May 22, 1956 J. H. BRADFORD 2,746,735

MATERIAL MIXING BURNER FOR PROCESSING FURNACES

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FIG. 1.

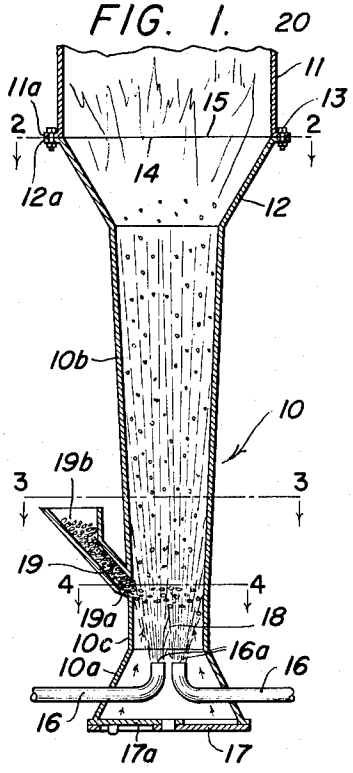
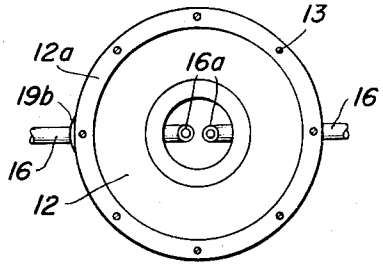


FIG. 2.



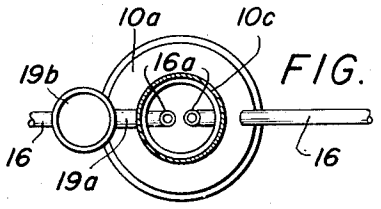


FIG. 3.

FIG. 4.

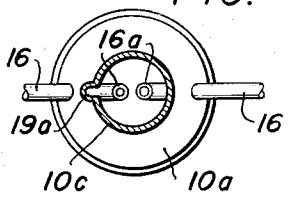


FIG. 5.

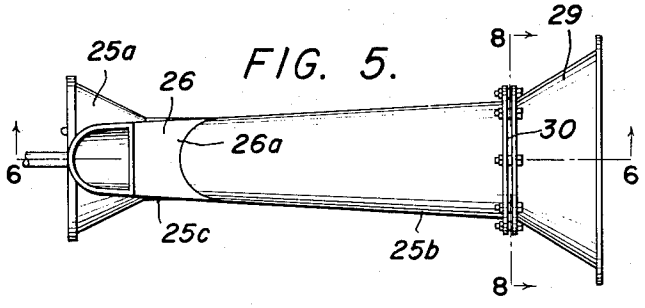
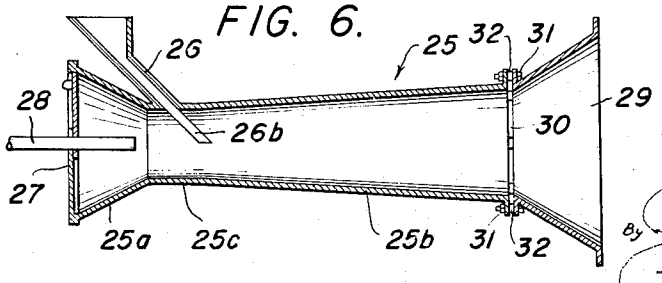


FIG. 6.



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MATERIAL MIXING BURNER FOR PROCESSING FURNACES

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FIG. 7.

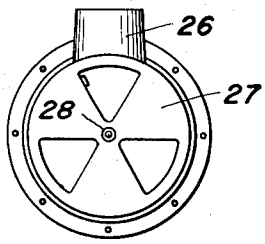


FIG. 8.

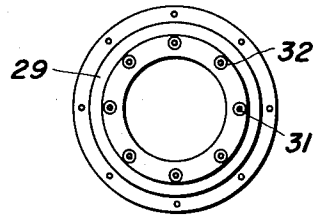


FIG. 9.

