United States Patent

[11] **3,578,816**

[72] Inventor **Junn-Ling Chao**
Houston, Tex.

[21] Appl. No. **802,615**
[22] Filed **Feb. 26, 1969**
[45] Patented **May 18, 1971**
[73] Assignee **Shell Oil Company**
New York, N.Y.

[54] **METHOD OF FACILITATING THE RESUSPENSION OF THE SOLID PHASE OF A SLURRY IN A SHUTDOWN PIPELINE**
3 Claims, 6 Drawing Figs.

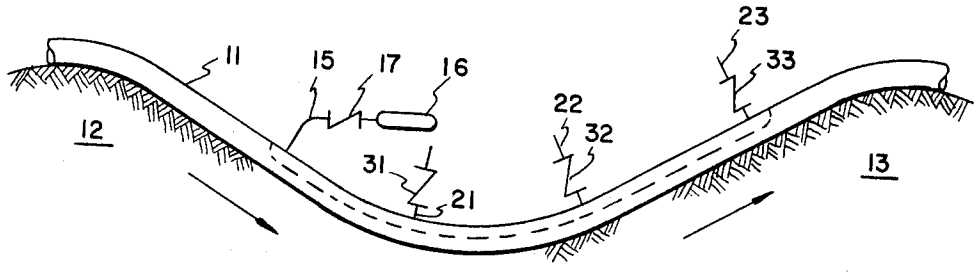
[52] **U.S. Cl.** **302/66,** 302/14, 302/64
[51] **Int. Cl.** **B65g 53/04**
[50] **Field of Search** 302/14, 16, 64

[56] **References Cited**
UNITED STATES PATENTS

2,391,484	12/1945	Seymour	302/64X
2,598,207	5/1952	Bailey et al.	302/64X
2,829,600	4/1958	Sveda	302/64X
3,265,445	8/1966	Cronin	302/64

Primary Examiner—Andres H. Nielsen
Attorneys—Thomas R. Lampe and J. H. McCarthy

ABSTRACT: Method for facilitating the resuspension of settled solids in a shutdown slurry pipeline. As flow in the pipeline is terminated a bladder or bag in the line is inflated in those locations where plug formation by slumping slurry solids is likely to occur. In this manner the settling solids will only occupy the space in the line not occupied by the bladder. Upon restart, the bladder is deflated to allow lateral movement of the solids in the line, thereby facilitating resuspension thereof.



