

Jan. 15, 1963

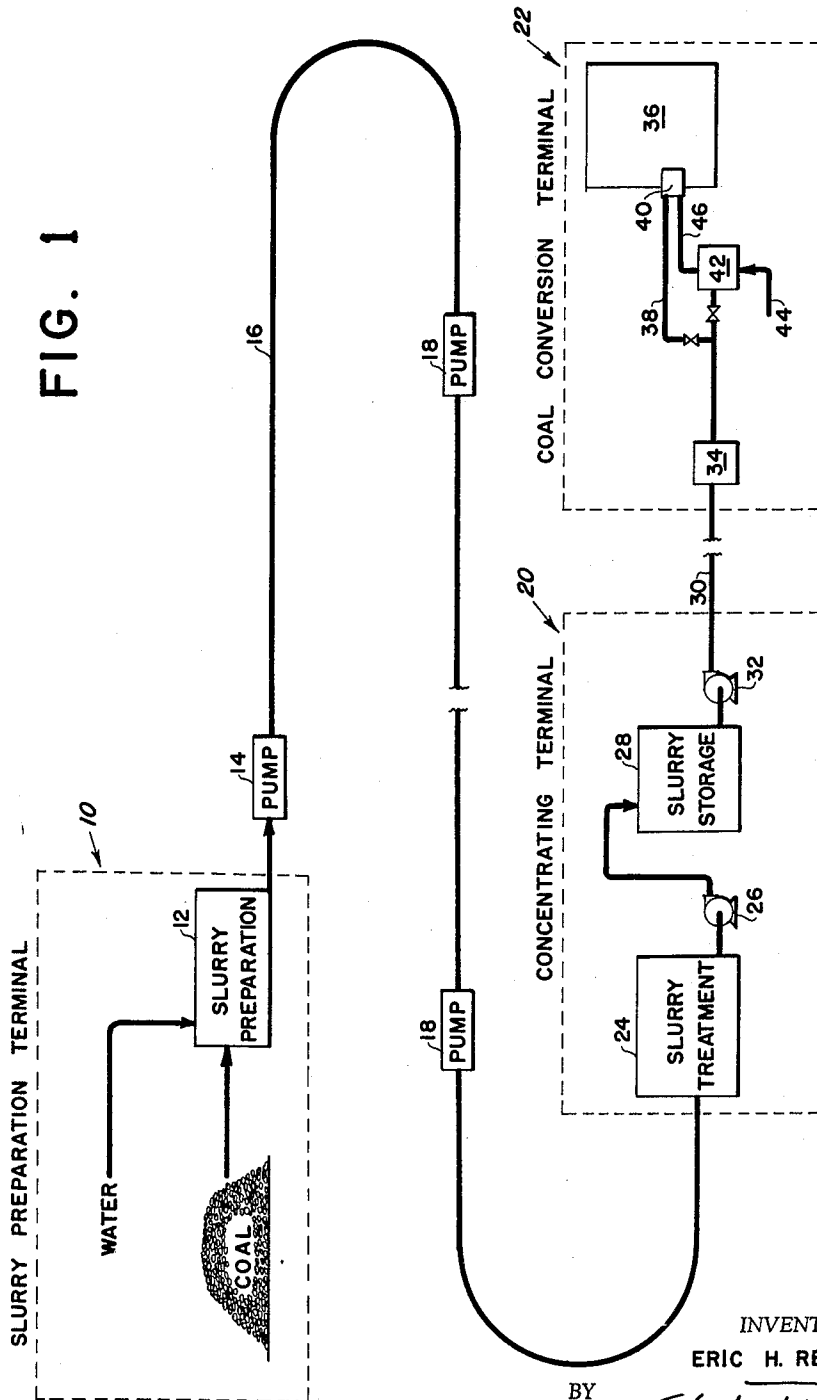
E. H. REICHL

3,073,652

TRANSPORTATION OF COAL BY PIPELINE

Filed May 26, 1961

2 Sheets-Sheet 1



INVENTOR.

