United States Patent

Scott

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[54] **PERMAFROST STABILIZATION FOR BEARING HEAVY STRUCTURES**

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[52] **U.S. Cl.**.....**61/36 A,** 52/11, 52/50

[51] **Int. Cl.**.....**E02d 3/10**

[58] **Field of Search**.....61/35, 36, 36 A, 50, 11; 52/169, 742

[56] **References Cited**

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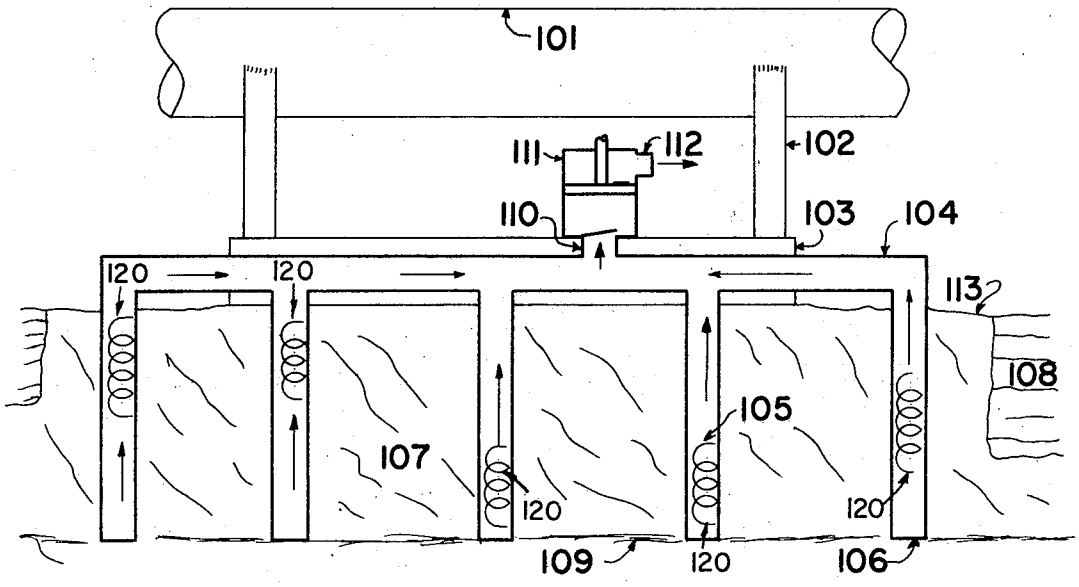
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Assistant Examiner—Philip C. Kannan
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[57] **ABSTRACT**

A process and apparatus are disclosed for improving load bearing capability of permafrost for mounting structures in arctic regions. The structures are loaded upon or within the permafrosted soil with means for melting the permafrost and means for removing water beneath the structures so that water accumulated from the melted permafrost may be drawn from below the structure and removed to the surface.

