# United States Patent [19]

**Gorobets et al.**

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[54] **JET MILL**


[76] Inventors: **Vladimir Ivanovich Gorobets; Larisa Zhanovna Gorobets,** both of ulitsa Sevastopolskaya, 26a, kv. 5; **Anatoly Alexandrovich Ivanov,** prospekt K. Marxa 13/15, kv. 29; **Georgy Petrovich Tropin,** ulitsa Bazhova 28, kv. 10, all of Dnepropetrovsk; **Veniamin Ivanovich Chirkov,** ulitsa Planetnaya 14, kv. 28, Moscow; **Veniamin Viktorovich Konstantinov,** ulitsa Fadeeva 59, kv. 70, Volgograd; **Viktor Deomidovich Belyaev,** ulitsa Kaverina, 14, kv. 1, Dnepropetrovsk, all of U.S.S.R.



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[51] **Int. Cl.** ..... **B02c 19/06**

[58] **Field of Search** ..... 241/39, 79.1, 80; 219/382



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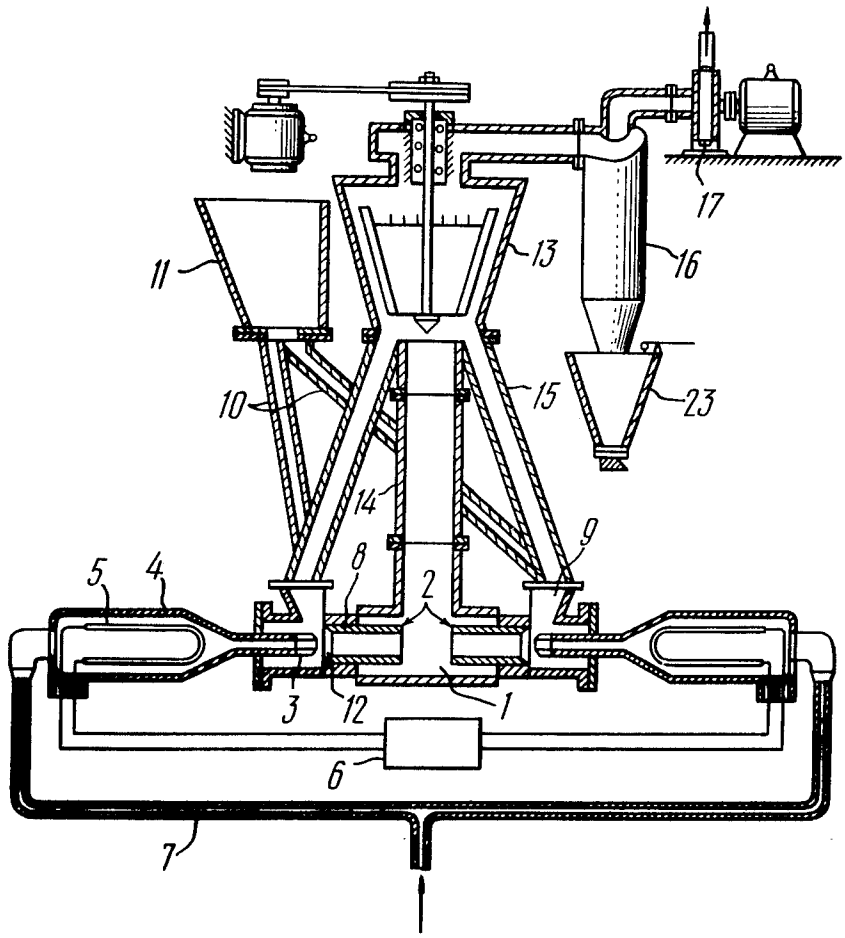
*Primary Examiner*—Granville Y. Custer, Jr.
*Assistant Examiner*—Craig R. Feinberg
*Attorney, Agent, or Firm*—Holman & Stern



[57] **ABSTRACT**

The improvement relates to the heater of compressed gas which is delivered from the heater to the nozzles of a jet mill, the flow of compressed gas escaping from the nozzles drawing in and accelerating the particles of the material being comminuted. The improvement consists in that each nozzle of the jet mill communicates by way of the inlet thereof with a chamber housing a heater element. The chambers communicate with a source of compressed gas supply. Compressed gas is delivered to the nozzles through a chamber housing a heater element.