ERIC H. REICHL

BY

Stanley J. Price

HIS ATTORNEY

Jan. 15, 1963

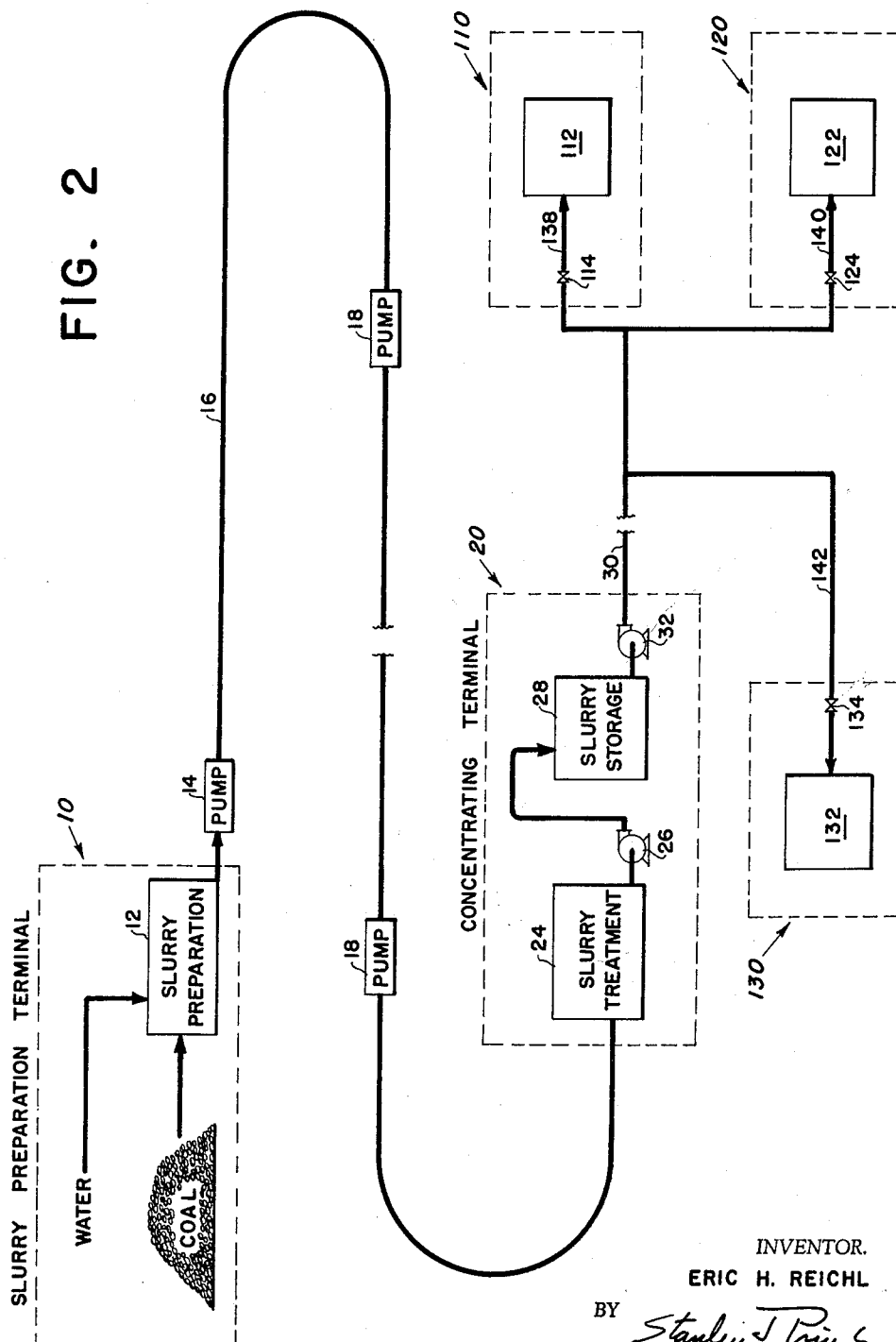
E. H. REICHL

3,073,652

TRANSPORTATION OF COAL BY PIPELINE

Filed May 26, 1961

2 Sheets-Sheet 2



INVENTOR.

ERIC H. REICHL

BY

Stanley J. Price

HIS ATTORNEY

1

3,073,652

TRANSPORTATION OF COAL BY PIPELINE
Eric H. Reichl, Pittsburgh, Pa., assignor to Consolidation
Coal Company, Pittsburgh, Pa., a corporation of Penn-
sylvania

Filed May 26, 1961, Ser. No. 112,965

7 Claims. (Cl. 302-66)

This invention relates to a method of transporting coal as a coal-water slurry through a long distance pipeline to a coal conversion unit. More particularly, this invention relates to a method of transporting a coal-water slurry at one solids concentration through a long distance pipeline to a concentrating terminal and thereafter transporting the coal-water slurry at a different solids concentration through a second pipeline to a coal conversion terminal.

