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APPARATUS FOR THE EXPLOSIVE PULVERIZATION OF COAL

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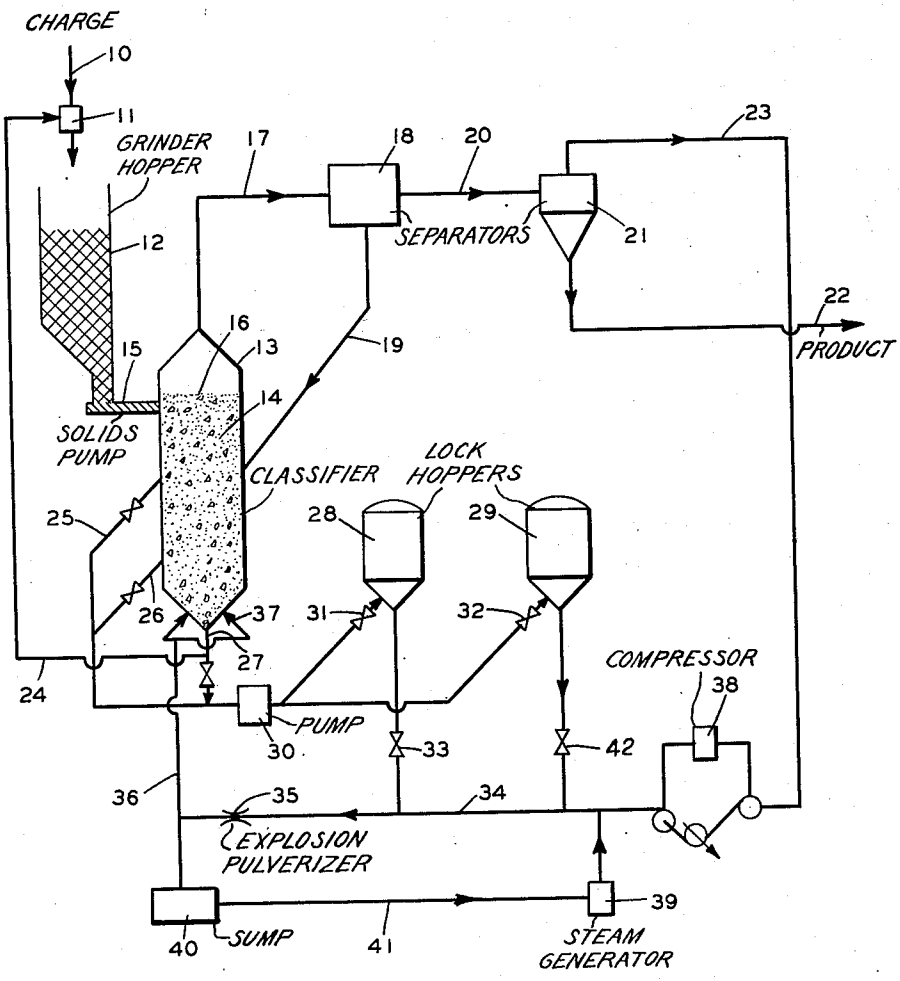

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APPARATUS FOR THE EXPLOSIVE PULVERIZATION OF COAL

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2 Claims. (Cl. 241—39)

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This invention relates to the explosion pulverization of coal and more particularly to an improved method and apparatus for vertically classifying the explosion pulverization products in a mass of coal particles which is maintained in a fluidized condition by introducing the explosion products upwardly through said mass.

Recent developments of new products and processes employing finely divided coal have been hampered in attaining commercial standing because of the high cost of reducing the coal to pulverized condition by methods heretofore known. For instance, a fuel comprised of oil containing colloidally suspended coal particles has been limited in application because no economic method was available for producing sufficiently pulverized particles. It is a primary object of this invention to provide a commercially practicable method for powdering coal by explosion pulverization and an apparatus adapted for the employment of said method.

Although explosion pulverization has been previously proposed as a means for comminuting permeable substances by permeating the particles with a fluid under pressure and then suddenly reducing said pressure, such processes have never met with commercial success for the powdering of coal. One of the principal reasons for this failure has been that the pulverization process has been found to pulverize only a minor proportion of the particles subjected to the pressure reduction step. The balance of the particles must be recycled through the process for new treatment. It is an object of this invention to provide an efficient and economical means for classifying the products of explosion pulverization into those particles which have been sufficiently pulverized and those which are adapted to be subjected to explosion pulverization. If desired, a third classification of the particles too large for explosion pulverization may be withdrawn for recycling to a preliminary mechanical grinder.

