# United States Patent [19]

**Doose**

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[54] **CONDUIT SYSTEM FOR THE TRANSPORT OF LIQUID AND/OR GASEOUS MEDIA AND METHOD**


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[51] **Int. Cl.**..... **F16l 9/18,** H01b 9/06

[58] **Field of Search** ..... 312/1; 174/15 C, 17 GF, 174/ DIG.6; 137/375, 1; 200/168 G



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[57] **ABSTRACT**

In a conduit system for transporting fluids which includes a vacuumized tubular casing containing fluid medium-carrying conduits, there is provided an outer protective tube surrounding the vacuumized tubular casing and defining therewith an annular jacket which contains an inert gas. The inert gas is such that it does not condense during a possible entry into the vacuumized tubular casing, exhibits a pressure which is higher than the pressure of the environment surrounding the protective tube and higher than the pressure of the fluid being transported, and has a boiling point below the operating temperature of the fluid being transported.


**6 Claims, 2 Drawing Figures**

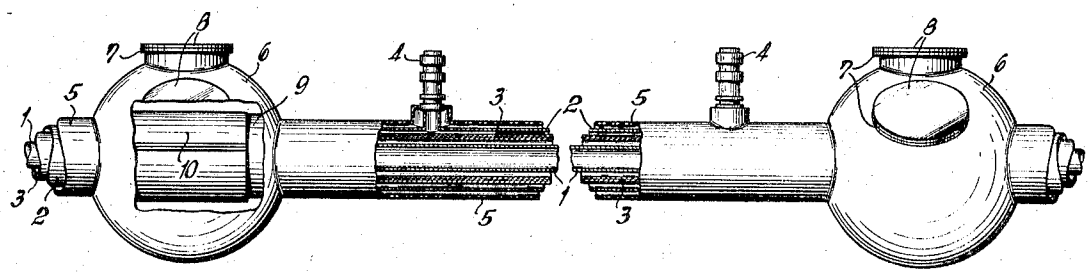


FIG. 1

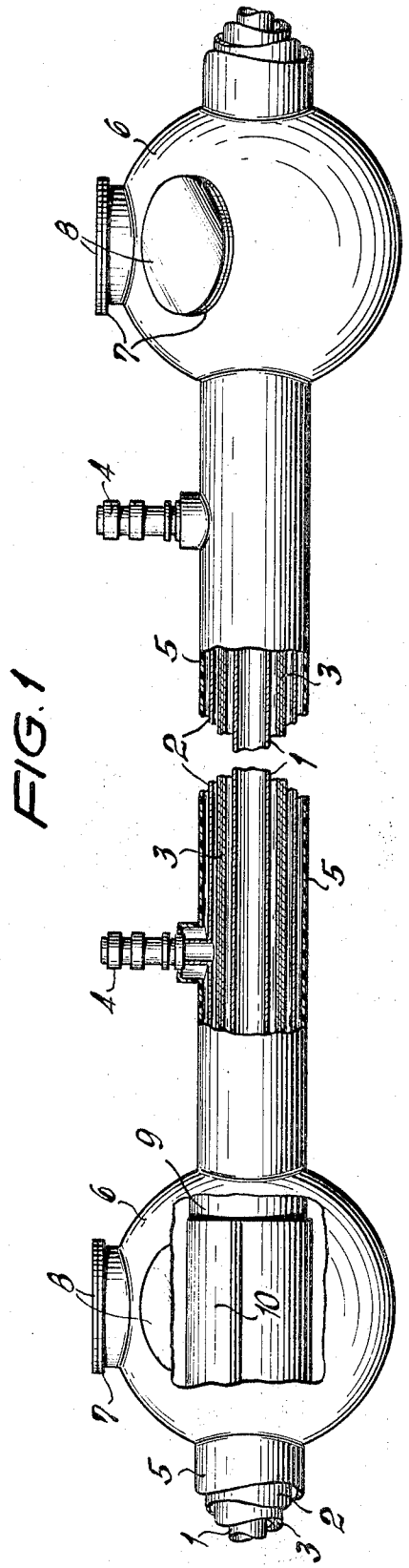
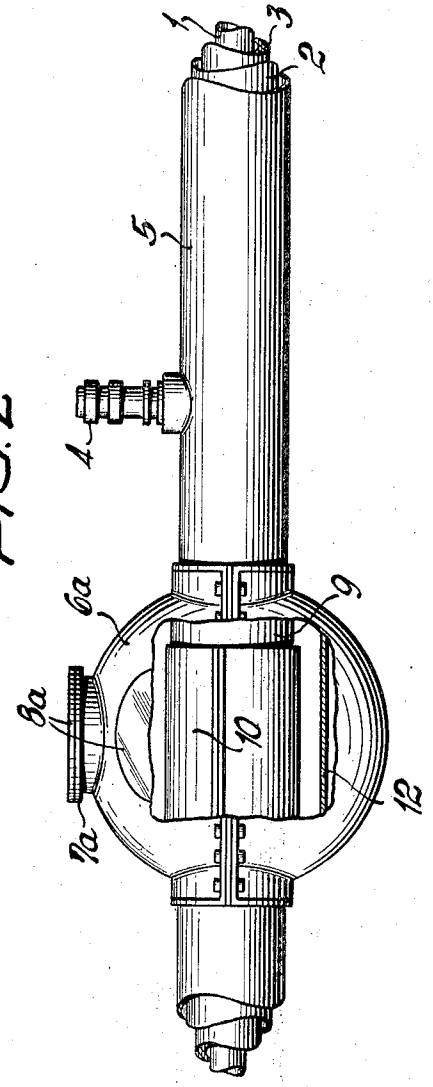



