

Oct. 18, 1932.

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1,883,218

METHOD OF AND APPARATUS FOR PULVERIZING AND TREATING MATERIAL

Filed June 16, 1928

3 Sheets-Sheet 1

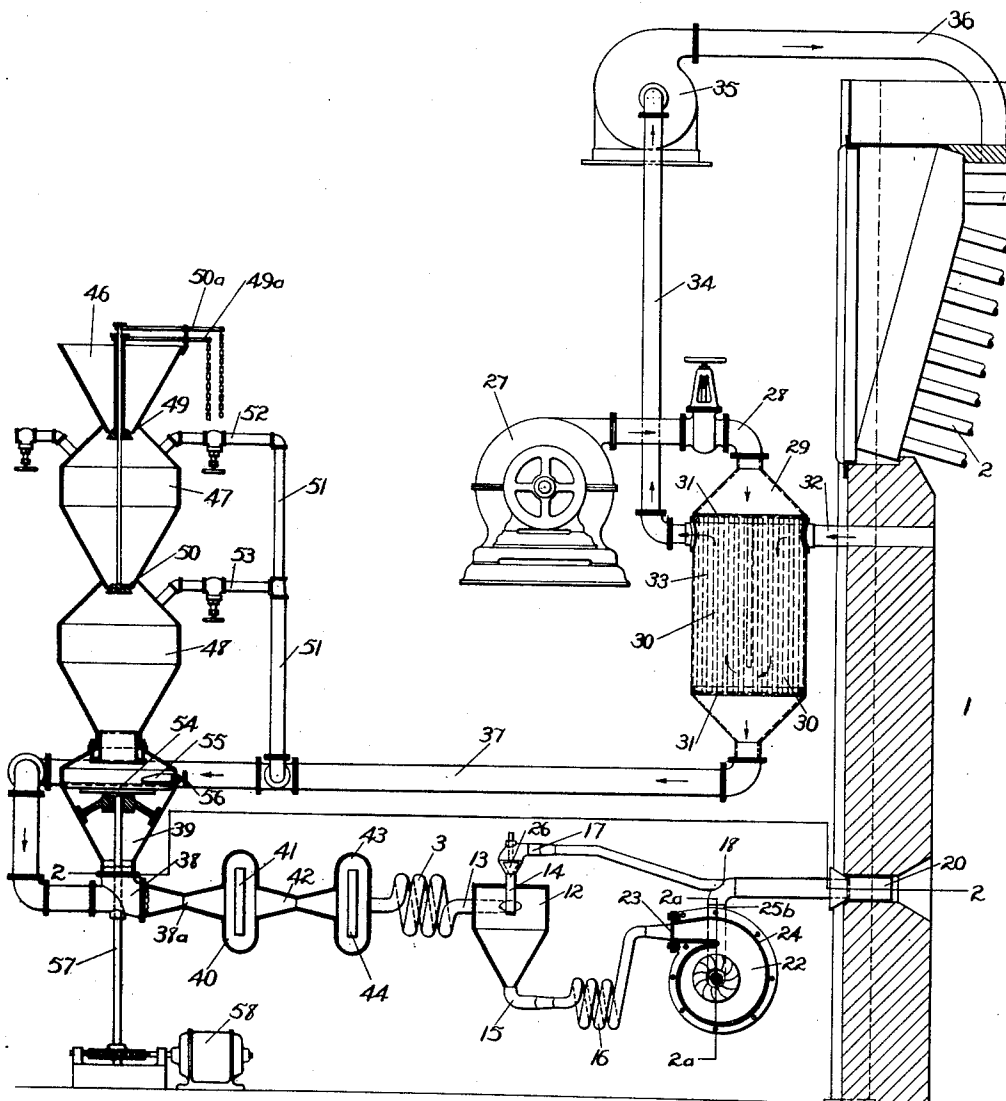