**4 Claims, 3 Drawing Figures**



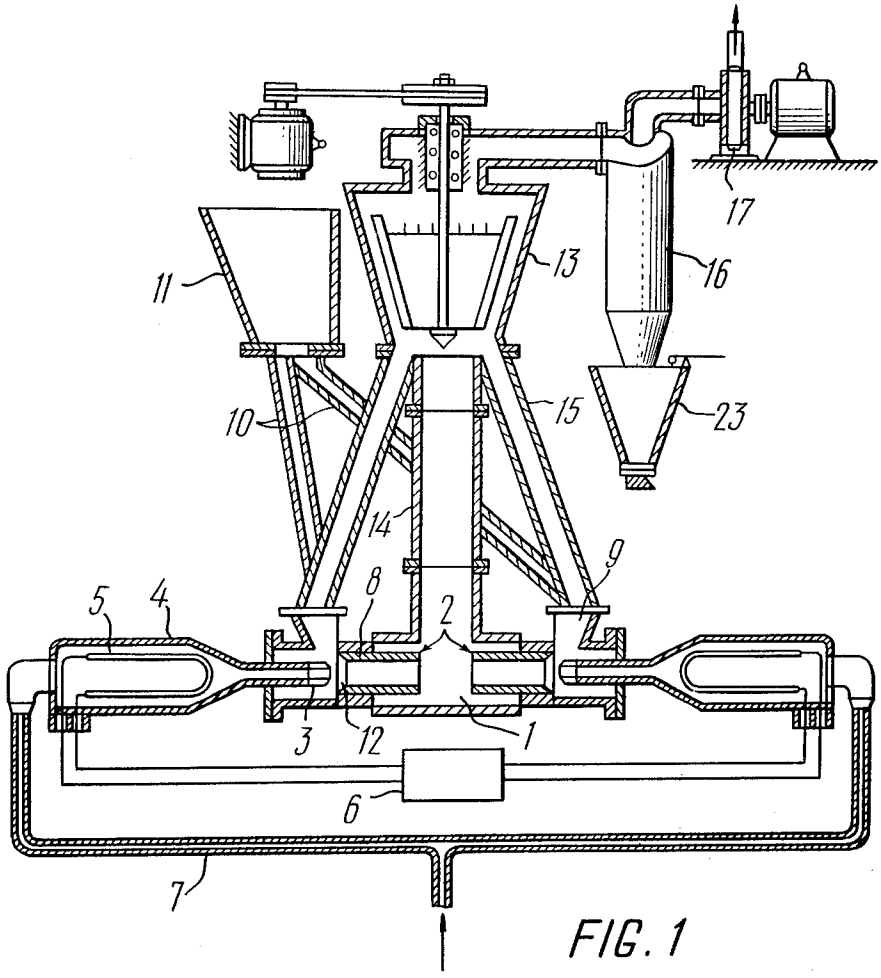



FIG. 1

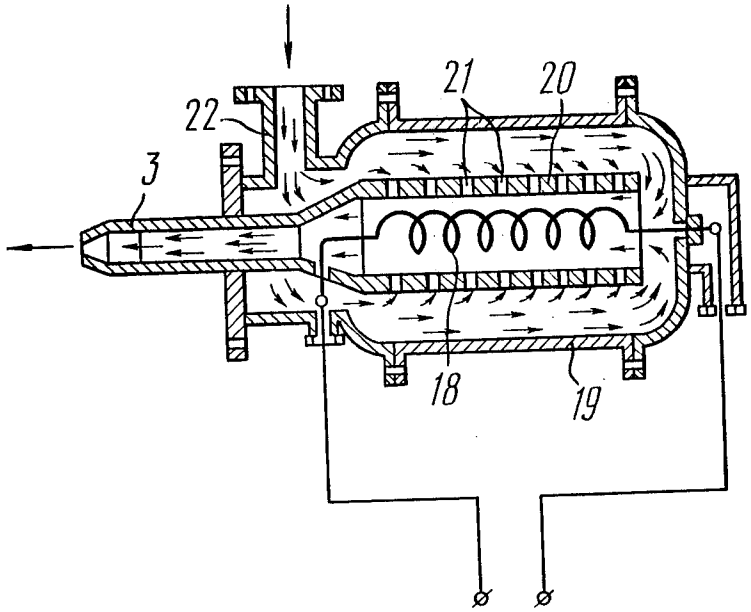



FIG. 2

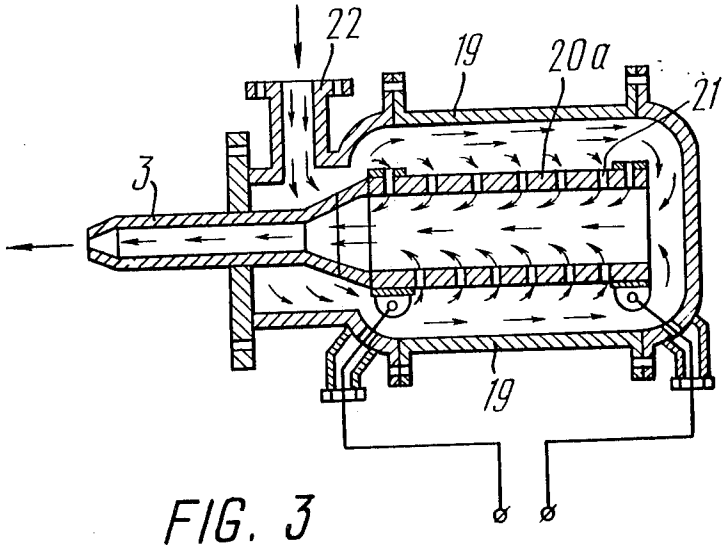



FIG. 3

# JET MILL

## BACKGROUND OF THE INVENTION

The invention relates generally to grinding equipment and more particularly to jet mills, wherein the material is ground through the collision of the particles thereof accelerated by the jets of compressed gas or vapor forced through the nozzles.

At present jet mills have gained wide acceptance.

It is common knowledge that the main working component of a jet mill is a milling chamber with built-in injectors which draw in, accelerate and deliver the particles of the material to be ground to the milling chamber.

Jet mills also incorporate a classifier for sizing the particles of the material in the course of grinding, a precipitator separating the ground particles of the material from the stream of exhaust gas, as well as an exhaust device venting the exhaust gas from the mill after the gas has been stripped of the comminuted material.

The compressed gas which forms the working flow accelerating the particles of the material being comminuted is supplied to the injector nozzles from a compressed gas source, such as a low-pressure compressor or a compressed gas vessel.

The working flow in jet mills is frequently formed by the exhaust vapor from heat and electric power plants delivered through special pipelines. In such a case the heat and electric power plant itself is the source of the working medium.

Besides, those skilled in the art know of a jet mill which employs fuel combustion chambers as the source of compressed gas the chambers being integral components of the mill and communicating with the nozzles of the injectors (see, for example, U.S.S.R. Author's Certificate No. 314,545, Cl. Bo2c 1906). Naturally, in this case the products of fuel combustion constitute the medium which forms the working jet.

However, the jet mills using heat and electric power plants or compressor units as their source of compressed gas feature a serious drawback which consists in their excessive power consumption caused by the need to ensure a high compression ratio of the gas, since in this case the particles are accelerated primarily by the potential energy of a comparatively low-temperature compressed gas whose heat energy is insufficient for particle acceleration. Another disadvantage of the jet mills employing vapor as the working medium is the fast rate of wear of the mill parts due to the high corrosivity of vapor.

Among the disadvantages of the jet mills employing the products of fuel combustion as their source of compressed gas note the fast rate of wear of the equipment due to the high corrosivity of the fuel combustion products, the difficulties involved in the temperature control, the need for on-site fuel stocks and the pollution of the atmosphere with the combustion products.

