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[54] **COAL EXTRACTION METHOD AND APPARATUS**
10 Claims, 1 Drawing Fig.

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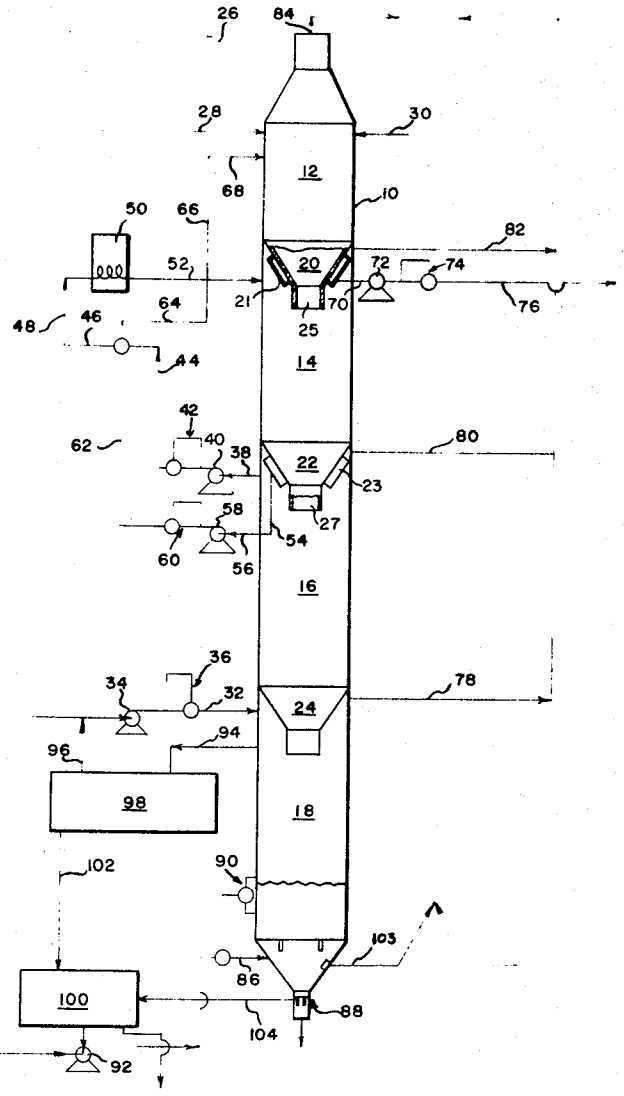
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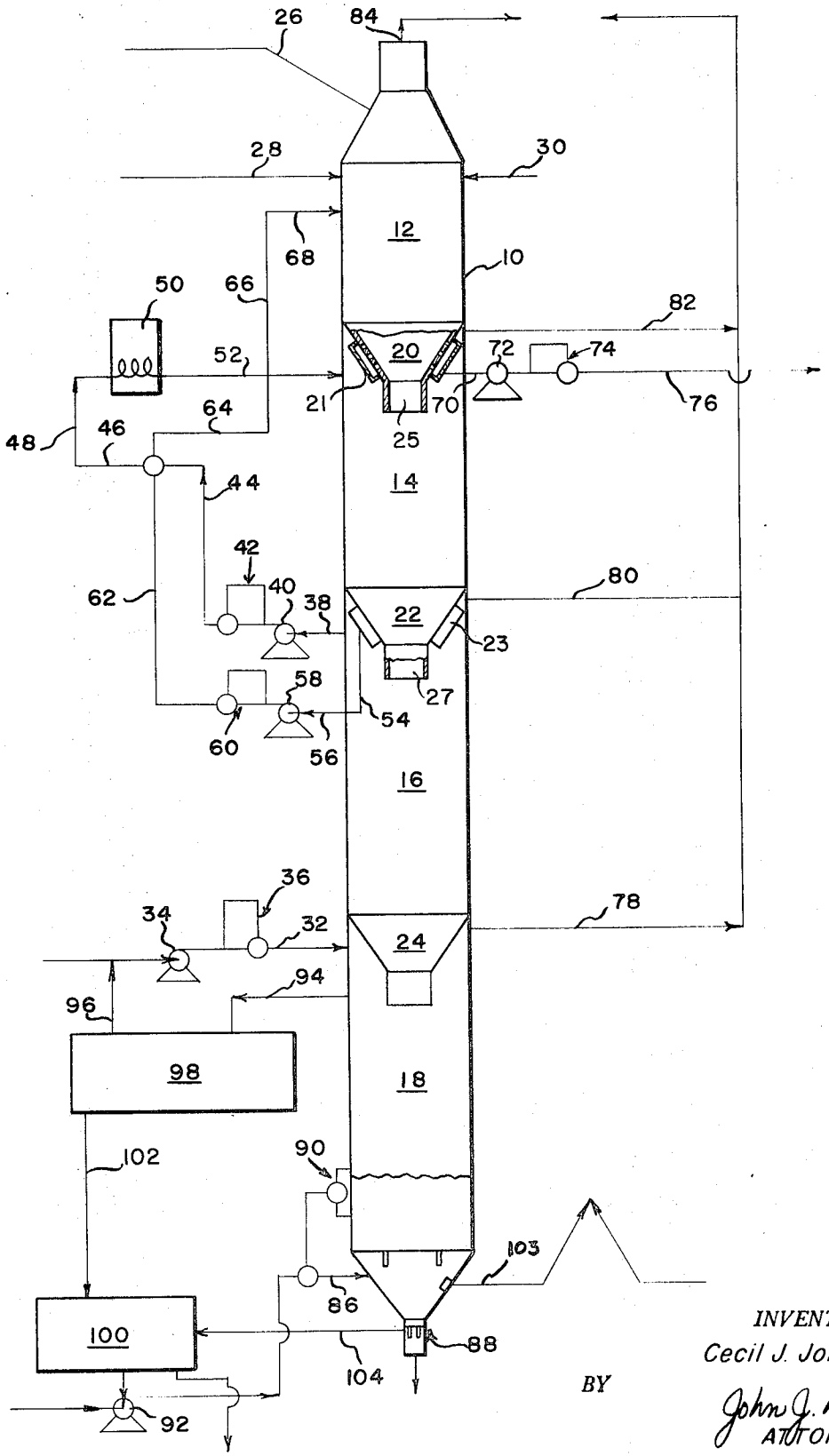
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ABSTRACT: Method for extracting coil liquids from a continuously moving bed of coal solids comprising the steps of moving the coal solids through extractor and stripper zones in a stream of sand which serves as a conveyor for the coal solids. The sand also serves as a cleaning means for filter screens used in the process. Further, the sand stream permits the coal liquids to swell freely.