A recently discovered process for transporting coal as an aqueous slurry has made it possible now to transport coal over long distances through a pipeline. A commercial pipeline has been constructed to transport coal from a mine in southern Ohio to a consumer along the shore of Lake Erie, an actual distance of 108 miles. Several million tons of coal have been successfully transported over this distance through this commercial pipeline at a substantial savings in transportation costs.

The process employed to transport the coal as an aqueous slurry through this commercial pipeline is set forth in U.S. Patent #2,791,471 entitled "Transportation of Coal by Pipeline." The process described in the aforementioned patent has proved both successful and commercially feasible. The hereinafter described invention is directed to an improvement of the process set forth in the above-mentioned patent.

In any coal pipeline installation there are three basic stages: (1) a preparation stage where the coal is prepared and mixed with water to form a coal-water slurry; (2) a long distance transportation stage wherein the coal-water slurry is transported from a preparation terminal to a coal conversion terminal by pumping the slurry through a pipeline; and (3) a conversion stage where the coal in the slurry is converted by combustion, gasification, chemical reformation or the like.

In the past it has been the practice in the conversion stage to remove substantially all the water from the slurry and recover relatively dry coal particles. The dried coal particles are then stored and handled in a conventional manner.

The economics of dewatering, storing and handling the dried coal particles in the conversion terminal in a sense controlled the size of the coal particles that were transported through the long distance pipeline. The dewatering, storing and handling characteristics of the dry particles increased in difficulty with the increased content of extremely fine particles in the product. There are many problems present in separating extremely fine particles from a water slurry that are not present when relatively coarse particles are separated from a water slurry. For instance, the filtration characteristics of a slurry having a substantial portion of extremely fine particles is unfavorable economically. The thermal drying of the filter cake and the clarifying of the liquid filtrate are also more difficult when extremely fine particles are present. There are also dust and explosion hazards present during the dewatering and drying process. The storage and handling of the fine coal particles is another difficult operation. The accurate metering or feeding of the dry fine coal particles to conventional burning apparatus by conventional known mechanical means is difficult and the difficulty is further increased by the presence of extremely fine coal particles.

2

In view of the problems encountered in the separation of the water from the extremely fine coal particles, it was found highly desirable to transport a slurry which contained a minimum amount of extremely fine coal particles. It was found, however, that some extremely fine particles in the slurry were required to obtain desirable pumping characteristics. It is believed that the fine coal particles serve with the water as a vehicle for the coarser coal particles and tend to retain the coarser particles in suspension while being transported through the pipeline at lower and more economic velocities. With a sufficient amount of extremely fine coal particles, the dynamic stability of the coal-water slurry is improved and the tendency for the coal particles to settle is markedly reduced. It is believed that less energy is consumed in maintaining the larger sized particles in suspension while the slurry is being transported through the pipeline. The improved dynamic stability of the slurry also permits greater latitude in the velocity at which the slurry is transported through the pipeline.

It is the principal object of this invention to obtain the advantages of a more dynamically stable slurry in the long distance pipeline by employing a substantial amount of extremely fine coal particles in the slurry and to further eliminate the hazards and problems encountered in removing substantially all of the water from the slurry in the coal conversion terminal. By my invention it is now possible to transport a dynamically stable slurry over long distances through a pipeline at optimum pumping costs and to further eliminate a substantial portion of the mechanical equipment required to remove the water from the slurry in the coal conversion terminal. By my improved method of transportation, a dynamically stable coal-water slurry having a predetermined size distribution of coal particles and solids concentration is transported through a long distance pipeline at a predetermined velocity to provide reduced transportation costs. The flow of the slurry is interrupted at a concentrating terminal and a portion of the water is removed therefrom by conventional means such as partial filtration, centrifuging or thermal treatment. The more concentrated slurry, that is, the slurry having a greater solids concentration than the slurry transported through the long distance pipeline, is pumpable through a pipeline by conventional pumping means. The more concentrated slurry is also further stabilized in that it is statically stable and can be stored in conventional tank type storage means for extended periods of time without a substantial separation of the water from the coal particles. Moreover, the concentrated slurry is both statically and dynamically stable in that there is little tendency for the coarser particles to settle out more rapidly than the finer particles and there is little tendency for the heavy coarser particles to solidify or pack. The more concentrated slurry remains free flowing after substantial periods of storage. The more concentrated slurry is withdrawn from the storage means at any desired rate and pumped through another pipeline either to or within the coal conversion terminal to a coal conversion unit. The transportation from the concentrating terminal to the conversion terminal is substantially simplified because the coal particles are now handled as a "liquid" instead of dry coal particles.