## SUMMARY OF THE INVENTION

It is an object of the present invention to obviate or mitigate the foregoing diadvantages of the known jet mills.

The primary object of the invention is to improve the system of heat supply to the compressed gas so as to avoid the need for fuel combustion but without raising the compression ratio of the gas forming the working jet.



Other objects of the invention are to avoid using corrosive working media, such as combustion products or vapor, prolong the useful life of the jet mills, simplify maintenance, rule out the need to have fuel stocks and eliminate the menace of air pollution with the combustion products.

The present invention contemplates improving the system of heat supply to the compressed gas so as to avoid the need for fuel combustion but without raising the compression ratio of the gas forming the working jet.

Accordingly there is provided a jet mill in which the material is ground through the collision of its particles accelerated and delivered to the milling zone by the jets which are formed as compressed gas is fed through the nozzles, wherein, in accordance with the invention, each nozzle communicates by way of the inlet thereof with a chamber housing a heater element and communicating with a source of compressed gas supply.

In order to improve the efficiency of heat exchange between the gas and the heater element, as well as to prolong the useful life of the heater element, the latter should be preferably placed inside the chamber in a perforated sleeve, whereof one end is connected to the nozzle, while the other end of the sleeve should communicate with the cavity of the chamber, and the pipe supplying compressed gas is built into the section of the chamber opposite that where the sleeve end communicating with the chamber cavity is disposed.

With the foregoing embodiment of the chamber, the bulk of compressed gas supplied thereinto is delivered to the heater element through the open end of the sleeve, with the inner walls of the chamber being exposed to the flow of cold gas. This will permit avoiding the need to construct the chamber walls from a high-temperature material and will additionally minimize heat losses through the chamber walls.

A part of the compressed gas delivered into the chamber will penetrate into the sleeve of the heater element through the perforations in the sleeve walls. The gas inflow penetrating into the sleeve through the perforations in its walls will decelerate the main flow inside the jacket, thereby raising the efficiency of heat exchange between the compressed gas being heated and the heater element. Furthermore, with the slowing-down of the main flow, the rate of corrosion of the heater element is reduced resulting in its lower rate of wear.

Another design of an air-pressure mill is possible, according to which the perforated sleeve itself is a heater element. In this case the heat exchange in the chamber housing the heater element is intensified. However, with the heater element removed from inside the sleeve, the aerodynamic drag is reduced.

## BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described in detail, by way of example, with reference to the accompanying drawings, wherein:

FIG. 1 is a schematically illustrated elevation view of a jet mill in accordance with the invention;

FIG. 2 is a preferred embodiment of a chamber housing a heater element enclosed in a perforated jacket; and

FIG. 3 is another embodiment of a chamber with a heater element formed as a perforated sleeve.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The jet mill of this invention incorporates a milling chamber **1** (FIG. **1**) with injectors **2**, whereof nozzles **3** communicate by way of the inlets thereof with chambers **4** housing electric heater elements **5** supplied from a current supply source **6**. The chambers **4** communicate via pipes **7** with a source (not shown) of compressed gas supply, a low-pressure compressor or a compressed gas vessel. Along with the nozzle **3**, the injector also incorporates a mixing sleeve **8**. The nozzles **3** are disposed inside inlet chambers **9** for the material to be ground. The inlet chambers **9** communicate via pipes **10** with a feed hopper **11** and are disposed adjacent the entrance port **12** of the mixing sleeves **8**.

The jet mill also incorporates a comminuted material classifier **13** which communicates via a pipe **14** with the milling chamber **1** and via pipes **15** with the corresponding inlet chambers **9**. The outlet of the classifier **13** is connected with a precipitator **16** serving to separate the comminuted material from the gas stream.

The precipitator **16** is coupled to an exhaust device **17** venting the exhaust gas from the mill.

In order to improve the efficiency of heat exchange between the heater element and the gas to be heated, and also to prolong the useful life of the heater element, the chamber housing the heater element should be preferably constructed as described hereinafter with reference to FIG. **2**.