Fig. 1

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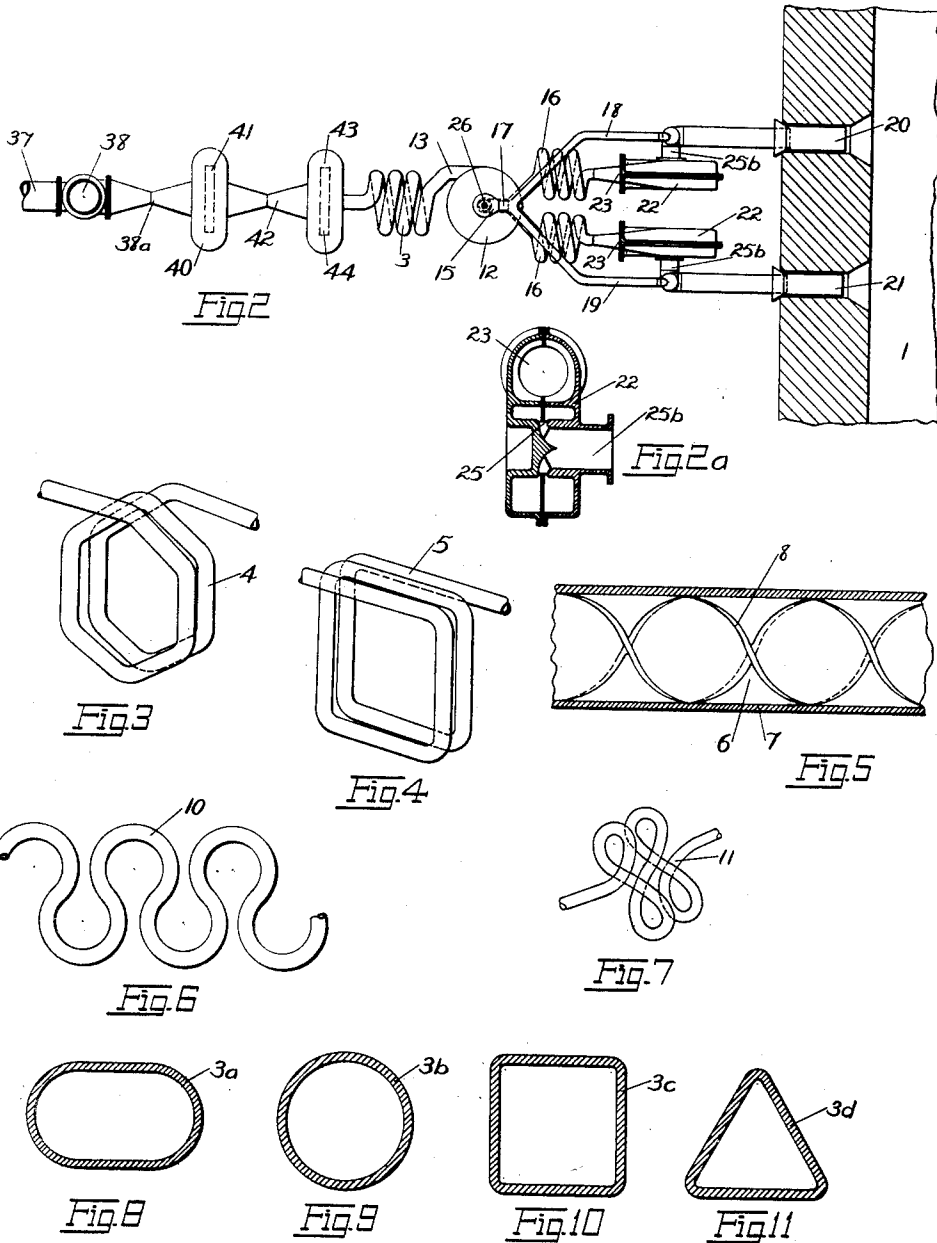
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METHOD OF AND APPARATUS FOR PULVERIZING AND TREATING MATERIAL