10 Claims, 2 Drawing Figures



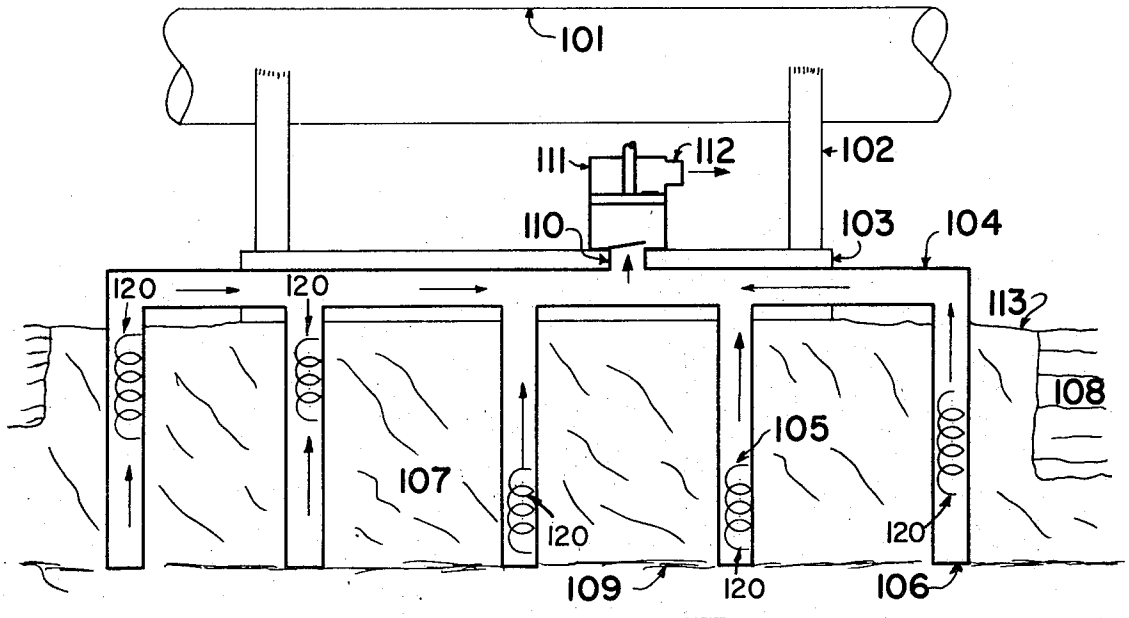


Fig I

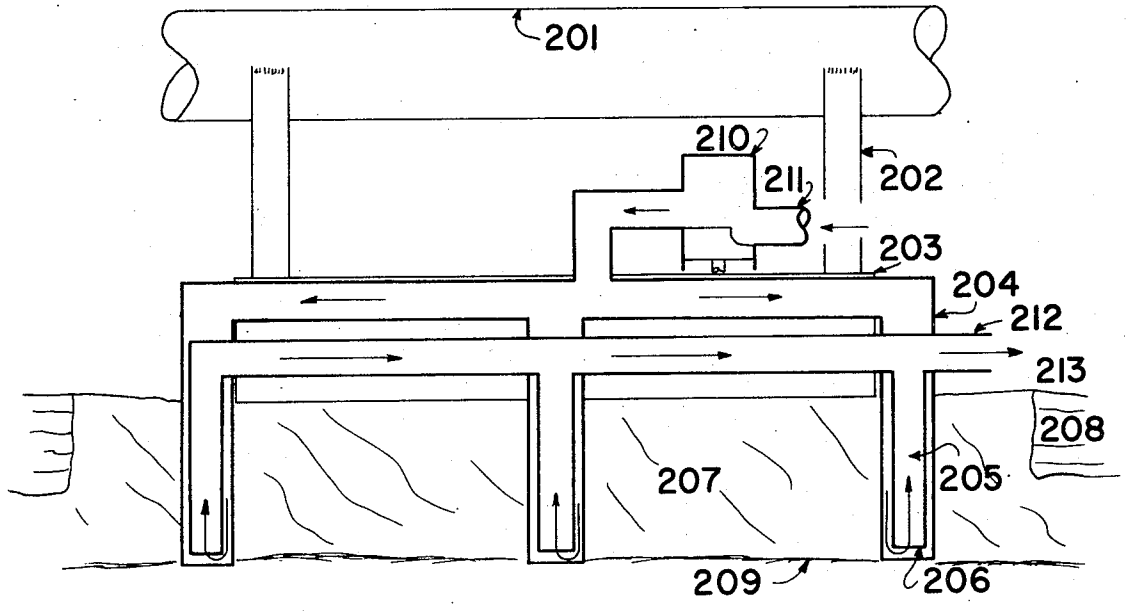


Fig II

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PERMAFROST STABILIZATION FOR BEARING HEAVY STRUCTURES

BACKGROUND OF THE INVENTION

The present invention relates to the construction of ground loading structures in arctic regions. More particularly, the present invention is a process and apparatus for the construction of pipelines or other weighted structures on permafrosted soil in arctic regions.

In the construction of heavy structures on ground surfaces, such as unconsolidated sands and clays, it is necessary that the ground surfaces be modified to bear the weight of structures placed upon them. The soil materials are such that the ground surfaces are inherently unstable structurally as they yield considerably with loading and in some cases flow with continued loading. The tendency to yield and to flow is increased by increasing water content in the ground surface.

Often, to increase structural stability or load bearing capacity of soils, silts, sandy clays, etc., a method of desaturating the porous space of these materials is required to remove water so that the soils can be compacted. One method for the removal or desaturation of the porous space of these materials may be accomplished by emplanting drainage tubes or water relief conduits in the soils beneath the load bearing structures.

In the construction of pipelines or other weighted structures in arctic regions, it is frequently required that the structures traverse permafrost land. As long as the permafrost land or soil remains frozen, stable load bearing properties are maintained. If the structure, however, is heated above the freezing point of the frozen ground, the continued conduction of heat to the frozen ground will cause internal water to become fluid. The soil becomes uncompacted and exhibits a high porosity as the heated structure transmits heat thereto and is likely to cause the ground surface or permafrost land to yield and flow under load of the structure placed upon it. This loading allows the pipeline to sink into the permafrosted soil. The sinking of a heated pipeline in permafrosted soil will eventually cause failure of the pipeline and loss of product, thus damaging the environment and ecology of the area and resulting in great economic loss. What is required is a method for preventing the sinking of a heated structure into permafrosted soil by reducing the water content of the permafrosted soil as it is heated.

It is an object of the present invention to provide a method for the construction of heavy heated structures on permafrost land.