Another object of this invention is to provide a method of pumping a coal-water slurry through a pipeline from a mine to a distant location and thereafter increasing the solids concentration of the slurry and pumping the concentrated slurry through another pipeline to a coal conversion unit.

A further object of this invention is to eliminate the necessity of removing substantially all of the water from the coal-water slurry.

A further object of this invention is to provide a method

3

of transporting coal to distant locations through a pipeline and thereafter transporting the coal as a concentrated slurry to a coal conversion unit.

These and other objects of this invention will be more completely disclosed in the following specification, the accompanying drawings and the appended claims.

In the drawings, FIGURE 1 is a schematic illustration of my improved coal pipeline transportation system.

FIGURE 2 is a schematic illustration of a coal pipeline system wherein the slurry is transported to a concentrating terminal where the slurry is concentrated and thereafter transported through other pipelines to a plurality of coal conversion units.

Referring to the drawings wherein like numeral references designate similar parts in each figure, the numeral 10 generally designates a slurry preparation terminal which is located adjacent to a coal mining area or a coal cleaning plant. The coal is comminuted to a predetermined size consist and is mixed with water in slurry preparation apparatus 12.

The particulate coal has a spectrum of sizes that will provide minimum pumping costs when transported over long distances in the pipeline. It has been discovered when between about 20 to about 40 percent of the coal particles are of a size that pass through a 325 mesh Tyler Standard Screen the fine coal particles serve with the water as a vehicle for other larger sized particles. For example, the larger sized particles may range in size from a top size of about 4 mesh Tyler Standard Screen and have a spectrum of smaller sizes. The coal particles, that is, both the fine and coarse particles, are mixed with water to form a coal-water slurry having a solids concentration of between 35 and 60 percent by weight coal particles. It has been discovered that a slurry prepared as described above is dynamically stable in that the tendency of the larger sized coal particles to settle out of the slurry is reduced and less energy is required to maintain the larger sized particles in suspension while the slurry is transported through the pipeline. The dynamically stable slurry provides optimum transportation costs over long distances.

The slurry is withdrawn from the slurry preparation apparatus 12 and transported by means of pump 14 through a long distance pipeline 16. The slurry is transported through the pipeline 16 at a velocity which maintains the coal particles uniformly suspended in the water. For example, the slurry may be transported through the pipeline at velocities between 3 and 7 feet per second.

At intervals along the pipeline additional pumps 18 maintain the desired velocity of the slurry from the preparation terminal 10 to a concentrating terminal generally designated by the numeral 20.

The concentrating terminal 20 in FIGURE 1 is indicated as being spaced from the coal conversion terminal 22. It should be understood, however, that the concentrating terminal 20 may form an integral part of the coal conversion terminal 22 where the entire output of the pipeline is consumed at the coal conversion terminal and space for storage is available adjacent the conversion units. The concentrating terminal 20 includes slurry treating apparatus 24 where a portion of the water is removed from the slurry. Slurry treatment apparatus 24 is schematically illustrated and may include any suitable mechanical means for removing a portion of the water from the slurry. The slurry is concentrated in the slurry treating apparatus 24 to provide a more concentrated slurry that is both statically and dynamically stable. The concentrated slurry should have a solids concentration of between 60 and 75 percent coal by weight. The substantial amount of extremely fine coal particles in the slurry now makes it possible to increase the slurry concentration to between 60 and 75 percent solids and yet have a slurry that retains its flow characteristics. The concentrated slurry is statically stable in that there is no substantial segregation of coal particles according to size while the concentrated slurry is stored under quiescent

4

conditions. The larger sized particles remain substantially uniformly suspended throughout the concentrated slurry even after extended periods of time under quiescent conditions. There is little tendency of the heavy coarser particles to solidify or pack so that the concentrated slurry retains the desirable properties of a liquid. At this increased concentration the concentrated slurry is readily pumpable through a pipeline with conventional pumping apparatus. The pumping costs, because of the increased solids concentration, are substantially greater than that of the more dilute dynamically stable slurry that is transported over long distances through the long distance pipeline. These additional pumping costs are offset many times by the advantages now present in storing and handling the coal particles as a highly concentrated slurry.