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3 Sheets-Sheet 2



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METHOD OF AND APPARATUS FOR PULVERIZING AND TREATING MATERIAL

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3 Sheets-Sheet 3

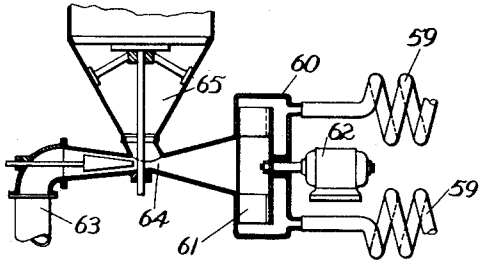


Fig. 12

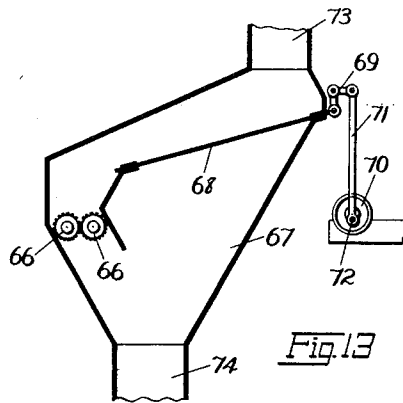


Fig. 13

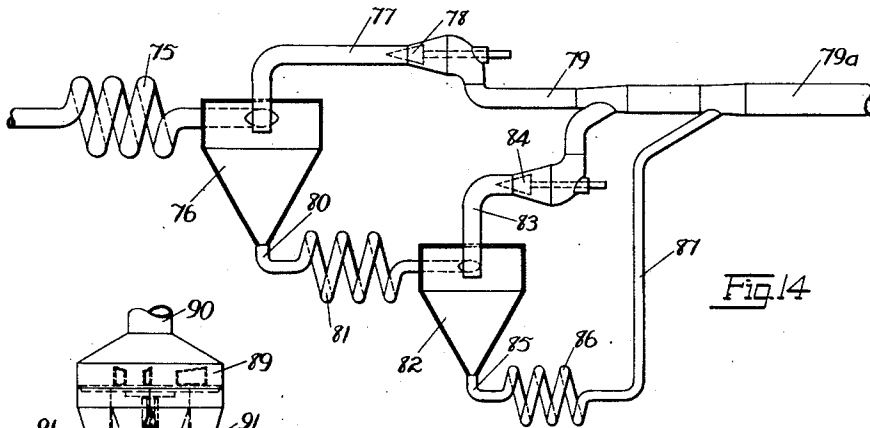


Fig. 14

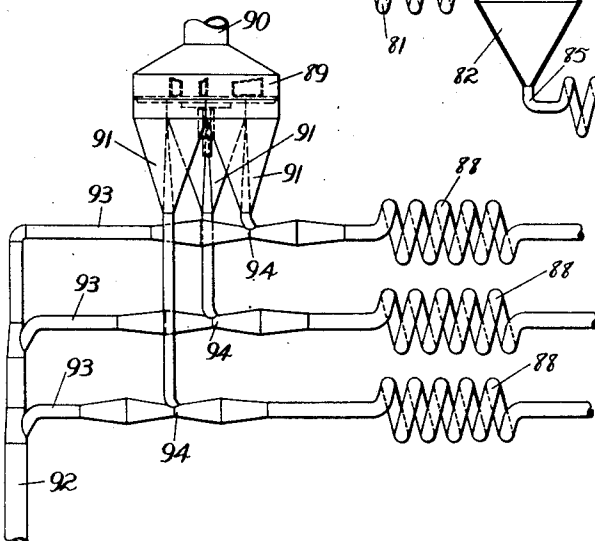


Fig. 15

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR PULVERIZING AND TREATING MATERIAL

Application filed June 16, 1928. Serial No. 285,833.

This invention is directed to the treatment and pulverization of material and is of particular advantage in the pulverization of fuel which is directly delivered to a burner and the accompanying drawings and description are exemplifications of my invention so applied.

I have discovered that material, such as coal, may be driven at high velocity through the driving force of air along a deflected surface such as is afforded by a coil or pipe and that this will accomplish the abrasive impingement of the fuel through the abrasive impingement of the material so driven upon the deflected wall and the abrasive action of the material upon itself will accomplish the pulverization to a very high degree of fineness in a very economical manner. In utilizing this discovery, pulverizing units in the form of coils may be arranged in series, or in parallel. The flow from one unit may be distributed through several units. Separators may be interspersed between the units. The direct pulverizing apparatus, therefore, involves no moving parts and if the material pulverized is in the form of fuel it, with the air, may be delivered directly to the burner.