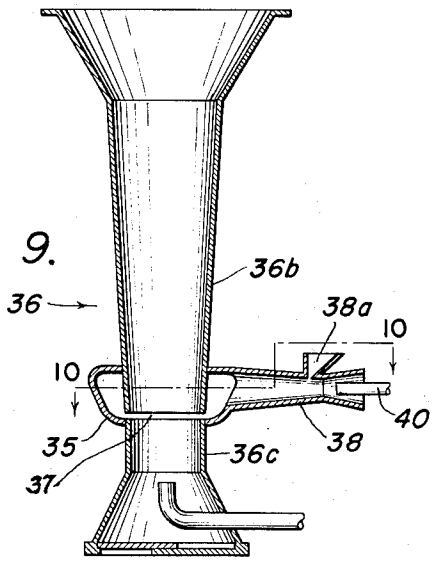


FIG. 11.

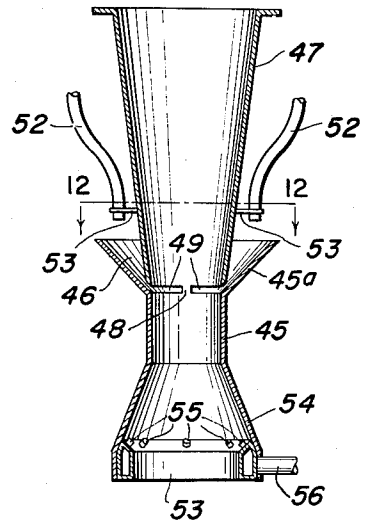
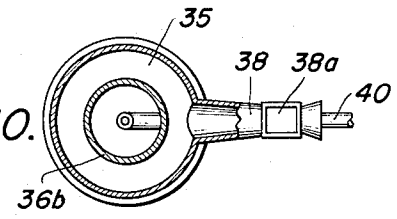


FIG. 10.



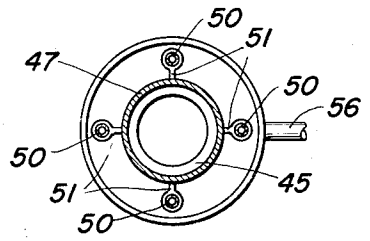


FIG. 12.

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2,746,735

MATERIAL MIXING BURNER FOR PROCESSING FURNACES

James H. Bradford, Tooele, Utah, assignor of one-half to Combined Metals Reduction Company, a corporation of Utah

Application October 4, 1951, Serial No. 249,660

11 Claims. (Cl. 263—21)

This invention relates to industrial burners for use in material processing furnaces.

The present application constitutes a continuation in part of my copending application Serial No. 44,194, filed August 13, 1948, for Processing Furnace for Discrete Solids, now Patent No. 2,639,132, wherein is disclosed and claimed a novel apparatus for heat processing such materials as perlitic rock in the manufacture of, for example, perlite insulating granules.

In accordance with my invention, I have found that heat processing furnaces for treating a variety of materials in the production of desired end products become considerably more efficient in operation if the material to be treated is introduced into the furnace by means of a Venturi tube, functioning as a burner. Not only is material feed accomplished rapidly and conveniently, but there is a very effective mixing action with the inflowing fuel and combustion-sustaining air, which makes for a very desirable and advantageous uniformity of heat treatment.

Whether the burner of the invention is installed in a vertical furnace or in a horizontal furnace, great improvements in processing results have been achieved. Where installed in connection with a vertical furnace, as specifically set forth in my above-referred-to copending application for patent, additional beneficial results are achieved by reason of the very effective, upwardly acting, dynamic column existing throughout the complete cross-sectional area of the burner.

Principal objects of my invention, therefore, are:

To effect superior results in the heat processing of finely divided materials in material processing furnaces;

To provide for thorough and effective mixing, with fuel and a combustion supporting fluid, of finely divided material particles to be processed;

To provide a simple, compact, and efficient burner unit for material processing furnaces, whether the latter be of vertical, horizontal, or of other type.

The Venturi tube burner of the invention embodies a Venturi tube of usual formation, that is to say, having oppositely directed truncated cones or the like interconnected by a relatively short and constricted throat portion of substantially cylindrical or like formation. Feed means for the supply of finely divided material is directed into such Venturi tube, preferably within or substantially at the constricted throat portion thereof, whereby finely divided material to be heat processed in the furnace proper is thoroughly and effectively mixed with fuel and combustion supporting fluid to form a dynamic suspension, immediately prior to actual combustion. In certain preferred embodiments of the burner, a divergent junction member of conical or like formation is secured to the discharge cone of the Venturi tube to provide an ignition zone of lower stream velocity than the Venturi tube proper.

