the other of said opposing surfaces.

2. A microwave heating system comprising means for providing therein an electromagnetic field for heating substances located therein, and access means disposed from the exterior of said system to said field adapted for passage of said substances, said access means comprising at least two waveguide members to provide inlet and outlet passages, respectively, for said substances, each of said waveguide members having a hollow cross-section with one inner dimension thereof greater than the operational wavelength of said system, and a plurality of substantially aligned quarter-wavelength enclosures having substantially a predetermined integral multiple of half-wavelength spacings therebetween associated with each of said waveguide members, the respective said quarter-wavelength enclosures associated with each of said waveguide members being disposed on each of two predetermined opposing surfaces of the associated waveguide member, the quarter-wavelength enclosures of one said opposing surface of each of said waveguide members being substantially aligned with the quarter-wavelength enclosures of the respective other said surface.

3. A microwave heating system according to claim 2, wherein said operational frequency of said system is approximately 2400 megacycles and each of said cross-sections has a width of approximately 300 millimeters and a maximum height range of 120 to 150 millimeters.

4. A microwave heating system according to claim 2 wherein said waveguide members further comprises means for dampening the non-reflected, resisual microwave energy present in said waveguide members.

5. A microwave heating system according to claim 4 wherein said dampening means comprises a coating of heat dissipating substances disposed on the inner surfaces of each of said waveguide members.

6. A microwave heating system according to claim 5 wherein said coating comprises at least one layer of graphite.

7. A microwave heating system according to claim 4 wherein said dampening means comprises grid rods disposed within each of said waveguide members.

8. A microwave heating system according to claim 2 wherein each of said waveguide members further comprises means for producing a given wave type.

9. A microwave heating system according to claim 7 wherein said wave type producing means comprises slots disposed in a predetermined manner along the surfaces of each of said waveguide members.

10. A microwave heating system according to claim 8 wherein said wave type producing means comprises rods disposed within the inner surfaces of each of said waveguide members.

References Cited in the file of this patent

UNITED STATES PATENTS

2,364,526	Hansell	Dec. 5, 1944
2,473,724	Okress et al.	June 21, 1949
2,500,752	Hanson et al.	Mar. 14, 1950
2,627,571	Hiehle et al.	Feb. 3, 1953
2,649,578	Albersheim	Aug. 18, 1953
2,683,238	Millman	July 6, 1954
2,684,469	Sensiper	July 20, 1954
2,685,065	Zaleski	July 27, 1954
2,820,127	Argento et al.	Jan. 14, 1958
2,868,939	Pound	Jan. 13, 1959