I have found also that it is desirable to break the material to some extent prior to the pulverizing action and this can be accomplished by driving the material against impact walls with the same driving air force as is used in the pulverizing action. This may be more economically accomplished in the use of air if the breakers are arranged in series and with means for accelerating the material at the point of contact.

In carrying forward my invention also I have found it of advantage to heat the air after it is delivered to the passage under pressure and, preferably, before the introduction of the fuel, this heating of the air expanding the same and increasing its effectiveness in the apparatus both as to the velocity with which the material is driven through the apparatus and as to its effect upon the material, particularly as a fuel both as to pulverization and combustion. In this manner I am enabled to provide a pulverizing appa-

ratus which has a small initial cost and may be operated efficiently and economically.

Features and details of the invention will appear more fully from the specification and claims.

Preferred embodiments of the apparatus with which the method may be practiced are illustrated in the accompanying drawings as follows:—

Fig. 1 marks a side elevation of the apparatus, partly in section, to better show construction.

Fig. 2 a plan view of the same, parts being in section, to better show construction.

Fig. 2a a horizontal section of the impinging separating pulverizer on the line 2a—2a in Fig. 1.

Figs. 3, 4, 5, 6 and 7 various forms of abrasive coils.

Figs. 8, 9, 10 and 11 various forms of cross section of conduit, or abrasive tubes.

Fig. 12 an alternative construction of a preliminary breaker.

Fig. 13 a modified form of preliminary breaker.

Fig. 14 a modification of a series of pulverizing units with interspersed separators.

Fig. 15 a modified form illustrating a manner of feeding the material.

1 marks the furnace and as illustrated this is to be used in relation to a steam generator 2.

The initial pulverizing unit 3 is in the form of an ordinary coil of pipe of comparatively restricted cross section with relation to the amount of fuel introduced. It affords a continuing deflected surface against which the fuel, through its inertia, is thrown with abrasive impinging action which accomplishes the pulverization of material to a very high degree of fineness with a minimum of driving energy. The essential feature of the unit is that it shall have a deflecting surface so that the fuel with a continuous movement has this abrasive impingement. The coil may be varied within wide limits as indicated by the coil 4, in Fig. 3, the coil 5, in Fig. 4, or it may have the circuitous path formed by the structure in Fig. 5 wherein the passage 6 is formed within a

tube 7 by the insertion of a twisted plate 8 so that the surfaces forming the wall of the passage are continuously deflected causing abrasive impingement of the material as it is driven through the passage. Further examples of forms of coil are illustrated in the coil 10 of Fig. 6, the coil 11 of Fig. 7, and various cross sections of the tube may be used, as indicated at 3a in Fig. 8, 3b in Fig. 9, 3c in Fig. 10, and 3d in Fig. 11. This deflected surface may also be accomplished by utilizing the deflected walls of a chamber, as the chamber 12, Fig. 1, having its intake 13 directioned along the line of the wall preferably tangent to a cylindrical surface and a discharge from such chamber at the axis and vertically as at 14. With such a structure the driving force of the air impels the material, or coal, against the walls and this abrasive impingement accomplishes the pulverization and during this pulverization the coarser particles seek the immediate contact with the walls and the finer particles are carried out and discharged with the air. In the preferred structure, as I have used it, I supply the chamber 12 with a discharge passage 15 at the bottom. Thus it is possible to advance the material from the chamber 12 prior to its complete pulverization and the chamber 12 in this respect operates as a separator, the finer material passing out through a discharge opening 14 and the coarser material through the discharge passage 15. In the preferred apparatus, the material is carried from the discharge 15 to a secondary unit 16, similar in form to the unit 3, but preferably of smaller cross sectional area and of smaller coil so that the material deflection is sharper and the total discharge for the air of smaller cross section so that as the material is pulverized and advances the air velocity is increased. The finer material separated out through the discharge pipe 14 is carried by a pipe 17 through a pipe 18 to a burner 20 and by a branch pipe 19 to a burner 21. Preferably the discharge through the pipe 15 is divided through two units 16, as clearly shown in Fig. 2, these units operating in series with relation to the initial unit 3 but in parallel with relation to each other. The units 16 discharge to a pulverizing separator 22 having an intake 23 and an annular impinging wall 24. A discharge 25 is made in the form of a narrow slot which may have guide vanes if desired. The width of this slot at the entrance to the slot determines the size of the largest particles which are discharged. This slot is immediately increased in width changing the movement of air from high velocity and converting it into pressure and the separator has a discharge 25b which leads to the pipes 18 and 19 and thence to the burners 20 and 21. By shimming the sections of the case the width of the slot may be regulated.