Further objects and features of the invention will become apparent from the following detailed description

of the several preferred specific embodiments thereof illustrated in the accompanying drawings.

In the drawings:

Fig. 1 represents a fragmentary, central, vertical section taken through the lower portion of a material processing furnace equipped with the burner of the invention, only a portion of the furnace proper being shown;

Fig. 2, a horizontal section taken on the line 2—2 of Fig. 1;

Fig. 3, a horizontal section taken on the line 3—3 of Fig. 1;

Fig. 4, a horizontal section taken on the line 4—4 of Fig. 1;

Fig. 5, a top plane view of a somewhat different embodiment of the invention adapted for use with a horizontal processing furnace;

Fig. 6, a longitudinal vertical section taken on the line 6—6 of Fig. 5;

Fig. 7, an end elevation looking from the left as respects Fig. 5;

Fig. 8, a vertical transverse section taken on the line 8—8 of Fig. 5;

Fig. 9, a view corresponding to that of Fig. 1, but illustrating, per se, a somewhat different embodiment of the invention;

Fig. 10, a horizontal section taken on the line 10—10 of Fig. 9, certain parts appearing in top plan;

Fig. 11, a view corresponding to that of Fig. 9, but illustrating a still different embodiment of the invention; and

Fig. 12, a horizontal section taken on the line 12—12 of Fig. 11.

Referring to the drawings: The embodiment of Figs. 1 through 4 is adapted for use with a vertical processing furnace.

In the form illustrated, the burner comprises a Venturi tube, indicated generally **10**, having a short, convergent, inlet member **10***a* of truncated, conical formation; a relatively long, divergent, outlet member **10***b* of truncated, conical formation; and a short, constricted, throat member **10***c* of cylindrical formation, interconnecting the inlet and outlet members.

For the purpose of merging the discharge end of the outlet member **10***b* of the Venturi **10** with the larger open lower end of a furnace tube **11**, and to provide an ignition zone immediately in advance of the combustion zone proper of the furnace, a divergent junction member **12** is secured to the discharge end of the outlet member **10***b* in any suitable manner, for example, by welding. Such junction member **12** preferably possesses an externally extending, circumferential flange **12***a* to provide for conveniently attaching the burner to a similar flange **11***a* at the lower end of the furnace tube **11**. The attachment is advantageously accomplished by a series of bolts **13**.

As so constructed and attached to the furnace tube **11**, the burner of the invention provides an upwardly divergent firing tube having an outlet **14** which is substantially coextensive in area and configuration with the firing orifice **15** of the combustion chamber of the furnace. It should be noted that the walls of the burner, including the junction member **12**, slope at an angle to the horizontal greater than the minimum angle of repose of the material being processed, so that no particles of material can collect on inner surfaces of the burner during operation of the furnace.

The burner is provided with means for the supply of fuel to the inlet member thereof. Such means preferably embodies one or more jet orifices directed upwardly toward the Venturi throat, for the purpose of injecting atomized fuel into the flow stream of com-

bustion supporting fluid passing through the burner—where such fluid is supplied under pressure to the lower open end of the burner—or for the purpose of inspirating such a stream, where the lower open end of the burner is merely open to the atmosphere, as shown. The fuel supply means may be one or more jet pipes **16** having respective jet orifices **16***a*, or may be an annulus having a plurality of jet openings, as in the embodiment of Fig. 11. Gas is preferred as the fuel, but oil or a powdered solid fuel may also be employed under suitable conditions of introduction. Compressed air is advantageously utilized as an atomizing agent.

In the instant embodiment, a shutter or damper arrangement **17**, having an adjustable closure member **17***a*, controls the quantity of air inspirated by the burner. The jet **18** of atomized fuel and the air inspirated thereby effect a vigorous mixing action within the Venturi throat.