FIG. 2




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# CONDUIT SYSTEM FOR THE TRANSPORT OF LIQUID AND/OR GASEOUS MEDIA AND METHOD

## BACKGROUND OF THE INVENTION

This invention relates to a conduit system for the transport of liquid and/or gaseous media having extremely high or extremely low temperatures with respect to the environment, from which they are to be securely isolated. The conduits which carry the said media are usually disposed in a tubular vacuum casing. Conduit systems of this type often serve for the transport of media over large distances. In case the system includes a plurality of conduits for the transport of the medium or media, they may be in a concentric and/or axially parallel arrangement.

In known conduit systems of the aforenoted type tubular casings are provided which simultaneously serve for the support of the conduits in which the media flow. It is known, for example, in systems designed for the transport of liquid gases having a low boiling point, to vacuumize the annular space between the gas conduits and the casing and to dispose therein powder or solid insulating means, such as radiation shields. In such a known arrangement advantage is taken of the very good thermal insulating properties of the vacuum. In general, the vacuum is below $10^{-4}$ mm Hg pressure since below this value the heat conductivity of gases may be neglected. If the conduit system designed for the transport of liquid or gaseous media contains fluid that reacts with oxygen, such as, for example, hydrogen, there is the possibility of oxyhydrogen formation which endangers the environment to an unpermissible extent.

A further disadvantage of known conduit systems becomes apparent particularly when very low-temperature media have to be transported over long distances, for example, for the cooling of electric conductors. The substance of this disadvantage resides in the fact that under conditions prevailing in practice, it has not been possible to manufacture perfectly vacuum-tight tubular casings. As a result, through the leaks in the tubular casing atmospheric gases find access to the very low-temperature conduit components and condensate there. Since, because of the condensation they could not be drawn off by pumping, they form in the range of the leaking locations layers of condensed air which grow continuously during the year long operation. These layers of condensed air grow into the radiation shields, for example superinsulation and increase the undesired heat infiltration. This results in a substantial lowering of the value of conductivity in the evacuated annular space of the conduit system. In addition, since leaks have also been formed on the conduits disposed inside the tubular casing, the transported media (such as coolant for the electric conductors) have leaked out of the conduits into the vacuum. This has required the provision of pumps to draw away continuously the leaked-out coolant. In case the vacuum is as low as $10^{-5}$ mm Hg pressure — as this has been very often the case — it has been necessary to provide high-capacity vacuum pumps, such as turbo-molecular pumps, in order to maintain the vacuum at the desired magnitude. Such an arrangement is disadvantageous since these pumps, because of their mode of operation and their requirement for relatively frequent maintenance are not adapted for a continuous operation for an unlimited period, let alone an underwater operation which is sometimes necessary.