Referring again to FIGURE 1, the concentrated slurry withdrawn from slurry treating apparatus 24 is pumped by means of pump 26 to a slurry storage tank 28 where the statically stable concentrated slurry may be stored for extended periods of time without substantial size segregation of the particles in the slurry. As stated above, the concentrated slurry is statically stable and the coal particles do not have a tendency to pack or form an immobile mass of solids as is the case when a dilute slurry is permitted to stand under quiescent conditions for a short period of time.

The concentrated slurry is withdrawn from the storage tank 28 and pumped through another pipeline 30 by means of a pump 32 to the coal conversion terminal 22. A metering or control device 34 is positioned in the pipeline 30 to control the amount of coal that is introduced into the conversion apparatus. The concentrated slurry from pipeline 30 may take two alternative routes in the coal conversion terminal 22 as illustrated in FIGURE 1. If the burner of furnace 36 is adapted to burn a slurry having a concentration of between 60 and 75 percent solids, the concentrated slurry is pumped from pipeline 30 through a branch conduit 38 directly into the burner apparatus 40. If the burner is one which operates at maximum efficiency when all the coal particles have a size which passes through a 200 mesh Tyler Standard Screen, the concentrated slurry from pipe line 30 is introduced into a comminuting means 42. Heated gas is introduced into comminuting means 42 at a predetermined velocity through conduit 44. The heated gas vaporizes the water in the slurry and conveys as a suspension the coal particles, certain of which are comminuted in comminuting means 42, through conduit 46 to the burner 40. Valve means are provided in pipeline 30 and conduit 38 to control the flow of concentrated slurry into burner 40. It will be noted in the above description that there is a closed circuit from the slurry preparation terminal 10 to the place of coal conversion which in this instance is burner 40. Within the concentrating terminal 20 the slurry is concentrated and stored as a dynamically and statically stable slurry in the storage tank 28. The concentrated slurry is transported from the concentrating terminal 20 to the coal conversion terminal 22 by pumping the concentrated slurry through another pipeline. The concentrated slurry is further transported through the coal conversion terminal 22 to the coal conversion unit 36 by pumping the concentrated slurry through other conduits or pipes. The method described eliminates the dust hazards and storage problems heretofore described and further provides a means whereby coal particles can be accurately metered into the coal conversion unit.

In FIGURE 2 there is illustrated another arrangement whereby the statically and dynamically stable concentrated slurry is transported from a concentrating terminal to a plurality of coal conversion units which may be located in a single coal conversion terminal or a plurality of coal conversion terminals spaced at substantial distances from each other. The arrangement schematically illustrated in FIGURE 2 provides a means whereby the

output of the coal pipeline 16 may be distributed to a series of coal conversion units not necessarily within the confines of a single coal conversion terminal. For example, the dynamically and statically stable concentrated slurry can be transported to a plurality of power plants located around the periphery of a large metropolitan area, or the dynamically and statically stable concentrated slurry may supply other conversion units such as coke ovens, blast furnaces, or the like.

Referring to FIGURE 2 the coal conversion terminals are generally designated by the numerals 110, 120, and 130 respectively. Each of the coal conversion terminals includes a coal conversion unit generally designated by the numerals 112, 122, and 132 respectively. The other apparatus illustrated in FIGURE 2 are similar to that of FIGURE 1 and have the same numerals. In FIGURE 2 there is illustrated a means of supplying the plurality of coal conversion units 112, 122 and 132 in conversion terminals 110, 120 and 130 from the central concentrating terminal 20. The various valves 114, 124 and 134 in the respective branch conduits 138, 140 and 142 control the flow of concentrated slurry from the pipeline 30 to the respective coal conversion units 112, 122 and 132.

It will be appreciated from the brief description of FIGURE 2 that it is now possible to supply coal from a distant mine to a coal conversion complex which includes a concentrating terminal and a plurality of coal conversion terminals. The coal may be conveniently stored within the concentrating terminal as a dynamically and statically stable slurry. The concentrated slurry may be transported from the concentrating terminal to the respective coal conversion units at any desired rate.

The following are two examples of how my improved method may be practiced.