For the purpose of utilizing this vigorous mixing action to best advantage, I provide means for introducing finely divided material to be processed, into said Venturi throat. Such means advantageously takes the form of a steep chute **19**, which levels out at a discharge portion **19***a* directed across the Venturi throat, and which includes a hopper portion **19***b* for receiving finely divided material to be processed from any suitable supply of same.

In operation, finely divided material to be processed is projected from the discharge portion **19***a* of the chute **19** into and across the stream of atomized fuel and combustion supporting fluid passing upwardly through the Venturi throat, where, by reason of the high velocity of the stream, it is intimately and substantially uniformly mixed therewith for discharge into the combustion or reaction chamber **20** of the furnace proper **11** throughout the entire cross-sectional area of the firing orifice **15** thereof. Ignition usually occurs within the junction member **12**, by reason of the reduced velocity of the upwardly rising mixture. However, whether actual ignition and combustion takes place there or within the upper divergent portion **10***b* of the Venturi tube, depends largely upon the regulation of fuel and air supply. Under certain conditions of regulation, ignition and combustion might even be delayed until the mixture reaches the furnace tube proper.

The embodiment of Figs. 5 through 8 is adapted for use with a horizontal type of furnace, and is provided with an air gap between the Venturi tube and junction member for supplying secondary air.

As illustrated, the Venturi tube of this embodiment, indicated **25**, is essentially the same as that of the previously described embodiment, comprising an inlet member **25***a*, an outlet member **25***b* and a throat member **25***c*.

Since the burner is disposed in horizontal position when installed, the material injection chute, here indicated **26**, enters the Venturi tube at an angle suitable for such position.

While the chute **26** may be essentially the same as that indicated **19** in the previous embodiment, the opportunity is taken in this embodiment of showing a modified construction which may replace that of the chute **19** in any of the embodiments of the invention.

As so modified the chute **26** comprehends and discharges over substantially a semi-circumferential portion of the Venturi throat, thereby injecting a wide stream of material to be processed, the same extending across the entire diametrical width of the Venturi throat, see the line of intersection **26***a* in Fig. 5 and the discharge slit **26***b* in Fig. 6.

In this horizontal embodiment, it is preferred that the chute directly intersect the Venturi throat member intermediate the length thereof, as shown, in order to take advantage of the maximum velocity and carrying capacity of the stream. In the previous embodiment, it will be noted, the chute **19** is directed downwardly so as to discharge directly into the Venturi throat, but actually intersects the burner somewhat above the throat member **10***c*, thereby taking full advantage of the length of the column of rising gases within the Venturi throat to minimize any tendency for larger pieces of the material to drop through the burner.

As in the previous embodiment, a damper arrangement, here indicated **27**, controls inflow of air or other combustion supporting fluid to the inlet member **25***a* of the Venturi tube. Furthermore, a jet pipe **28** provides for the introduction of atomized fuel from any suitable source.

In the present instance, the junction member, here indicated **29**, is spaced somewhat apart from the discharge end of the outlet member **25***b* in its connection therewith, in order to provide a circumferential gap **30** for the introduction of secondary air. Such spaced connection of junction member to Venturi tube is advantageously provided by a series of bolts **31** and spacers **32**, see Figs. 6 and 8.

The vertical embodiment of Figs. 1 through 4 may also be provided with a circumferential gap for admission of secondary air, in similar fashion.

The embodiment of Figs. 9 and 10 exemplifies a somewhat different and in some respects a more advantageous arrangement for injecting, into the burner, material to be processed.

As illustrated, an annular manifold **35** encircles the Venturi tube **36** at the juncture between the throat member **36***c* and the outlet member **36***b*, which juncture is defined by a circumferential gap **37** through which the material to be processed is injected.

Forced injection of the material to be processed is accomplished by means of a Venturi type of feeder comprising a Venturi tube **38** discharging into the manifold **35**, and supplied with material from a hopper-like chute **38***a* disposed immediately in advance of the Venturi throat of such feeder. A pipe **40** discharges a jet of compressed air through said Venturi throat, to produce a dynamic suspension of the material to be processed prior to its entry into the manifold **35**.

Otherwise, the burner is similar to the embodiment of Figs. 1 through 4, the material injection opening being preferably located at the upper end of the Venturi throat, as in that previous embodiment. It should be realized, of course, that a similar forced feed arrangement may be employed with the horizontal burner of Figs. 5 and 6.