It is a further object of the present invention to provide a method for removing the water from beneath heated structures on permafrosted soils.

It is still a further object of the present invention to provide means for melting the water contained in permafrosted soil underneath structures constructed on permafrosted soils and provide means for lifting the water from the soil so as to prevent the heated structure from sinking into the permafrosted soil.

With these and other objects in mind, the present invention may be more fully understood by referral to the following drawings and discussion.

SUMMARY OF THE INVENTION

The objects of the present invention are accomplished by a process and apparatus for the removal of frozen water from below a permafrosted soil carrying a heavy structure. The apparatus comprises one or more conduits penetrating the permafrosted soil from the ground surface. Means for heating the permafrosted soil to melt the frozen water are applied to the permafrosted soil. In conjunction with the means for heating the permafrosted soil are means for removing the melted water from the permafrosted soil through the conduits. The means for heating the melted water from the permafrosted soil may comprise the heat dissipated from the heated structure. Additional means for heating the permafrosted soil may comprise an electric heating element formed within the conduits and means for removing the melted water may comprise a fluid pump, the inlet of which is positioned at the bottom of the conduit.

It is also within the present invention that the conduit may comprise two concentric tubes forming an annular section therebetween and an inner section therein comprising the smaller of the two concentric tubes. The means for heating the melted water from the permafrosted soil may comprise heat from the heated structure or the exhaust gas from an internal combustion engine injected down the annular section of the conduit with the means for removing the melted water comprising production of the exhaust gas-entrained water mixture formed, from the inner section of the conduit. The apparatus may further comprise packing the conduit with an aggregate selected from the group consisting of sand, gravel and porous cement such that further support is afforded the conduit.

The objects of the present invention may also be achieved by a process for the removal of frozen water from permafrosted soil below a loaded structure in which one or more holes are drilled into the permafrosted soil below the loaded structure. Conduit is placed in the drilled holes so that they extend from the ground surface and heat is applied to the permafrosted soil below the structure such that the frozen water contained in the permafrosted soil is melted and removed from the permafrosted soil through the conduit.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention may be more fully understood by referral to the following drawings in which:

FIG. 1 represents an embodiment of the apparatus of the present invention for the removal of frozen water from the permafrosted soil below a loaded structure in which a single tube conduit is utilized with heating means in conjunction with a pump; and

FIG. 2 represents apparatus in the form of a dual conduit assembly with two concentric tubes which are utilized in conjunction with a heated gas for the entrainment and production of the melted water from the permafrosted soil.

DETAILED DESCRIPTION OF THE INVENTION

The apparatus and process of the present invention for the removal of water from permafrosted soil below a heated-loaded structure will generally be used for the construction of pipelines in arctic regions. The inherent

problem to be deferred by the apparatus and process of the present invention is that of melting of permafrosted soil, which subsequent to melting becomes unstable with its load bearing properties being lost. Melting the water from the frozen ground slurries the soil in an uncompacted state such that it may flow and yield from the heated load bearing structure and does not supply the requisite support for the structure. It has been found that the instability of such structures on permafrosted soils is not due to the lack of conformity of the soil itself, but due to the movement of water which melts therein. Removing the water leaves a solid support behind which may be compacted by the weight of the structure. A firm support exhibiting stable load bearing properties may be maintained by the use of the apparatus and process of the present invention.

FIG. 1 represents one embodiment of the present invention in which heated pipeline **101** is positioned upon stanchion **103**, having support legs **102** such that it transmits convective and conductive heat to the permafrosted soil **108**. This heat transfer melts the water contained therein and under normal conditions would cause instability of the melted permafrosted soil **107** and sinking of the pipeline **101** into the melted permafrosted soil **107**. The apparatus of the present invention consists of one or more conduits **105** penetrating the melted permafrosted soil **107** from the ground surface **113** and having a screen **106** over the bottom thereof. Additional heat may be applied to the permafrosted soil **108** through electric heating elements **120** contained within the conduits **105** such that the water contained within the permafrosted soil **108** melts and forms a reservoir of water **109** under the melted permafrosted soil **107**. The water **109** is drawn through conduit **105** by suction pump **111** intregally connected to the conduit **105** by connection head **110** such that water is produced from the pump **111** through exit **112**. Therefore, through continuous use of the apparatus of the present invention the permafrosted soil in the vicinity of the stanchion **103** is continually melted and the water therefrom removed such that the stanchion **103** will not sink into the melted permafrosted soil **107**, which remains rigid and uniformly conform throughout the life and usage of the pipeline **101**. Obviously, pipeline **101** may be positioned on a gravel bed or within the soil, thereby eliminating the stanchion **103** and support legs **102**.