A further disadvantage of previously known explosion pulverization methods as applied to pulverizing coal, has been encountered in the difficulty and cost of increasing the pressure on the granulated coal preparatory to explosion pulverization. An object of the present invention is to provide a method and apparatus by means of which known fluid pumping means may be employed to increase the pressure on said granulated coal material.

These objects and other objects, which will become apparent from the description of a typical application of the invention, are achieved by employing a large fluidized mass of particles which are maintained in a turbulent circulatory condition so that the particles therein classify themselves vertically with the heaviest particles near

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the bottom of said mass, the lightest particles in the upper portion of said mass, and particles of intermediate size according to elevation. In the preferred form of my invention this turbulent fluidized condition of the mass of particles is maintained by introducing upwardly therethrough a mixture of particles and gas which is the product of explosion pulverization; that is, after the mixture of particles and the gaseous explosion pulverization medium have experienced a sudden reduction in pressure from a substantially elevated pressure to a pressure only slightly greater than that prevailing in the mass of fluidized particles, this mixture is introduced, usually through a plurality of openings through the bottom of a vessel containing the fluidized mass.

Although the invention may be employed for the explosion pulverization of materials other than coal, or for the explosion pulverization of coal and other materials with a great variety of vapors (mercury or zinc vapors, for instance) or gases (such as air, nitrogen, or hydrocarbons), the process has been developed primarily for the explosion pulverization of coal by means of steam vapor, for which the process is uniquely adapted. It has been found that most coals have a crystalline structure and a degree of permeability such that it is desirable to apply the explosion pulverization method to coal granules of a predetermined maximum size, which may be found experimentally in the case of each particular type of coal. For this reason, the system is uniquely valuable for explosively pulverizing coal on a large commercial scale. Furthermore, since steam is relatively cheap and non-reactive with coal, it is a preferred explosion medium for the presently disclosed process.

A typical embodiment of an apparatus suitable for practicing my method is illustrated in the accompanying drawing. Coal enters the apparatus at 10 and is ground in grinder 11 to a coarse feed powder (a number 4 mesh has been found quite suitable) and delivered to a large feed hopper 12 from the bottom of which the coarse coal is fed into a large vessel 13 containing a fluidized bed 14, the nature of which will be described in detail hereinafter. The feed may be introduced by a solids pump, a standpipe, or any other effective device; in the present embodiment the elevation of the hopper 12 gives some standpipe effect; a spiral screw-type of feeding means is indicated diagrammatically at 15. The exact point in the vessel at which the feed is introduced is not very important, but in most cases best results are obtained by introducing the coarse powder into vessel 13 near the top of fluidized bed 14.

The fluidized mass 14 is comprised of particles of coal which are maintained in a "pseudo-liquid"

or "fluidized" bed by continuously introducing upwardly through said bed a gasiform fluidizing medium. The term gasiform rather than gaseous is used here since the fluidizing medium may not be a true gas but may be, for instance, a mixture of gas and solid particles which is much less dense than the bed of particles within vessel 13 and is capable of flowing thereinto and therethrough in the manner of a fluid under pressure. The fluidized condition thus produced in bed 14 is characterized by the relatively high concentration of particles of solid material per unit volume of occupied space, and maintained by the low velocity flow of fluidizing medium upwardly through the bed. The maintenance of a definite minimum gaseous velocity is regarded as desirable to maintain the bed in a turbulent fluidized state in which the particles tend to move among one another in a circulatory manner. Preferably, the upward velocity of the gas through the fluidized bed 14 is sufficiently high to maintain sufficient turbulence in the bed so that any given elevation within vessel 13, the smaller and lighter particles will tend to drift in an upward direction and the larger and heavier particles in a downward direction with a result that the entire fluidized bed 14 tends to classify itself according to particle size ranging from the heaviest particles at the lowest point to the lightest particles near the upper surface 16 of fluidized bed 14. The optimum velocity of a fluidizing medium, both with respect to its minimum and maximum value, will be dependent upon the density, size, and shape of the solid particles being fluidized and upon the properties of the fluidizing medium. Thus, for any particular size or sizes of particles and quality of fluidizing medium this velocity is adjusted within a range so as to maintain the desired turbulent but dense condition of fluid bed 14.