A coal-water slurry is prepared in the slurry preparation terminal 10. A representative size consist and size distribution of the coal particles is as follows:

Weight percent of coal (Tyler Standard Screen):

	Percent
on 8 mesh	0
on 14 mesh	.3
on 28 mesh	11
on 48 mesh	26.4
on 100 mesh	17.6
on 200 mesh	10.6
on 325 mesh	6.6
through 325 mesh	27.5

The coal particles are mixed with water to have a solids concentration of about 55 percent coal by weight in water. The coal is transported through the pipeline 16 at a velocity of between about 4 and 6 feet per second to the concentrating terminal 20. The slurry is introduced into the slurry treatment apparatus 24 where sufficient water is removed from the slurry to provide a concentrated slurry having a concentration of about 72 percent by weight of coal in water. The concentrated slurry is pumped by means of pump 26 to slurry storage vessel 28 and pumped from storage vessel 28 through pipeline 30 to a coal conversion unit.

Another example of how my invention may be practiced is as follows. The slurry is prepared in the slurry preparation terminal by mixing coal particles having the following representative size consist:

Weight percent of coal (Tyler Standard Screen):

	Percent
on 8 mesh	8.2
on 14 mesh	22.8
on 28 mesh	20.5
on 48 mesh	12
on 100 mesh	6.1
on 200 mesh	2.6
on 325 mesh	1.1
through 325 mesh	26.7

with water to form a slurry having between 50 and 60 percent by weight of coal in water, transporting the slurry through the pipeline 16 at a predetermined velocity to provide minimum pumping costs, introducing the slurry into slurry treatment apparatus 24 in the concentrating terminal 20, removing a portion of the water from the slurry so that a concentrated slurry having a concentration of between about 60 and 70 percent coal by weight is obtained. The concentrated slurry is transported from slurry treatment apparatus 24 by means of pump 26 to slurry storage vessel 28 where the concentrated slurry may be maintained for extended periods of time under quiescent conditions. As required, slurry is withdrawn from slurry storage vessel 26 and pumped by means of pump 32 through pipeline 30 to coal conversion terminal 22.

It should be understood that the size consist of the coal particles in the slurry may deviate substantially from the representative size consist set forth in the examples and the examples are for illustrative purposes only. It has been discovered to obtain the desired dynamic stability during transportation through the long distance pipeline and to obtain a statically and dynamically stable concentrated slurry at the concentrating terminal that the slurry should include between about 20 and 40 percent of the coal particles with a size which passes through a 325 mesh Tyler Standard Screen. When about 20 percent of the coal particles are of a size which passes through a 325 mesh Tyler Standard Screen the coarser particles should have a top size not greater than 4 mesh Tyler Standard Screen to obtain the desired dynamic stability. When the content of the fine particles which pass through a 325 mesh Tyler Standard Screen is increased above 20 percent, the coarse particle top size may also be increased.

According to the provisions of the patent statutes, I have explained the principle, preferred construction and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiments. However, I desire to have it understood, that within the scope of the appended claims the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A method of transporting coal over long distances for conversion at distant locations which comprises preparing a slurry of coal and water comprising between 35 and 60 percent by weight of said coal in said water, said coal having a spectrum of sizes with a top size of about 4 mesh Tyler Standard Screen, transporting said slurry through a pipeline over long distances to a distant location, interrupting the transportation of said slurry at said distant location, thereafter adjusting the solids concentration of said slurry so that said concentrated slurry has between about 60 and 75 percent by weight of said coal in said water, transporting said concentrated slurry through a second pipeline over a shorter distance to a second location, and converting said coal in said concentrated slurry at said second location.

2. A method of transporting coal over long distances for conversion at distant locations which comprises obtaining coal having a spectrum of sizes and between about 20 and 40 percent by weight of —325 mesh particles, preparing a water slurry comprising between 35 and 60 percent by weight of said coal in water, pumping said slurry through a pipeline at a velocity of between about 3 and 7 feet per second over long distances to a distant location, interrupting the transportation of said slurry at said distant location, thereafter removing a portion of said water from said slurry to provide a concentrated slurry having a solids concentration of between 60 and 75 percent by weight of said coal in said water, pumping said concentrated slurry through a second pipeline over a shorter distance to a second location, and converting the coal in said concentrated slurry at said second location.