Another embodiment of the present invention is shown in FIG. 2 in which heated pipeline **201** is positioned on stanchion **203** having support legs **202**. The apparatus of the present invention comprises an outer conduit **204** and an inner conduit **205** forming an annular section therebetween and an inner section therein the smaller of the concentric tubes. Outer conduit **204** and inner conduit **205** which penetrate the permafrosted soil **208** through melted permafrosted soil **207** from the ground surface **213**. The bottom of the inner conduit **205** has a screen **206** positioned across it to prevent the entrance of the soil therein. The two concentric tubes, outer conduit **204** and inner conduit **205** are each consecutively joined such that the outer conduit **204** is connected to the exhaust manifold **211** of an internal combustion engine **210**. The exhaust from the internal combustion engine **210** is injected through outer conduit **204** into the melted permafrosted soil **207**, entrains water **209** therein and is produced through the inner conduit **205** such that the exhaust gas-entrained water mixture exits from the inner conduit **205** at exit **212** on the ground surface **213**. Therefore, through the utilization of the apparatus as depicted in FIG. **2**, an internal combustion engine **210** supplies the means for heating the outer conduit **204** and the means for removing the water **209** produced from the heating of the melted permafrosted soil **207** in the form of an exhaust gas-entrained water mixture from the inner conduit **205** of the apparatus. Continued utilization of the apparatus depicted in FIG. **2** prevents the movement of the stanchion **203** and therefore prevents the sinking of and stabilizes the heated pipeline **201**.

The apparatus of the present invention consisting of conduit, heating means and means for removing the melted water from the permafrosted soil may further comprise the packing of the conduit with an aggregate such as those materials selected from the group consisting of sand, gravel and porous cement or any other medium which will allow the flow of melted water or a heated gas-entrained water mixture therethrough, while maintaining support for the pipeline or loaded structure carried thereon. The materials of construction of the conduit utilized in the present invention would be that of standard pipeline materials which will withstand the extreme temperature changes of the arctic regions and provide corrosion resistance to the gas-water mixtures which may be passed therethrough.

When utilizing the process for the removal of frozen water from a permafrost zone below the loaded structure, to melt the frozen water contained therein the permafrosted soil, the water is continuously removed through the conduit. The process may comprise a further step of packing the conduit after its placement with aggregate as disclosed herein so as to prevent the movement of the soil within the melted permafrost zone.

The present invention discloses apparatus and a process for the construction of pipelines or other loaded structures in arctic regions. The permafrost land is retained in a stable load bearing state such that the loaded structures or pipelines may be constructed on generally uncompacted soil. The high porosity and low yield and flow characteristics of these soils are rendered stable with the sinking of the heated pipeline into the permafrosted soil avoided so that the possibility of pipeline failure and loss of product thereby damaging the environment and ecology of the area is curtailed.

While the present invention has been described herein with respect to the particular embodiments thereof, it will be appreciated by those skilled in the art, however, that various changes and modifications can be made without departing from the scope of the invention.

Therefore, I claim:

1. Apparatus for the removal of water from permafrosted soil below a loaded structure, which comprises:

a. one or more conduits penetrating the permafrosted soil;

b. means for heating the permafrosted soil to melt the water contained therein; and

c. means for removing the water from the permafrosted soil through the conduits.

2. The apparatus of claim 1 in which:

a. the means for heating water from the permafrosted soil comprise electric heating elements formed within the conduits; and

b. the means for removing the melted water comprise a fluid pump with the inlet of the pump positioned in the bottom of the conduit.

3. The apparatus of claim 2 in which the conduit is packed with an aggregate selected from the group consisting of sand, gravel and porous cement.

4. The apparatus of claim 2 in which the conduit has a screened bottom to prevent the movement of solids therein.

5. The apparatus of claim 4 in which the conduit is packed with an aggregate selected from the group consisting of sand, gravel and porous cement.

6. The apparatus of claim 1 in which:

a. each conduit comprises two concentric conduits, an outer conduit and an inner conduit forming an annular section there between;

b. the means for heating the permafrosted soil comprises a heated gas injected down the annular section of the conduit to form a heated gas-entrained water mixture with the melted water from the permafrosted soil.

7. The apparatus of claim 4 in which the heated gas is exhaust gas from an internal combustion engine.

8. The apparatus of claim 7 in which the inner conduit has a screened bottom to prevent the movement of solids therein.

9. A process for the removal of frozen water from permafrosted soil below a loaded structure, comprising:

a. drilling one or more holes in the permafrosted soil below the loaded structure;

b. placing conduit in the drilled holes;

c. heating the permafrosted soil below the loaded structure; and

d. removing the melted water from the permafrosted soil through the conduits.

10. The process of claim 9 further comprising packing the conduit after its placement with an aggregate selected from the group consisting of sand, gravel and porous cement.

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