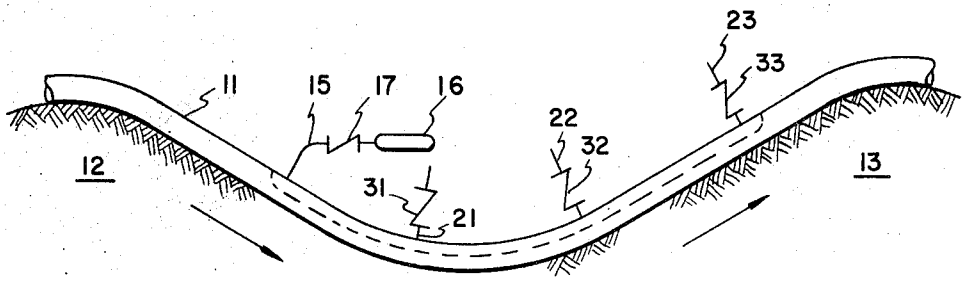


FIG. 1

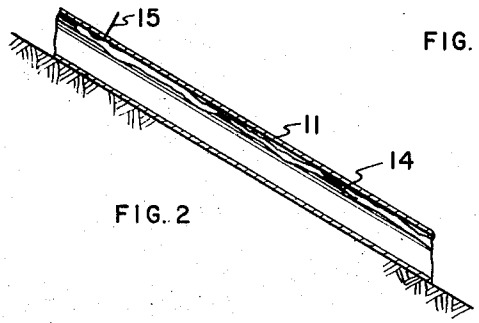


FIG. 2

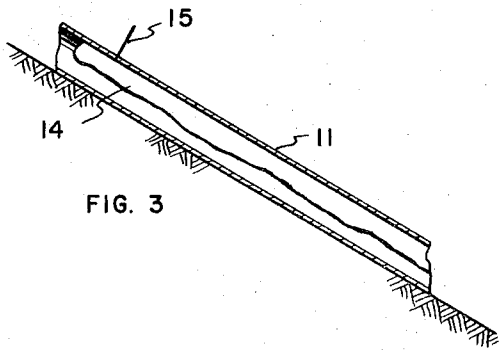


FIG. 3

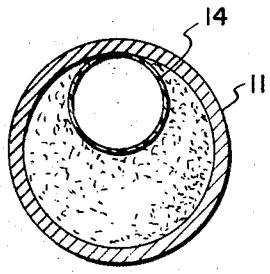


FIG. 5

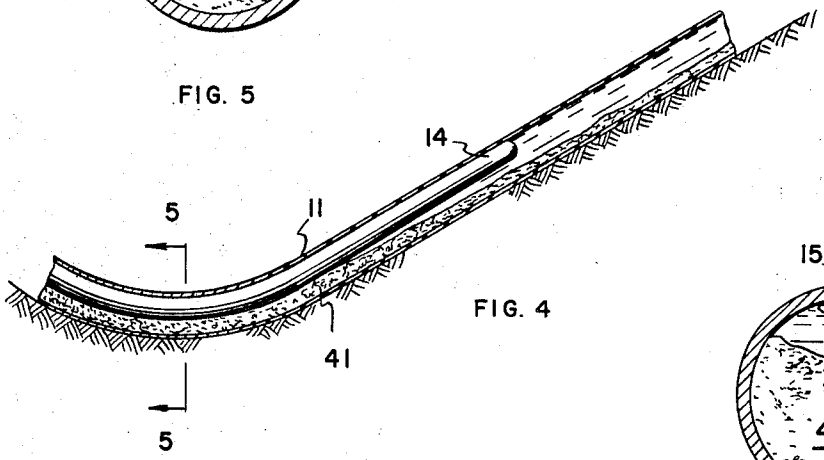


FIG. 4

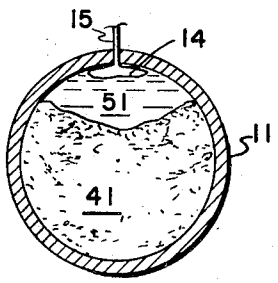


FIG. 6

INVENTOR:
JUNN-LING CHAO
BY: Thomas R. Lampe
HIS ATTORNEY

METHOD OF FACILITATING THE RESUSPENSION OF THE SOLID PHASE OF A SLURRY IN A SHUTDOWN PIPELINE

The present invention relates to pipeline transport operations; and more particularly, to a method for preventing the downward movement of slurry solids in an inclined portion of pipeline during a shutdown period.

Transportation by pipeline is a major and growing industry. With the use thereof formerly confined almost entirely to movement of water, gas and petroleum products, pipelines, with the advent of slurry transport, have become useful for long and short hauls of a wide variety of raw materials and finished products.

With respect to the pipeline transportation of materials in slurry form, problems arise when such materials are moved through pipelines inclined to go over a hill or down into a valley. At these locations, during a planned or emergency line shutdown, the solids of the transported slurry may settle out vertically and subsequently slide down the inclined portions of the pipeline, thereby causing a compacted plug which may be very difficult to dislodge and move when line shutdown is terminated and transport activities are resumed.

These difficulties are most commonly avoided by laying solids-carrying or slurry pipelines so that they do not exceed a slope or angle of inclination below which sliding does not occur. Alternatively, the inclined pipeline sections are emptied at each shutdown. Obviously, these alternative prior art approaches are not always feasible or economical, especially in those situations where long and relatively steep slopes are encountered. Slopes of this nature are being encountered with increasing frequency as pipeline operations are being extended to new relatively inaccessible mountainous areas in the United States and elsewhere.