3. A method of transporting coal over long distances for conversion at distant locations which comprises preparing a slurry of particulate coal and water, said particulate coal having a spectrum of sizes a portion of which passes through a 325 mesh Tyler Standard Screen, said slurry having solids concentration and size distribution so that said solid particles remain uniformly suspended in said water while being transported through a pipeline at a velocity of between about 3 and 7 feet per second, pumping said slurry through a pipeline at a velocity of between 3 and 7 feet per second over long distances to a distant location, interrupting the transportation of said slurry at said distant location, thereafter removing a portion of the water in said slurry to provide a concentrated slurry having a solids concentration of between 60 and 75 percent by weight of said coal in said water, pumping said concentrated slurry through a second pipeline to a second location and converting the coal in said concentrated slurry at said second location.

4. A method of moving coal from a mine to a distant location for conversion thereat which comprises preparing a slurry of coal and water which has a concentration of between 35 and 60 percent by weight of said coal, said coal in said slurry having a spectrum of sizes, pumping said slurry through a pipeline at a velocity of between about 3 and 7 feet per second over long distances to a concentrating terminal, interrupting the transportation of said slurry at said concentrating terminal, thereafter adjusting the solids concentration of said slurry in said concentrating terminal to provide a more concentrated slurry having a solids concentration of between 60 and 75 percent by weight of said coal in said water, pumping said concentrated slurry through a second pipeline to a coal conversion terminal, and converting said coal in said concentrated slurry in coal conversion apparatus in said conversion terminal.

5. A method of transporting coal over long distances for conversion at distant locations which comprises preparing a slurry of coal and water having a concentration of between 35 and 60 percent by weight of said coal in said water, said coal having a spectrum of sizes and between 20 and 40 percent of said coal having a size which will pass through a 325 mesh Tyler Standard Screen, pumping said slurry through a pipeline over long distances to a coal burning terminal, interrupting the transportation of said slurry adjacent said coal burning terminal, removing a portion of said water in said slurry to provide a more concentrated slurry having a concentration between 60 and 75 percent by weight of said coal in said water, pumping said concentrated slurry through a second pipeline to said coal burning terminal and in said coal burning terminal to coal burning apparatus, and burning the coal in said concentrated slurry in said coal burning apparatus.

6. A method of transporting coal over long distances for conversion at distant locations which comprises preparing a slurry of coal and water having a concentration of between 35 and 60 percent by weight of said coal in water, said coal particles having a spectrum of sizes and between 20 and 40 percent by weight of said coal particles having a size which will pass through a —325 mesh Tyler Standard Screen, pumping said slurry through a pipeline at a velocity of between 3 and 7 feet per second over long distances to a conversion terminal, interrupting the transportation of said slurry, thereafter adjusting the solids concentration of said slurry to provide a more concentrated slurry having a solids concentration of between 60 and 75 percent solids by weight of said coal in water, said concentrated slurry being capable of maintaining said particles in suspension under quiescent conditions, maintaining an inventory of said concentrated slurry, pumping said concentrated slurry through a second pipeline to coal conversion apparatus, metering said concentrated slurry at a controlled rate from said pipeline into said conversion apparatus for conversion of said coal therein.

7. A method of transporting coal over long distances for conversion at distant locations which comprises preparing a slurry of particulate coal and water having a concentration of between 35 and 60 percent by weight of said coal in water, said particulate coal having a spectrum of sizes and a substantial portion which is retained on a 200 mesh Tyler Standard Screen, said particulate coal having between 20 and 40 percent by weight which passes through a 325 mesh Tyler Standard Screen, pumping said slurry through a pipeline at a velocity of between 3 and 7 feet per second over a distance to a concentrating terminal, interrupting the transportation of said slurry in said concentrating terminal, removing a portion of the water in said slurry to provide a concentrated slurry having a concentration of between 60 and 75 percent by weight of said particulate coal in said water, maintaining an inventory of said concentrated slurry within said concentrating terminal, pumping said concentrated slurry through a second pipeline to a coal burning terminal and in said coal burning terminal to coal pulverizing apparatus, supplying heated air to said coal pulverizing apparatus, vaporizing at least a portion of said water in said concentrated slurry and comminuting at least a portion of said coal particles having a size which is retained on a 200 mesh Tyler Standard Screen to a size which will pass through a 200 mesh Tyler Standard Screen, conveying said coal particles as a suspension in said vaporized water and said air to a pulverized fuel burner and burning said coal particles in said pulverized fuel burner.

No references cited.