Valves 26 are provided for the discharges 14 by which the amount of pulverized material discharging from the axes of the chambers may be regulated and in this way the degree of fineness of the materials so discharged may be controlled.

Air for the system is supplied by an air pump 27 of any approved design. It delivers the air through a pipe 28 to a heater 29. The heater 29 may be of any ordinary form. As shown it comprises a series of tubes 30 through which the air passes, these tubes extending from headers 31 connected with the inlet and discharge from the heater. Hot gases are delivered through a pipe 32 to a heater chamber 33, affecting a heat exchange from the chamber through the tube 30. The gases are taken from the chamber by way of a pipe 34 and a fan 35 and delivered by a pipe 36 back to the top of the furnace. The air is carried from the heater by way of a pipe 37 to the intake side 38 of a Venturi tube 38a. Fuel is delivered to the intake 38 from a feeder 39. Fuel and air are delivered from the venturi 38a to a breaker 40, this breaker consisting of an enlargement of the passage forming a chamber in which chamber is arranged an impact wall 41 directly facing the direction of movement of the fuel as it emerges from the Venturi tube. The fuel and air emerging from the breaker 40 passes through a second venturi 42 and is delivered to a second breaker 43, similar in construction to the breaker 40, having the enlarged chamber in which an impact wall, or plate 44 is placed in direct line of the movement of fuel from the venturi 42.

The purpose of the venturi in advance of these impact breakers is to give to the particles of fuel at the restriction of the venturi a higher velocity which, through the inertia of the material, is maintained at the point of impact. A more economical breaking of the material may be obtained by providing a series of these impact breakers as against a single breaker with higher velocity and the breakage as a whole may be more thoroughly and economically accomplished. Other breakers may be substituted for this type of breaker as will appear later herein.

A regulated feeding of the coal may be accomplished in any convenient manner. As shown, I have provided an air lock scheme of fuel delivery involving a hopper 46 for receiving the fuel, an air lock chamber 47 below the hopper 46 and an air lock chamber 48 below the chamber 47. The hopper is separated from the chamber 47 by a valve 49 and the chamber 47 from the chamber 48 by a valve 50, these valves being supplied with operating means 49a and 50a so that coal may be passed from the hopper to the chamber 47, this chamber closed and the valve 50 opened, depositing the coal in the chamber 48 and the valve 50 closed. Air may be delivered to

the chambers 47 and 48 by way of the pipe 51 leading from the pipe 37 and provided with valved branch pipes 52 and 53. The material is deposited from the chamber 48 upon a rotating feed table 54. A scraper 55 operates above this table and may be regulated from a wheel 56 in the usual manner. The coal drops off the edge of the table 54, is carried to the passage 39 of the feeding apparatus and delivered to the inlet 38 of the venturi 38a. The table 54 is driven by a shaft 57 receiving its power from a motor 58.

In the operation of the device, the air is driven from the pump 27 and given sufficient pressure to assure a high velocity through the various passages. The air picks up the fuel from the fuel feeding device, drives the fuel at high velocity against the impact breakers, thus breaking it into small lumps. This fuel is then carried at high velocity through the initial pulverizing unit 3, is carried from this unit to the pulverizing separator 12. The finer particles are separated out and delivered directly to the burner, the coarser particles being carried through the secondary pulverizing units arranged in parallel to each other and in series to the initial pulverizer. The discharged coarser material from the secondary units is carried through the impinging separators 22 and the final discharge from these pulverizing separators assures the desired fineness and this is delivered to the burners with the finer material from the separators 12.