Since in conduit systems known heretofore an absolute vacuum-tight condition could not be achieved, it was also not feasible to fully prevent the leakage of radioactive liquids or gases into the atmosphere; consequently, it has been necessary to provide a proper monitoring system.

A further disadvantage of the known conduit systems resides in the fact that for maintenance or repair work on the tubular conduits designed for the transfer of the medium, it has been necessary to open the tubular casings with the undesirable consequence that at least in the range of such openings the protective effect has been disrupted. It has been therefore necessary to first shut off, and, as the case may have been, heat or cool the medium-carrying conduits. Consequently, portions of the conduit system could not operate for a substantial period of time. In case the conduit system has served for the transport of radioactive media, it has been necessary to take very expensive and complex measures for preventing the media from entering into the atmosphere.

Further, pipe line systems which have to be laid under water, or underground in water are exposed to corrosion to a particularly great extent. It is a further disadvantage of the known conduit systems that repair or maintenance work has been possible only if the system sections are raised above the surface of the water since the penetration of even the smallest quantities of water on a single occasion renders the system unusable. The necessary of raising portions of the conduit system for performing work thereon and then subsequently lowering them, results almost inevitably in damages to the heretofore undamaged adjacent sections. It is thus seen that great difficulties are involved in maintaining conventional conduit systems in a satisfactory operational condition under the aforenamed circumstances.

## OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved conduit system in which the penetration of gases which may condensate or which may react with the fluid (liquid or gaseous media) transported by the system, as well as the outward leakage of poisonous, radioactive or explosive fluids from the system is prevented both in operation and during repair and maintenance work regardless of whether such work has to be performed under water or under other unfavorable conditions.

Briefly stated, according to the invention, in a conduit system of the afore-outlined type, the tubular casing which encloses the fluid conduits and which may be vacuumized, is surrounded by a gastight protective outer tube and in the annular space defined by the tubular casing and the surrounding outer tube there is contained an inert gas having a boiling point below the operational temperature of the conduit system.

The invention will be better understood, as well as further objects and advantages of the invention will become more apparent, from the ensuing detailed specification of two exemplary embodiments of the invention taken in conjunction with the drawing.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a partially sectional longitudinal side eleva-

tional view of a first embodiment of the invention, and

FIG. 2 is a longitudinal side elevational view, partially broken away, of a second embodiment of the invention particularly adapted to be associated with the transfer of electric energy.

## DESCRIPTION OF THE EMBODIMENTS

Turning now to FIG. 1, there is illustrated a conduit 1 for the transfer of a fluid, surrounded by a tubular casing 2. It is to be understood that instead of a sole conduit 1 a plurality thereof may be present either in a coaxial or in an axially parallel arrangement. In the embodiment which is shown in FIG. 1 and which is adapted for the transport of liquefied or very low-temperature gases, the space defined between the conduit or conduits 1 and the tubular casing 2 is maintained, for heat insulating purposes, at a vacuum that is lower than $10^{-4}$ mm Hg. pressure. For an improvement of the insulation there are further provided insulating means 3 in the aforenoted space. The vacuum is maintained by means of absorption pumps 4 disposed at predetermined intervals along the conduit system. These pumps are preferably of the ion-getter type, since they are known to operate continuously even under water for years without maintenance. According to the invention, the tubular casing 2 is surrounded by a protective outer tube 5 in such a manner that between the tubular casing 2 and the protective outer tube 5 there is formed an annular space. The material of which the protective outer tube 5 is made is in each instance adapted to the actual requirements; it has been found particularly expedient to use a synthetic material to provide an effective protection against the corrosion of the tubular casing 2 from external effects. The annular space defined between the tubing casing 2 and the protective outer tube 5 contains an inert gas which does not condensate even at the lowest temperatures that prevail during the operation of the conduit system and which at the same time constitutes a gas barrier protecting the components associated with the conduit system.