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COAL EXTRACTION METHOD AND APPARATUS

This application is a continuation of Ser. No. 810,135 filed Mar. 25, 1969, now abandoned.

This invention relates to a method of continuously separating coal liquids from coal solids. Specifically, this invention relates to continuously extracting coal liquids from coal solids by entraining the coal solids in a continuously moving stream of sand or the like and passing the intermixed solids and sand through extraction zones wherein coal liquids are extracted from the coal solids and taken off for further refining.

It is well known in the prior art to solvent extract coal by the use of fixed-bed processes and by continuously rotating contactors and filters. The fixed-bed process is undesirable in that the coal solids after a period of time swell and then have a tendency to cake resulting in plugging and constriction of the solvent flow-through paths. The rotating-type contactor and filter results in increased maintenance and operating costs and lacks the efficiency of the here-described process.

It is an object of this invention to bring coal solids into contact with solvents for purposes of extracting coal liquids from the coal solids by entraining the coal solids in a continuously moving stream of sand or other siliceous material and passing the intermixed sand and coal solids through a plurality of coal extractor and stripper zones.

It is a further object of this invention to provide a fluid media such as sand or the like for carrying the coal solids through the solvent processing which allows the coal solids to freely expand and swell without fear of clogging the solvent flow-through paths and the filter screens. The sand, being a fluid material, will provide room for the increase in size of the coal solids.

It is a further object of this invention to use the sand as a filter. As the intermixed stream of coal solids and sand passes through the various processing zones, the sand serves as an effective and continuously moving filter for the coal liquids and solvent. Since the sand stream is continuously moving, the abrading action of the individual particles effectively maintains a nonclogged condition. Further, the sand, as an abradent, helps clean the filter screens that separate the various zones.

It is a further object of this invention to minimize the number of moving mechanical parts in the overall system thereby substantially eliminating the problems of frictional wear and erosion.