By heating the air as a preliminary feature after it leaves the pump not only is the air expanded and its energy increased but this added temperature acting on the fuel tends to absorb a greater proportion of its moisture and put it in condition to be more readily pulverized and the added heat also assists in the combustion of the fuel.

As before stated, by arranging the breakers in series a more complete and economical breaking of the material may be accomplished with less loss of energy. By the use of an ordinary coil as a pulverizing unit the pulverizing is accomplished practically without moving parts and with a very great economy in the consumption of power. The pulverizing may be carried to a very high degree of fineness. By separating the fully pulverized material from the coarser material at intervals secondary pulverizer units may be made to operate only on the coarser material and the removal of the fully pulverized material permits the unit to operate more effectively and exclusively upon the coarser materials. The number of pulverizer units in the series may be varied according to the quality of the material being pulverized. Preferably the total cross section of the passage is slightly decreased, thus increasing the velocity and it is also desirable to form the coil units somewhat smaller as the material becomes finer

thus giving a sharper deflection and thus a more acute impingement of the material upon the deflected wall.

A modification is shown in Fig. 12. In this modification pulverizer units 59 are arranged in parallel. They receive their material from a breaker formed with a chamber 60 and a rotating beater 61, the beater receiving its power from a motor 62. Air under pressure is delivered from a pipe 63 through a venturi 64 and the fuel is fed from a hopper 65 to the restricted portion of the venturi 64, the venturi here inducing a flow of material from the hopper to the air passage.

In Fig. 13 a modification is shown for feeding the fuel. It consists of a breaker comprising breaker rolls 66. The breaker rolls are arranged in a hopper 67 in which is arranged an inclined screen 68, the discharge from the screen leading to the breaker rolls 66. The screen is vibrated from a rocker 69, the rocker being driven from a motor 70 through a pitman 71 operating from a crank 72 on the motor 70. Fuel is delivered to the hopper through an inlet passage 73 and is discharge through a passage 74 to the air passage leading to the pulverizer units.

In Fig. 14 is shown a series of pulverizer units and separators between these units, these being arranged in a single tandem form all delivering to a single burner. An initial unit 75 discharges to a separator 76. The fine fuel from the separator is discharged through a pipe 77 and thence by a valved connection 78 to a pipe 79, the pipe 79 leading to the final burner pipe 79a. The coarser material leads from the separator 76 by a discharge passage 80 to a secondary unit 81 and thence to a second separator 82. The finer material discharges from the secondary separator by way of a valved opening 84 to the pipe 79. The coarser material is discharged from the separator 82 by a pipe 85, pulverizer unit 86, pipe 87 to the burner pipe 79a.

In Fig. 15 there are shown a series of pulverizer units 88 arranged in parallel, these receiving their fuel from a single feeding mechanism 89, this feeding mechanism comprising an intake pipe 90 and the usual feed table delivering to a series of discharge hoppers 91, one for each unit. The air is delivered from a supply pipe 92 and branch pipes 93 lead to each pulverizer unit. Venturis 94 are arranged in the branch pipes and the fuel is discharged from the hoppers 91 to the restricted portions of the venturis 94, the venturis thus assisting in the feeding of the fuel to the system.

What I claim as new is:—

1. In a pulverizer, the combination of a plurality of units comprising an initial unit and secondary units, the secondary units being in series with the initial unit and in parallel with each other, each unit comprising a member having a passage having a wall de-

flected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; and devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage.

2. In a pulverizer, the combination of a plurality of units in series, each unit comprising a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; and devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage, the wall of the secondary unit having a sharper deflection than the initial unit.

3. In a pulverizer, the combination of a plurality of units in series, each unit comprising a passage in the form of a coiled tube; means moving gaseous fluid at high velocity through the passage; and devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage, the coil of the secondary unit being of less diameter than the initial unit.