The embodiment of Figs. 11 and 12 illustrates the use of an annular header supplying a plurality of fuel jets disposed circumferentially of the inlet opening of the burner, and a still different feed arrangement for the material to be processed. Furthermore, it illustrates a burner construction embodying only the Venturi tube, and no junction member. As illustrated, this embodiment comprises a Venturi throat member **45** having an upwardly and outwardly flaring rim **45***a*, which defines an annular chute **46** for the introduction into the burner of the material to be processed.

The outlet member **47** of the burner is spaced upwardly from the throat member **45** by spacer columns **48**, to define a substantially circumferential gap **49** therebetween. Since such gap **49** is disposed at the bottom of the chute **46**, gravity feed is accomplished about substantially to complete periphery of the Venturi throat.

Any suitable provision may be made for the supply of material to the chute **46**. As shown, four equally spaced pipes **50** are supported by respective brackets **51** in positions above the chute enabling discharge thereinto of respective streams of finely divided material from any suitable supply of same.

An annular fuel supply conduit or header **53** is disposed at and circumferentially of the lower part of the inlet member **54** of the burner, and is provided with a series of

jet nozzles 55. Fuel is supplied to the header 53 through pipe 56 from any suitable fuel source.

While the Venturi tubes of the several embodiments here illustrated are shown as made up of conical and cylindrical members, it should be realized that members having various polygonal cross-sections may be employed if desired.

Whereas this invention is here illustrated and described with respect to certain preferred structural forms thereof, it should be understood that various changes may be made therein and other forms may be produced, on the basis of the teachings hereof, by those skilled in the art without departing from the generic inventive concepts defined by the broader of the following claims.

I claim:

1. A material mixing combustion burner for industrial processing furnaces, comprising a Venturi tube having convergent inlet member, divergent outlet member, and a throat member therebetween; jet means for the supply of fuel to said inlet member; and a feeder for material to be processed, said feeder having a discharge portion directed into said throat member at a location beyond the said convergent inlet member, and said divergent outlet member having its outlet end entirely open as a single discharge orifice.

2. The combination set forth in claim 1, wherein there is additionally included a divergent junction member at the discharge end of the outlet member of the Venturi tube, said junction member having a divergency which is effectively greater than the divergency of said Venturi outlet member to provide a fuel-ignition zone.

3. The combination set forth in claim 2, wherein there is a gap between the junction member and the Venturi outlet member, for the entry of secondary air to the burner.

4. The combination set forth in claim 1, wherein the jet means comprises an annular header positioned within the inlet member, concentrically therewith, and an annular series of jet nozzles directed toward the Venturi throat.

5. The combination set forth in claim 1, wherein the feeder comprises a gravity flow chute.

6. The combination set forth in claim 5, wherein the chute has a width substantially equal to the diameter of the throat member, and the discharge portion thereof comprehends a semi-circumferential portion of the periphery of said throat members.

7. The combination set forth in claim 5, wherein the chute is annular, and the discharge portion thereof comprehends substantially the entire periphery of said throat member.

8. The combination set forth in claim 1, wherein damper means covers the inlet end of the inlet member of the Venturi tube to provide for varying the quantity of combustion supporting fluid passing thereinto.

9. The combination set forth in claim 1, wherein the feeder for material to be processed includes means for forcing the feed.

10. The combination set forth in claim 1, wherein there is a peripheral gap between the throat member and the outlet member of the Venturi tube; and wherein the feeder for material to be processed comprises an annular manifold surrounding said gap in open communication therewith, and means for producing a dynamic fluid suspension of material to be processed said means having a discharge directed into said manifold.

11. A device for mixing material particles with a fluid to produce a dynamic fluid suspension of the material, comprising a Venturi tube having convergent inlet member, divergent outlet member, and a throat member therebetween; means for forcing a stream of fluid through said Venturi tube from the said inlet member thereof toward and out of said divergent outlet member thereof; and a feeder for the said material particles, said feeder having a discharge portion directed into said throat member of the Venturi tube at a location beyond the said convergent inlet member, and the said divergent outlet member having its outlet end entirely open as a single discharge orifice.

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