July 16, 1963 Z. B. ANDREWS 3,097,838

PNEUMATIC HEAT TRANSFER TYPE AIR DAMPER

Filed Feb. 27, 1961 2 Sheets-Sheet 1

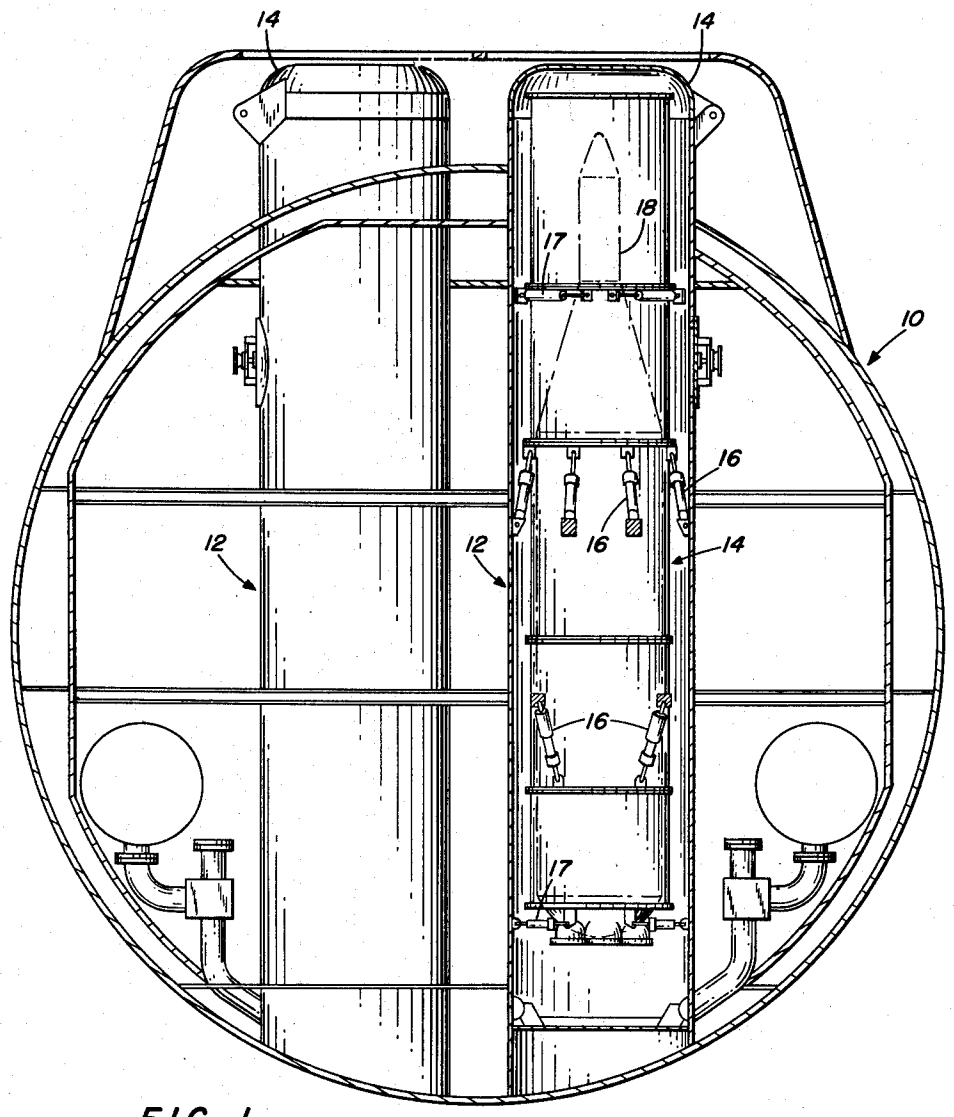


FIG. 1

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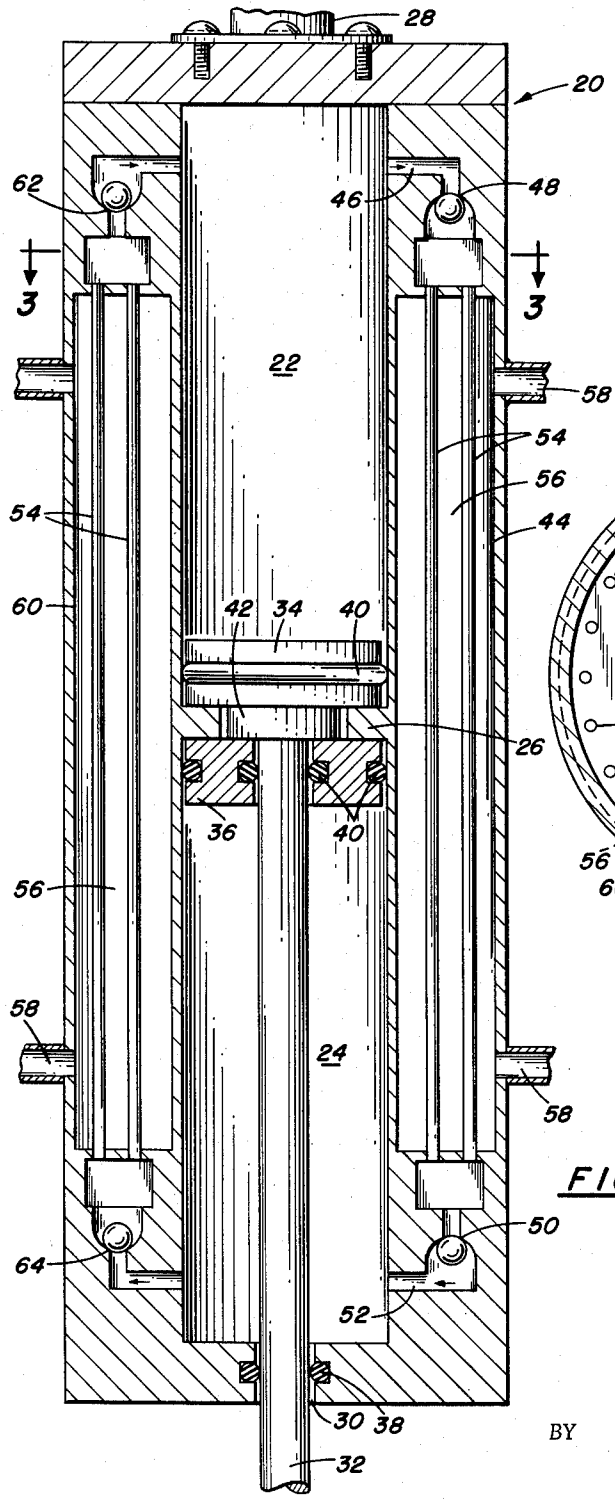


FIG. 2

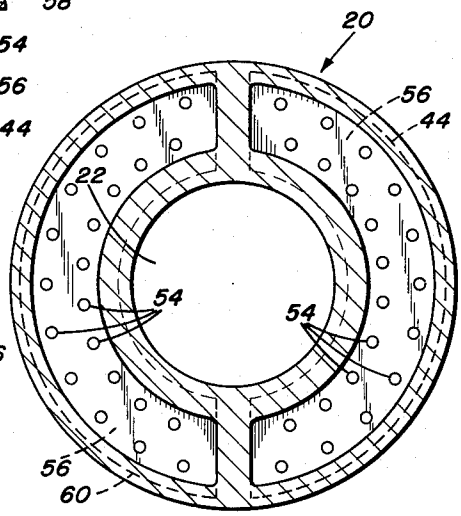


FIG. 3

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PNEUMATIC HEAT TRANSFER TYPE AIR DAMPER

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6 Claims. (Cl. 267—1)

The present invention relates generally to missile launchers and more particularly to shock absorbing means for the missile mount.

At the present state of the art there are three basic types of launching techniques; namely, surface launching from hard pads, launching from airborne craft, and launching from moving vehicles of either surface or undersea types. The present invention lends itself particularly well to the third type of launching system; however, it could very readily find use in any system for handling and launching ballistic or guided missiles as well as many other completely unrelated uses.