4. In a pulverizer, the combination of a plurality of units in series, each unit comprising a member having a tubular wall with an axial deflection; means moving gaseous fluid at high velocity through the passage; and devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage, the cross section of the tubular passage in the secondary unit being smaller than the cross section of the tubular passage in the initial unit.

5. In a pulverizer, the combination of a plurality of units in series, each unit comprising a passage in the form of a coiled tube; means moving gaseous fluid at high velocity through the passage; and devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage, the secondary unit having its coil of smaller diameter than the initial unit and the cross sectional area of the tube of the secondary unit less than the cross sectional area of the initial unit.

6. In a pulverizer, the combination of a

plurality of units in series, each unit comprising a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage; and a separator between said units discharging the coarser material to the secondary unit.

7. In a pulverizer, the combination of a plurality of units in series, each unit comprising a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material in the wall of the passage; a separator between said units discharging the coarser material to the secondary unit; and means uniting the flows from the separator.

8. In a pulverizer, the combination of a plurality of units comprising an initial unit and a plurality of secondary units, the secondary units being in series with the initial unit and in parallel with each other, each unit comprising a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage; and a separator between the initial and secondary units comprising a chamber with a deflected wall, an intake directioned along the wall, and two discharges, one positioned to receive the finer particles and the other the coarser particles, the latter discharge delivering to the secondary units.

9. In a pulverizer, the combination of a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage; and a breaker in advance of the deflection comprising an enlargement of the passage, and an impact wall in the enlargement facing the direction of the

movement of the material through the passage.

10. In a pulverizer, the combination of a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage, said means being in advance of the deflection of the wall; and apparatus heating the gaseous fluid between the means and the deflection of the wall.

11. In a pulverizer, the combination of an air pump; a pipe leading from the pump; a heater in the pipe; a fuel feeder delivering to the pipe; a series of breakers in the pipe, each breaker comprising an enlargement of the pipe and an impact wall facing the direction of movement of the material to the pipe, the pipe being restricted in the form of a venturi in advance of each breaker wall; a pulverizer unit in the form of a coiled pipe at the discharge of the second breaker; a separator at the discharge of the initial pulverizer unit, said separator comprising an annular chamber with a tangential intake, an axial upward discharge for the final material and a downward discharge for the coarser material; a plurality of secondary units in the form of coil pipes receiving the discharge of the coarser material; separators receiving the discharge from the secondary coils; axially extending discharges for the finer material; downwardly extending discharges for the coarser material; a third series of coils receiving the coarser material; and means uniting the passages carrying the finer materials from the separators with the material separated therefrom after such coarser material is pulverized.

12. In a pulverizer, the combination of a plurality of units comprising an initial unit and secondary units, the secondary units being in series with the initial unit and in parallel with each other, each unit comprising a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding fuel to the passage, the fuel being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the fuel on the wall of the passage; and a plurality of burners to which the mixture of fuel and gaseous fluid is delivered.

13. In a pulverizer, the combination of a plurality of units comprising an initial unit and a plurality of secondary units, the secondary units being in series with the initial

unit and in parallel with each other, each unit comprising a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding fuel to the passage, the fuel being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the fuel on the wall of the passage; a separator between the initial and secondary units comprising a chamber with a deflected wall, an intake directioned along the wall, and two discharges, one positioned to receive the finer particles and the other the coarser particles, the latter discharge delivering to the secondary units; and a burner to which the mixture of gaseous fluid and fuel is delivered.

14. In a pulverizer, the combination of a member having a passage having a wall deflected from the approaching path formed by the passage; means moving gaseous fluid at high velocity through the passage; devices feeding fuel to the passage, the fuel being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the fuel on the wall of the passage, said means being in advance of the deflection of the wall; apparatus heating the gaseous fluid between the means and the deflection of the wall; and a burner to which the mixture of fuel and gaseous fluid is delivered.