SUMMARY OF THE INVENTION

It is therefor a primary object of the present invention to provide an improved and economical method whereby solid slurry material being transported in an inclined pipeline section is readily resuspended after slumping thereof has occurred during a line shutdown.

This and other objects have been attained in the present invention by providing a method for facilitating resuspension of slurry solid phase material in a shutdown slurry pipeline wherein an inflatable tube or bag is mounted within the pipeline in those portions of the line where plug formation due to settled slurry solids is likely to occur. The tube is inflated upon termination of pipeline flow to restrict the settled solid material to only a portion of the line interior by injecting a suitable fluid into the tube. Upon pipeline restart, the bag or tube is deflated by venting the pressurized fluid therefrom. In this manner resuspension of the solid phase material is facilitated since the solid material may be eroded and then carried along in the line to mix with the slurry liquid phase.

DESCRIPTION OF THE DRAWING

The above-noted and other objects of the present invention will be understood from the following description, taken with reference to the accompanying drawing. In describing the invention in detail, reference will be made to the drawing in which like reference numerals designate corresponding parts throughout several views in which:

FIG. 1 is a diagrammatic view illustrating a given length of slurry pipeline which has been modified in accordance with the teachings of the present invention;

FIGS. 2 and 3 are enlarged cross-sectional views in longitudinal projection illustrating an inclined portion of the pipeline section of FIG. 1 with the pneumatic bag operatively associated therewith in a deflated and a partially inflated condition, respectively;

FIG. 4 is an enlarged cross-sectional view in longitudinal projection of the slurry pipeline with the pneumatic bag in a fully inflated condition;

FIG. 5 is a cross-sectional enlarged view taken along the line 5–5 of FIG. 4; and

FIG. 6 is a view similar to that of FIG. 5 but illustrating the bag in a deflated position prior to resuspension of the settled slurry solids.

Referring now to FIG. 1, a given length of slurry pipeline 11 is illustrated in the position assumed thereby as the pipeline proceeds to and from a valley formed between two hills or mountains 12 and 13. The terrain illustrated is typical of that encountered in pipeline laying activities, although it should be understood that the teachings of the present invention may be carried out in any topographical configuration wherein a portion of slurry pipeline is inclined.

The transportation of slurries consisting of solid particles in a fluid medium by use of pipelines similar to that disclosed in FIG. 1 is quite well known, and such expedient is finding increasing use, especially in those situations where the source of raw materials is relatively remote and inaccessible from the point of delivery, which may be a suitable processing plant, for example. In the disclosed arrangement, it may be assumed for purposes of illustration that the slurry material being transferred through pipeline 11 as by means of conventional pumps (not shown) is moving through the line in the direction indicated by the arrows. However, the teachings of the present invention are, of course, applicable regardless of the direction of flow of the slurry.

As long as flow continues in the pipeline with sufficient flow rate, the solid matter of the slurry will remain in suspension within the pumped liquid, even when the solid matter has a higher specific gravity than the liquid. If, however, the flow is stopped for any reason, i.e., the pipeline is shut down, such solid matter will settle out of suspension. In the situation where the line is horizontal or the slope of the line is not steep enough to cause sliding of the settled solids, no problem is created by such settling out. Under these conditions, a liquid-rich channel remains open at the top of the line which allows the settled material to be resuspended with a minimum of difficulty upon resumption of slurry flow.

A serious problem can exist when the pipeline must be inclined to go over a hill or down a valley, as illustrated, for example, in FIG. 1. At these locations, the settling of solids followed by their sliding down the slope during a protracted shutdown can result in a compacted plug of material which is difficult, if not impossible, to move or resuspend. In the illustrated pipeline configuration, such solids would slide downwardly into the valley formed between hills or mountains 12 and 13. The solid material would then compress under its own weight to form a plug in the valley in an obvious manner. Upon restart, the slurry solid material may remain compacted and be difficult to resuspend in the slurry liquid phase.