The finest particles within the fluidizing bed 14 will be carried by the fluidizing medium, which in the present preferred embodiment is composed principally of steam, upwardly from the surface 16 of fluidizing bed 14 through line 17. In the event that this overhead material is not as finely ground as desired, it may be passed to a separator 18 which will remove coarse particles and return them to vessel 13 through line 19. This separator may be of conventional design, such as cyclone separator of proper particle size selectivity. It is best to return the oversized particles from this separator to a point well below the top of the dense fluidized bed 14 to prevent their immediate reentrainment in the mixture of finely powdered coal by steam escaping through line 17. The finely powdered overhead product withdrawn from vessel 14 through line 17 and, if desired, freed of oversized particles from separator 18 is then passed by conduit 20 to any suitable means 21 for separating the solid particles from the steam. The finely pulverized coal product may be withdrawn from means 21 at 22 and the particle-free steam may be withdrawn through line 23 to be reused in the process.

By far, the greater portion of the coal introduced into vessel 13 through feeding means 15 will not be sufficiently fine to pass overhead through line 17 and will settle downwardly through the vessel 13 to be classified at various elevations according to size as heretofore described. If desired, the heaviest particles may be withdrawn from the lower portion of the vessel 13 and recycled to the grinder 11 through conveying means 24.

Those particles which are of a size adapted to the particular method of explosion pulverization being employed will tend to classify themselves at some particular elevation within fluidized mass 14. This elevation will occur dependent on the type of coal and the percentage of fines produced by grinder 11. A plurality of withdrawal pipes 25, 26 and 27 are, therefore, provided for withdrawing fluidized coal from various elevations within fluidized mass 14. The fluidized material so withdrawn is delivered to one or more lock hoppers 28 and 29; a pump 30 may be employed for this purpose, however, in most instances it will be found preferable to effect the movement of fluidized material from fluidized bed 14 to lock hoppers 28, and 29 merely by a difference in pressure head.

In the preferred embodiment zone, fluidized material from vessel 13 is introduced into lock hopper 28 through valve 31 at a relatively low pressure while at the same time entrance of material into lock hopper 29 is prevented by the closure of a valve 32. After lock hopper 28 is filled, valve 31 is closed and 32 is opened and fluidized material is permitted to flow from vessel 13 into lock hopper 29. Lock hopper 28 is provided with outlet valve 33 which is closed while valve 31 is opened and hopper 28 is being filled, after which it is opened to permit fluidized products to flow downwardly from the lower portion of hopper 28 into pipe 34 through which it is driven by steam at high pressure through an explosion pulverization nozzle 35 or any other suitable means for suddenly reducing the pressure on the fluidized material. From explosion pulverization means 35 the low pressure steam produced and the coal particles entrained therein are passed through line 36 to vessel 13, preferably through ports 37 in the bottom thereof, to flow upwardly through fluidized bed 14 and maintain it in a fluidized condition.

After hopper 28 has been emptied, valves 32 and 33 are closed and at the same time valve 31 is opened to permit hopper 28 to be refilled and the outlet valve 42 of hopper 29 is opened to permit its contents to be subjected to high pressure by the high-pressure steam in line 34 and to permit flow of the high-pressure fluidized material from hopper 29 into line 34 and thence to explosion pulverization means 35. Lock hoppers 28 and 29 are thus operated ultimately to maintain a substantially continuous flow of dense fluidized material from vessel 13 to one of the lock hoppers and a substantially continuous flow of low-pressure steam and explosion pulverization products from explosion pulverization means 35 upwardly through ports 37 into vessel 13. Steam entering vessel 13 through ports 37 is, of course, of sufficiently high pressure to overcome the pressure head existing because of the depth of fluidized bed 14. Also, since the low-pressure steam and coal particles produced by the explosion pulverization means 35 are of much lower density than fluidized bed 14 and, therefore, serve admirably as a fluidizing medium.