A heater element **18** (FIG. **2**) is disposed inside a chamber **19** in a sleeve **20** with perforations **21**. The sleeve **20** communicates by way of one end thereof with the nozzle **3** of the injector **2**. By way of its other, open, end the sleeve **20** communicates with the cavity of the chamber **19**. A pipe **22** is built into the chamber **19** to supply compressed gas, the pipe **22** being disposed in that section of the chamber **19** which is opposite the section where the end of the sleeve **20** communicating with the chamber cavity is disposed.

The mill operates in the following manner. Compressed gas is supplied via the pipes **7** to the chamber **4** (FIG. **1**) or **18** (FIG. **2**) and is heated in flowing around the heater element **5**.

In the other embodiment, the compressed gas is supplied to the chamber **19** through the pipe **22** and flows in the chamber as indicated by the arrows. The bulk of gas passes in the space between the walls of the chamber **19** and the sleeve **20** and enters the sleeve **20** through the open end thereof. A smaller portion of the heated gas finds its way into the sleeve **20** through the perforations **21**. Such a pattern of compressed gas transfer in the chamber **19** provides for the most efficient heat exchange between the gas and the heater element **18**, safeguards the walls of the chamber **19** against overheating and accordingly reduces the amount of heat losses through the walls of the chamber **19**. The gas flows entering the sleeve **20** through the apertures **21** decelerate the main compressed gas flow through the open end of the sleeve **20**, thereby improving the efficiency of the heat exchange and slowing down the rate of corrosion of the heater element surface.

The entire mass of gas is delivered from the sleeve **20** to the nozzles **3**, expands therein and escapes therefrom to the mixing sleeves **8** at a high velocity. During this process the material to be ground is drawn in from the inlet chambers **9** by the high-speed gas jet escaping from the nozzles **3** and, entering the mixing sleeves **8**, acquires a velocity equal or close to that of the gas. Supplied at a high velocity to the milling chamber **1**, the particles of the material collide with one another and with the walls of the milling chamber **1**, thereby being ground.

Having lost their speed, the particles are swept by the gas stream via the pipe **14** to the classifier **13** where they are sized. The oversize is returned via the pipes **15** to the inlet chambers **9**, mixed therein with the starting material, whereupon it is recycled. The particles comminuted to a required size are carried by the gas stream to the precipitator **16**, where they are precipitated and discharged through a bin **23**. The gas flow stripped of the particles of the comminuted material is vented by the exhaust device to the atmosphere.

In case the heater element is formed as a sleeve **20***a* (FIG. **3**) with perforations **21**, the pattern of compressed gas transfer inside the chamber **19** is unaffected for all practical purposes, but the heat exchange between the compressed gas heated in the chamber **19** and the sleeve **20***a* serving as the heater element is intensified to the utmost.

We claim:

**1.** A jet mill, wherein the material to be comminuted is ground through the collision of its particles accelerated by gas jets, comprising: a milling chamber; nozzles being disposed within said chamber and having outlets thereof directed toward the interior of said chamber; additional chambers communicating via pipes with a source of compressed gas and being connected directly to said nozzles; heater elements being disposed in said additional chambers; a classifier sizing the particles and communicating via pipes with said milling chamber; a precipitator being disposed downstream of said classifier and communicating therewith; an exhaust device being disposed downstream of said precipitator and venting exhaust gas from the mill; and a feed hopper communicating with said milling chamber at the points where said nozzles are disposed therein.

**2.** A jet mill as claimed in claim **1**, wherein each of said additional chambers communicating with the source of compressed gas houses a perforated sleeve associated with each heater element; each said sleeve communicating at one end thereof with the corresponding nozzle and at the other end with the chamber housing the sleeve; and wherein pipes, whereby said additional chambers communicate with said sources of compressed gas, are built into that section of said additional chambers which is opposite the section where said sleeve communicates with said chamber and adjacent the associated nozzle.

**3.** A jet mill as claimed in claim **2**, wherein each said sleeve is the heater element.

**4.** A jet mill as claimed in claim **2**, wherein each said sleeve encloses the associated heater element.

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