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PIPE LINE FOR CONVEYING SULFUR AND
OTHER HOT LIQUIDS

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The present invention relates to the transportation of hot liquids and, more particularly, to an improved composite pipeline and method for transporting hot liquids underground or under water for long distances of several miles or more. The materials which can be transported in this manner are those which are solid or viscous in their natural state but are free-flowing liquids when heated, such as sulfur, asphalt, heavy molasses and the like.

The mining of sulfur is economically achieved by changing it from a solid to a liquid at its source in the mine, and conveying the molten sulfur under pressure through a conduit leading from the mine to ground level. While this method may present some problems where the sulfur mine is beneath dry land and no substantial overland transportation is necessary, serious problems arise when the mine is beneath the sea, requiring transportation of the molten sulfur long distances to shore.

One of the principal objects of this invention is to provide a method of, and apparatus for mining a solid material capable of being melted by the application of heat and for transporting the material over great distances in a molten state.

Another principal object of this invention is to provide a method of, and apparatus for mining sulfur at sea and transporting the sulfur to the shore.

Another object of this invention is to provide such a system in which the material to be mined is changed to a liquid at its source and forced under pressure through a conduit buried beneath the ground or sea floor while maintaining the material in a liquid state.

Another object of this invention is to provide such a system in which the buried conduit is a composite pipeline and includes no expansion joints.

Another object of the invention is to provide such a system including a mining station or a mining platform at sea at which mining equipment is provided and a prestressed, composite piping arrangement extending from the platform or station to a distant destination.

Another object of this invention is to provide such a system wherein the prestressed piping arrangement is buried beneath the ground or sea floor from a point adjacent the platform or station to a distant destination.

Another object of this invention is to provide such a system wherein the prestressed condition of the composite piping arrangement is substantially relieved during the normal functioning of the system.

Although the principles of the invention are equally applicable to the mining of meltable material and transporting it great distances over dry land or land incapable of accommodating surface transportation, they will be shown and described as applied to a system for mining such a material as sulfur, where the sulfur dome is beneath a large body of water and at a great distance from shore.

In one aspect of the invention, an outer or main casing, adapted to contain a line for conveying the molten material and an insulated jacket line surrounding the latter for conveying water or other heating fluid, may be fabricated on shore in sections with or without the material-conveying and jacket lines therein. Each section may have two parallel sections of water line attached on opposite sides of the casing section in a manner to provide a multi-line section of piping having a relatively wide bottom

surface area for adequately supporting the piping arrangement within the soil at the sea bottom.

The three portions of each composite section may be welded to succeeding sections on shore, and the initial sections may be attached to a vessel (or barge) so that the pipeline is pulled out to sea as succeeding sections of the composite line are welded together. The assembled line may be pulled out to sea until the initial section is spaced from a mining platform by an amount substantially equal to the thermal strain to which the casing will be subjected during normal operation, or by an amount 50 to 70% thereof.

A sea-station or platform may be provided containing mechanism for prestressing the main or outer casing by subjecting it to a tensile stress sufficient to strain the main casing until it reaches the platform or mining location. This may be done by providing anchors, suitably of temporary nature, from which chains extend to sheaves attached to the offshore end of the main casing, thence vertically upwardly to the sea-station. The sea-station may extend from the mining platform to the offshore end of the main casing and include a hydraulic jack mechanism mounted on sliding guide ways. With the shore end of the casing securely anchored, the ends of the chains opposite those connected to the seaward anchors may be raised by the jacking mechanism thereby applying an axial strain to the main outer casing, causing it to be stretched to the sea-station. Alternatively, the mechanism and power for prestressing may be situated on shore or on a barge operating in conjunction with anchors and cables.

After the main casing is prestressed, it is buried to a predetermined depth below the sea bottom. Not only will this insulate the casing against excessive heat losses, but when the back fill has developed sufficient shearing strength, such casing will remain prestressed after the prestressing mechanism is removed or the anchor-forming part of the tensile stressing apparatus and the shore anchor are disconnected.

In another aspect of the invention, the insulated hot fluid conveying line that surrounds the molten material conveying line within the main casing has mounted at each quadrant and externally thereof a series of rollers or other antifriction means for facilitating its movement axially of the main casing during assembly, during temperature changes of normal use and during replacement.

The material-conveying line may be provided with radial pins at each of two quadrants externally thereof for the purpose of spacing the material-conveying line eccentrically within the hot water line, providing means for controlling buckling of the material-conveying line when in compression. Succeeding sections of these two lines may be welded on shore and guided into the trailing or shore end of the previously laid main casing or into each section of the main casing before it is laid. The roller means on the outer periphery of the hot fluid line may be located at periodic intervals along the assembled lines, thereby facilitating the movement of the two lines within the main casing.

In another aspect of the invention, the material-conveying and hot water lines when first assembled, may extend into the main casing to a point short of the end of the main casing. When the system is employed with sulfur, it will be subjected to a temperature of about 300° F. because, although the melting point of sulfur is only 240° F., its lowest viscosity occurs at about 300° F. and becomes excessive above 320° F. Accordingly, the sulfur may enter the sulfur line at 320° F. at the mine and drop to about 280° F. at the shore or destination end of the line. In order to minimize stresses due to the elevated operating temperatures, during assembly, water may be circulated in these two lines within the main casing at a predetermined temperature, causing them to expand a predeter-