The method of this invention specifically involves introducing an intermixed stream of coal solids and sand into an extractor tower and continuously moving said stream successively through a primary extractor zone, a secondary extractor zone, a primary stripper zone and a secondary stripper zone. Solvent is introduced into the bottom of the primary stripper zone and is forced upwardly and counter currently to the solids in said zone for purposes of removing coal liquids therefrom. The enriched solvent is taken off at the top of the primary stripper zone, heated, and introduced at the top of the secondary extractor zone. The solvent flows downwardly through the solids therein and is further enriched with coal liquids and is taken off of the bottom of the secondary extractor zone, cooled, and introduced at the top of the primary extractor zone. The solvent flows downwardly through the moving bed and is taken off along with the absorbed coal liquids at the bottom of the primary extractor zone and conveyed to refining apparatus. The combined solids stream, after the coal liquids are extracted therefrom, is passed through a water wash zone wherein the residual coal liquids and solvent are washed from the solids and separated therefrom.

The drawing shows schematically the process of this invention.

The extractor tower is generally indicated by the numeral **10**. The tower is divided into four zones: a primary extractor zone **12**, a secondary extractor zone **14**, a primary stripper zone **16**, and a secondary stripper zone **18**. The primary and secondary extractor zones are separated by a conical filter screen **20** surrounded by and communicating with a conical, generally annular chamber **21** which collects liquids passing through the filter screen. The secondary extractor zone and the primary stripper zone are separated by a similar screen **22** and chamber **23**. The screen and chamber assemblies have bottom openings **25** and **27** communicating the zones. The primary stripper zone and the secondary stripper zone are separated by a funnel **24**.

Crushed and dried coal is introduced into the tower **10** at **26**. Fresh sand and recycled sand is introduced to the tower at **28** and **30** respectively. The sand and coal solids are intermixed and passed through the respective zones successively and continuously. The sand acts as a conveyor for the coal solids. Other benefits of using sand or some other fluid media for conveying the coal solids will be fully explained herein.

During the process of extracting coal liquids from the coal solids, the zones of the tower will be filled at all times, with the materials in the respective zones being in different stages of extraction.

Fresh solvent for use in extracting coal liquids is introduced through the bottom of the primary stripper zone **16** at **32**. The amount of solvent fed to the zone is regulated by means of the pump **34** and flow control regulator **36**. The solvent is forced to flow upwardly through the bed of intermixed coal solids and sand in the primary stripper zone whereupon adhered coal liquid is removed from the coal solids and sand particles and entrained in the solvent. The coal-liquid enriched solvent is taken off of the primary stripper zone at the top thereof through line **38** by means of pump **40** and flow control regulator **42**. The enriched solvent continues through lines **44**, **46** and **48** and then through heater **50** whereupon the solvent is heated to a desired temperature and introduced to the top of the secondary extractor zone through line **52**.

The solvent in the entrained coal liquids is introduced at **52** and flows downwardly through the intermixed sand and coal solids extracting coal liquids from the coal solids. The further enriched solvent is taken off of the bottom of the secondary extractor zone through chamber **23**, line **54**, line **56**, pump **58** and flow control regulator **60**. The solvent and entrained coal liquids are still hot as a result of being passed through the heater **50**. The solvent continues through line **62** and passes in heat-exchange relationship with line **46** which contains solvent in a much cooler state. The solvent in line **62** is thereby cooled and introduced to the top of the primary extractor zone through **64**, **66** and **68**. The relatively cool solvent and coal liquids are passed downwardly through the solids in the primary extractor zone and are taken from chamber **21** at **70** by means of pump **72** and flow control regulator **74**. The liquid coal extract and solvent are passed through lines **76** to fractionation and refining apparatus. The purpose in cooling the solvent is that the coal solids upon first entering the tower cannot be heated to a high temperature because they will "coke up." Preferably the temperature of the solvents injected into the primary extractor zone is about 500°–650° F. However, the temperature of the solvents injected into the second zone may be raised to around 700°–900 ° F. without "coke-up" problems. The higher temperatures may exist in the secondary zone because the more unstable liquids that cause "coke-up" have been removed in the primary zone.

Gas generated during the extraction and stripping processes is taken off through lines **78**, **80**, **82** and **84** at spaced points through the extraction tower.

The stripped sand and coal solids continue downwardly through the respective zones and through the secondary stripper zone and are washed by hot water at about 400° F. introduced into the bottom of the secondary stripper zone via line **86**. The water is maintained at a certain level in the bottom of the secondary stripper zone serving as a water seal between the outlet generally indicated by the numeral **88** and the upper portions of the extractor tower. The level of water is maintained by regulator **90**. The emulsified water and solvent flow upwardly through the secondary stripper zone by means of pressure provided by pump **92** and are taken off via line **94** at the top of the secondary stripper zone. The emulsion is passed through an electric dehydrator **98** whereby the solvent

is separated from the water. The separated solvent is taken out of the dehydrator through line **96** and reintroduced with fresh solvent to the bottom of the primary stripper zone **16**. The separated water is conveyed to a water reservoir **100** through line **102**. The water in the reservoir **100** is fed to the fresh-water input line as necessary to be added to the bottom of the secondary stripper zone.