15. The method of pulverizing material which consists in compressing air and driving the material with the gaseous fluid at high velocity and with a continuous movement, causing the material through its inertia to abrasively impinge a wall deflected to the path of the approaching material, and heating the gaseous fluid after being compressed and previous to its deflection.

16. The method of pulverizing material which consists in compressing air and driving the material with the gaseous fluid at high velocity and with a continuous movement, causing the material through its inertia to abrasively impinge a wall deflected to the path of the approaching material and heating the gaseous fluid after being compressed and previous to the introduction of the material.

17. The method of pulverizing fuel which consists in compressing gaseous fluid and driving the fuel with the gaseous fluid at high velocity and with a continuous movement, causing the fuel through its inertia to abrasively impinge a deflected wall, heating the gaseous fluid after being compressed and previous to its deflection, and discharging the mixture of gaseous fluid and fuel to a burner.

18. In a pulverizer, the combination of a member comprising a chamber having a wall

- forming a complete circuit for the material; means moving gaseous fluid at high velocity through the chamber, the gaseous fluid being introduced to the chamber in a direction following the wall of the chamber and discharged through an opening within the wall obstructing the discharge of coarser particles; and devices feeding material to the gaseous fluid, the gaseous fluid driving the material with a continuous movement along the walls inducing an abrasive impingement of the material on said walls and continuing said movement until a degree of fineness permitting the discharge is reached.
19. In a pulverizer, the combination of a conduit; means for moving gaseous fluid at high velocity through the conduit; means for feeding material to the conduit; a pulverizing wall against which the material is driven by the gaseous fluid; means to separate after such pulverizing action the finer material from the coarser; and a second pulverizing wall against which the coarser material is driven by the gaseous fluid.
20. In a pulverizer, the combination of a conduit; means for moving gaseous fluid at high velocity through the conduit; means for feeding material to the conduit; a pulverizing wall against which the material is driven by the gaseous fluid; means to separate after such pulverizing action the finer material from the coarser; a second pulverizing wall against which the coarser material is driven by the gaseous fluid; and a furnace to which the mixture of pulverized material and gaseous fluid is directly delivered.
21. In a pulverizer, the combination of a conduit; means for moving gaseous fluid at high velocity through the conduit; means for feeding material to the conduit; a pulverizing wall extending across the path of the driving fluid against which the material is driven by the gaseous fluid and is pulverized by impact; means to separate after such pulverizing action the finer material from the coarser; and a second pulverizing wall against which the coarser material is driven by the gaseous fluid.
22. In a pulverizer, the combination of a conduit; means for moving gaseous fluid at high velocity through the conduit; means for feeding material to the conduit; a pulverizing wall against which the material is driven by the gaseous fluid; means to separate after such pulverizing action the finer material from the coarser; a second pulverizing wall against which the coarser material is driven by the gaseous fluid; and means for heating the gaseous fluid prior to its action against the pulverizing wall.
23. In a pulverizer, the combination of a conduit; means for moving gaseous fluid at high velocity through the conduit; means for feeding material to the conduit; a pulverizing wall against which the material is driven by the gaseous fluid; means to separate after such pulverizing action the finer material from the coarser; a second pulverizing wall against which the coarser material is driven by the gaseous fluid; means for heating the gaseous fluid prior to its action against the pulverizing wall; and a furnace to which the mixture of pulverized material and gaseous fluid is directly delivered.
24. In a pulverizer, the combination of a passage having a deflected wall; means moving a gaseous fluid at high velocity through the passage; devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflection inducing an abrasive impingement of the material on the wall of the passage; and a breaker comprising an impact wall in the passage facing the direction of movement of material through the passage.
25. In a pulverizer, the combination of a series of deflecting walls arranged in tandem, said walls forming a passage for the material to be pulverized; means moving gaseous fluid at high velocity successively past said walls; and devices feeding material to the passage, the material being driven through the passage with a continuous movement by the driving force of the gaseous fluid and the deflections inducing an abrasive impingement of the material to be pulverized on the wall of the passage, the deflection of the walls being more acute in the direction of the advance of the material.
- In testimony whereof I have hereunto set my hand.
- WALTER J. WOHLBERG.