The pressure of the inert gas lies expediently above the atmospheric pressure, since in this manner an outwardly screening barrier is formed about the conduit 1. Helium was found to be particularly advantageous to be used as the inert gas, since helium which may have entered the adjoining vacuum space, does not condensate even at the lowest operating temperatures. Further, even if the medium carried by the conduit 1 has very high temperatures, no chemical reaction with helium will take place.

It is a particular advantage of the conduit system according to the invention that the residual gas in the vacuum between conduit 1 and tubular casing 2 is formed practically exclusively of permanent gases, so that for the purpose of maintaining the vacuum, the aforenoted absorption pumps — which have no movable parts — may be used.

In case the transported media are poisonous or radioactive fluids, it is particularly advantageous to maintain the inert gas forming the protective barrier, at a pressure which is above the pressure of the fluids. In this manner the media are prevented from leaking into the atmosphere.

At predetermined intervals along the length of the conduit system, the protective outer tube 5 surrounding the tubular casing 2 is enlarged to form housings 6. In each housing 6 there are provided openings 7 which may be tightly closed by means of tightenable lids 8. Dependent upon the environment by which the conduit system is surrounded, the openings 7 are designed as glove box-type ducts (similar to those for handling contaminating matter from the outside) in such a manner that appropriate sluices (not shown) may be mounted thereon to make possible an entry into the housing. This is particularly advantageous in case the housings 6 should be accessible from under water. An access to the conduits 1 is then possible without difficulty through extensions 9 of the tubular casing 2 after removal of the closures 10 provides thereon. The housings 6 may be under vacuum or may be filled with an inert gas under sufficiently high pressure.

Turning now to the embodiment depicted in FIG. 2, the portions enlarged into housing 6*a* may be dismantled and the joints have a known vacuum-tight structure. The entrance openings 7*a* provided in the housing 6*a* are also closable in a vacuum-tight manner by the lids 8*a*. On these entrance openings sluices (not shown) may be mounted, so that an occasionally necessary introduction or removal of electric conduits may be performed in vacuum or in an atmosphere of a protective gas. To facilitate any repair work, in the housing 6*a* there is provided a platform 12. By means of the housings 6*a* provided at predetermined distances, it is possible in a simple manner to remove a damaged conduit portion through the entrance shaft 7*a* and the sluice mounted thereon and to insert a spare portion from an adjacent housing. During the performance of these operations, both the coolant flow in the conduits 1 and the insulating vacuum in the casing 2 are maintained without disturbance. Thus, according to the invention, the operation of the pipe line portion undergoing repair work does not have to be interrupted.

The protective tube 5 will operate with similar effectiveness in case the conduit is used for the transfer of very high temperature media or radioactive fluids.

That which is claimed is:

1. In a conduit system for transporting fluids with a high reliability of insulation with respect to the environment surrounding the system, said system being of the type that includes at least one fluid-carrying conduit surrounded by a vacuumized tubular casing, the improvement comprising a gastight protective outer tube surrounding said tubular casing for defining therewith an annular space and a protective inert gas which does not condense during a possible entry into said vacuumized tubular casing, said inert gas filling said space surrounding said tubular casing and having a pressure which is higher than the pressure of the environment surrounding said outer tube, a pressure higher than the pressure of the fluid being transported and a boiling point below the operating temperature of the fluid being transported.

2. A conduit system as defined in claim 1, wherein said inert gas is helium.

3. An improvement as defined in claim 1, including spaced housings along said conduit system, said housings are formed as enlargements of said gastight protective outer tube; each housing includes normally closed access opening means.

4. An improvement as defined in claim 3, wherein said opening means are designed as glove-like ducts.

5. In a method of transporting fluids by a conduit system including at least one fluid-carrying conduit surrounded by a vacuumized tubular casing, the improvement comprising the steps of surrounding said tubular casing with a layer of protective inert gas having a boiling point below the operating temperature of said conduit system and maintaining the pressure of said inert gas above the atmospheric pressure.

6. In a method of transporting fluids by a conduit system including at least one fluid-carrying conduit surrounded by a vacuumized tubular casing, the improvement comprising the steps of surrounding said tubular casing with a layer of protective inert gas having a boiling point below the operating temperature of said conduit system and maintaining the pressure of said inert gas above the pressure of the fluids to be transported.

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