Suitable disengager valves and disengager lock bins are provided at the bottom of the secondary stripper zone and separate the water from the coal solid residuals and sand. The separated water is introduced to the reservoir through line **104** and the solids are taken off through line **103**. The separated solids are passed to a carbon gasifier and gasified in accordance with the procedure set forth in our copending application Ser. No. 810,101 filed Mar. 25, 1969. entitled Method of Gasifying Carbonaceous Materials to a Carbon Monoxide Fuel Gas Product.

The dump valve **88** may be used in situations of emergency or when it is desired to empty the bottom of the extractor tower in a short period of time.

The sand which carries the coal solids through the four zones and the wash zone of the extractor tower also serves as a self-cleaning, continuously filtering medium and removes contaminants from the tower. The bed is continuously moving and the abrasion resulting between the individual particles serves to keep the material in suspension and reduces caking and clogging of the apparatus. Further, due to the fluid nature of the sand or similar materials the coal solids may expand without clogging the solvent flow-through paths. That is, the fluid media bed has a tendency to give and will shift in accordance with the dimensional changes in the coal solids. As mentioned earlier, the sand also cleans the conical screen filters **20** and **22**.

To minimize solvent losses the water seal at the bottom of the secondary stripper zone is maintained. Several flow controllers mentioned above are used to provide optimum flow within the coal extractor.

I claim:

1. A method of continuously extracting coal liquids from solid coal comprising the steps of introducing an intermixed stream of solid coal and sand into an extractor tower, continuously moving said stream successively through a primary extractor zone, a secondary reactor zone, a primary stripper zone and a secondary stripper zone using the sand as a conveying media, introducing a solvent into the bottom of said primary stripper zone, forcing said solvent upwardly through said primary stripper zone and stripping coal liquids from the continuously downwardly moving solid coal and sand therein, taking off the enriched solvent at the top of said primary stripper zone and heating the solvent, reintroducing the heated solvent at the top of the secondary extractor zone, extracting coal liquids from the solids therein and taking off the further enriched solvent at the bottom of the secondary zone, cooling the solvent and introducing it at the top of the primary extractor zone, extracting the coal liquids from the solids therein and taking off the solvent and coal liquids at the bottom of the primary extractor zone for refining, washing said solids with water, separating solvent from said wash-water and removing said coal solids and sand from said extractor apparatus.

2. A method of continuously extracting coal liquids from solid coal as defined in claim 1 wherein the solvent introduced to the top of the secondary extractor zone is heated to a temperature of between 700°–900° F.

3. A method of continuously extracting coal liquids from solid coal as defined in claim 2 wherein the solvent introduced to the top of the primary extractor is cooled to a temperature of between 500°–650° F.

4. A method of continuously extracting coal liquids from solid coal comprising the steps of entraining a stream of coal solids in a stream of fluid media to the top of an extractor tower, continuously moving said intermixed stream through an extractor zone and a stripper zone, introducing a solvent first to said stripper zone and then to said extractor zone for stripping and extracting coal liquids from said solids.

5. The method of claim 4 and including the further step of passing said stream through a hot wash zone for further removal of adhered coal liquids.

6. A method of continuously extracting coal liquids from solid coal as defined in claim 5 and including the step of introducing said wash-water to separator for separating the emulsified coal liquids and water and recycling the separated water for reuse in the wash zone.

7. A method of continuously extracting coal liquids from solid coal as defined in claim 4 wherein coal liquids are filtered from the solid stream between zones and said fluid media is used as a filter cleaner for preventing clogging.

8. A method of continuously extracting coal liquids from solid coal as defined in claim 4 and wherein said fluid media is sand and said sand conveys the coal solids through said zones and removes contaminants from said tower.

9. A method of continuously extracting liquids from solid carbonaceous materials comprising the steps of entraining a stream of carbonaceous solids in a stream of fluid media, continuously moving said stream through a liquid extraction zone and introducing a means to said zone for extracting liquids from said solids.

10. A method of continuously extracting liquids from solid carbonaceous materials as defined in claim 9 wherein said fluid media is sand.

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