According to the present invention, such resuspension of the slurry solid phase in the liquid phase upon pipeline restart is facilitated as follows. Disposed in pipeline 11 in those locations where slumping and consequent plug formation by the slurry solid phase is likely to occur is a tubular-shaped bag or bladder 14 which may be constructed of any flexible material which is pneumatically expandable and chemically inert with respect to the materials being transported within the pipeline. During slurry transport, bag 14 is maintained in the deflated condition illustrated in FIG. 2. In this condition, slurry flow is substantially unimpeded by the bag. Bag 14 is secured by any desired expedient to the top inner wall of pipeline 11 with the tubular portion of the bag closed at the ends in the fluidtight manner.

The interior of bag or bladder 14 is in communication with conduit 15 which extends through pipeline 11 and terminates at the other end thereof at a suitable source of compressed fluid, such as compressed air tank 16 (FIG. 1). A valve 17 is disposed in conduit 15 with said valve being of any suitable type, either manually or automatically actuated. Also communicating with the interior of bag 14 are vent lines 21, 22 and 23 having valves 31, 32 and 33, respectively, operatively associated therewith.

The operation of the above-described arrangement is as follows. Upon termination of slurry flow within pipeline **11** for any reason such as maintenance activities, bag **14** is inflated by opening valve **17** (which is closed during slurry transport) to provide communication between tank **16** and the interior of the bag **14**. The compressed fluid in the tank flows into the bag to inflate same, as shown in FIG. **3**. As stated above, actuation of valve **17** may be carried out by either manual or automatic means. It is necessary, however, that such inflation be carried out before the slurry solid phase has had an opportunity to slump down line **11**. Inflation continues until bag **14** is in the fully inflated condition illustrated in FIGS. **4** and **5**, whereupon valve **17** is closed. In this condition, the bag occupies a substantial portion of the pipe interior. During such inflation it is to be understood that valves **31**, **32** and **33** remain closed so that the fluid introduced into the bag does not have an opportunity to vent therefrom through lines **21**, **22** and **23**.

In FIGS. **4** and **5**, the slurry solid phase is indicated by means of reference numeral **41** and is shown as having slumped downwardly within pipeline **11** after termination of slurry flow in the line. It should be noted that the settled solids only occupy space within the pipeline not occupied by the inflated tubular-shaped bag or bladder **14**.

Upon restart of pipeline **11** the line pressure is gradually increased and valves **31**, **32** and **33** are opened. The increased line pressure collapses bag **14** and the pressurized fluid contained therein vents through lines **21**, **22** and **23** until the bag is fully collapsed as shown in FIG. **6**. Such collapsing action causes the formation of a liquid-rich channel **51** along the upper portion of the line. The deposited bed of solid material **41** lying along the bottom of the pipeline will then be eroded away by the flow with consequent resuspension of the solid phase within the liquid phase. In other words, the present invention prevents the complete formation of plug within the pipeline and provides a trouble-free channel to establish flow during restart.

I claim:

1. A method of facilitating the resuspension of the solid phase of a slurry material in a shutdown pipeline, said method comprising:

establishing a slurry-free zone in said pipeline in those locations of the line where slumping and compacting of the slurry solid phase under the influence of gravity is likely to occur upon shutdown; and

introducing a liquid-rich slurry into said zone upon pipeline restart whereby compacted solid phase materials positioned in said line will be eroded away and resuspended for transport.

2. The method of claim **1** wherein the step of establishing a slurry-free zone in said pipeline includes the steps of:

installing an inflatable bag in said pipeline in communication with said slurry; and thereafter

inflating said bag whereby said bag in its inflated state occupies a substantial portion of the cross-sectional area of said pipeline thereby forming said slurry-free zone.

3. The method of claim **2** wherein the step of introducing a liquid-rich slurry into said zone includes the step of deflating said bag thereby removing said slurry-free zone, said liquid-rich slurry thereafter occupying the zone previously occupied by said inflated bag.