The greater portion of the high-pressure steam required to be introduced into line 34 for the explosion pulverization step is obtained by recompressing in compressor 38 the low-pressure steam separated from the pulverized product material by separator 21. A steam generating source 39 is provided for starting and for providing make-up steam during the operation of the process if necessary. It is desirable to provide a sump 40 at some point in the system for withdrawing from it condensed steam, which may be recycled

through a pipe 41 to the steam generating means 39. In operation, surface level 16 of dense fluidized mass 14 is maintained by continuously supplying through screw conveyor means 15 coarse coal ground by grinder 11 to a preliminary fineness. The fluidized bed 14 within vessel 13 is maintained at approximately the same volume and is of approximately the same character at all times during the operation of the process but material is constantly being withdrawn through lines 25, 26 and 27 or through any suitable combination of them to be fed alternately either to lock hopper 28 or 29; also, a much smaller quantity of material is being withdrawn as finished or semi-finished product through overhead line 17. Of course, only a minor fraction of material passing through explosion pulverization means 35 is reduced to the required fines and it therefore usually happens that the amount of material being withdrawn from vessel 13 for cycling through the explosion pulverization step is several times the amount which is being added during the corresponding period of time from hopper 12 or is being withdrawn through overhead line 17.

While one preferred form has been illustrated and described, this invention is not limited to the conventional details referred to. For instance, some fluidizing means other than the explosion pulverization medium may be continuously pumped into the lower portion of vessel 13, withdrawn from the upper portion, above the surface 16 of the dense phase of fluidized mass 14, and reintroduced into the lower portion. Such a fluidizing medium may be used independently of the steam, the latter being employed solely as an explosion pulverization medium. Also, the invention is not limited to a method or apparatus in which the materials are conveyed from one point to another in fluidized form. Lines 25, 26 and 27 may be any suitable means for transporting a classified material from vessel 13 to the explosion pulverization step. Similarly, the invention is not limited to the withdrawal of overhead product in fluidized form; any suitable conveying means may be employed for withdrawing finely pulverized material from the uppermost layers of classifying vessel 13. Other parts of this system will also be found to be readily adaptable to other means of transportation to those skilled in the art. The regrinding of the coarsest material withdrawn from the lower portion of vessel 13 by line 24 is merely a suggestion which may be of advantage only in certain cases.

The invention is not limited to any particular means of explosion pulverization although it is peculiarly adapted to the combination of lock hoppers and explosion pulverization nozzle illustrated. The invention could be combined, however, with other means for raising the pressure on the coarse coal particles preliminary to explosion pulverization. For instance, the coarse coal particles may be formed into a slurry and pumped to a high pressure before being introduced into steam line 34, as described in the co-pending application Serial No. 774,768, now Patent No. 2,560,807, entitled "Method and Apparatus for Explosion Pulverization," and filed by Walter E. Lobo.

I claim:

1. An apparatus for pulverizing material which includes: a vertically elongated vessel; means for introducing granulated solid material into the upper portion of said vessel; means for introducing a gasiform suspension medium upwardly through said vessel to maintain particles therein in a turbulent fluidized state to cause them to classify themselves vertically according to size; lock hopper means; means for withdrawing fluidized solid particles from said vessel and transferring them to said lock hopper means; means for withdrawing said solid particles under pressure from said lock hoppers and introducing them into a high pressure gasiform medium to form a suspension and means for suddenly reducing the pressure thereon to produce explosive pulverization; means for reintroducing the gasiform medium and pulverized solid products from said explosion pulverization upwardly through said elongated vessel to maintain the contents thereof in the fluidized condition; means for withdrawing a finely pulverized product from the upper portion of said vessel; and means for withdrawing and recompressing gasiform medium from said vessel for reuse in said pressure reducing means.

2. An apparatus for pulverizing material which includes: a classification vessel; means for introducing granulated solid material into said vessel; means for introducing a gasiform suspension medium upwardly through said vessel to maintain particles therein in a turbulent fluidized state to cause them to classify themselves vertically according to size; lock hopper means; means for withdrawing fluidized solid particles from said vessel and transferring them to said lock hopper means; means for withdrawing said solid particles under pressure from said lock hoppers and introducing them into a high pressure gasiform medium to form a suspension; means for suddenly reducing the pressure thereon to produce explosive pulverization; means for reintroducing the gasiform medium and pulverized solid particles from said explosion pulverization upwardly through said elongated vessel to maintain the contents thereof in the fluidized condition; and means for withdrawing a finely pulverized product from the upper portion of said vessel.

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