The missile launching systems of the moving surface or undersea vehicle configuration are usually provided with a fixed supply of missiles stored in firing position to facilitate rapid launching. A customary method of accomplishing this fixed number of ready to launch missiles is to provide a tube type launching system which includes one or more launching tubes, each tube containing a missile therein and acting both as a storing and conveying means as well as a launcher. Since the vehicles of this category are frequently subjected to substantial structural stresses due to either irregular surface terrain or underwater or surface water movements the systems are subjected to much structural flexing. Because of this, the tube type systems generally are provided with an inner tube in which the missile is contained which is resiliently supported within an outer tube by some type of shock absorbing means in order to prevent the shock and structural flexing of the launching system from reaching the missile contained therein. The present invention relates to a spring-damper capable of performing the above function.

Accordingly, one object of the present invention is to provide a shock absorbing means for resiliently supporting a first tube interior of a second tube.

Another object of the present invention is to provide a shock absorbing means which enjoys the advantages of both pneumatic and hydraulic type shock absorbers.

Still another object of the present invention is to provide a shock absorbing means having greater shock absorbing capabilities than heretofore known.

A further object of the present invention is to provide a shock absorbing means which is capable of unusually high damping qualities even when under continuous use.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a transverse cross-section view of a typical ballistic missile undersea launching vehicle;

FIG. 2 is a longitudinal cross-sectional view of an embodiment of the shock absorber of the present invention; and

FIG. 3 is a sectional view substantially along the line 3—3 of FIG. 2.

Referring to FIG. 1, there is illustrated a ballistic missile submarine **10** having missile launching tubes **12** which are closed at the top by hatches **14**. As is readily apparent by reference to FIG. 1, the elements **16** and **17** serve not only to isolate inner tube **14** and the missile **18** contained therein from any sudden shocks, such as would originate from rolling seas, depth charges, or the like, which would cause structural flexing of the tubes **12**, but also serve as resilient spring supports for the tube **14** within the missile launching tubes **12**. While self-centering pneumatic spring-dampers **16** serve chiefly to eliminate detrimental effects of vertical movements, similar devices **17** operate in like manner on rotary movement around the vertical axis of the missile launching tube.

In FIG. 2, there is illustrated an embodiment of a unique self-centering pneumatic spring damper capable of performing both the supporting and shock absorbing functions requisite of elements **16** and **17**. The illustrated suspension shock absorber comprised essentially of a housing **20** enclosing working chambers **22** and **24** which are separated by internally extending flange **26**. At one end of the housing **20** there is a fixed attachment means **28** by which the shock absorber is connected to one of the members, the relative movement of which is to be damped. At its other end the housing **20** has an opening **30** receiving in slidable engagement the connecting rod **32** which serves to connect in operable engagement another of the members to be damped to the movable pistons **34** and **36**. A pneumatic seal is provided between the housing **20** and the pistons **34** and **36** and between the piston **36** and the rod **32** by seals or rings **40**. There is also provided a bushing or seal **38** to assure a pneumatic seal between housing **20** and rod **32**. The rod **32** is provided at its inner end with a collar or flange portion **42** in order that pistons **34** and **36** may be moved independently from their center position upon the movement of the rod **32** in the required direction.

On one outer surface of body **20** there is provided a bypass channel or conduit **44** to which access is had from the working chamber **22** by passage **46** and valve **48**, and from which exit is had to the chamber **24** through a valve **50** and passage **52**. The conduit or passage **44** consists of a plurality of capillary tubes **54** (best illustrated in FIG. 3) which may be contained in an open chamber **56** having connecting ports **58** to which a heat removing liquid may be passed in order that heat transfer may be accomplished more effectively. On its opposite side the body **20** carries a return passage or conduit **60** which is identical to the conduit **44** except that the valves **62** and **64** are so arranged as to allow passage of the gas from chamber **24** to chamber **22** rather than from chamber **22** to chamber **24**.

In operation, the motion of the piston rod **32** in a compression stroke moves the piston **34** away from its center position compressing the air or other gas in chamber **22**. This gas, heated by compression, flows through the check valve **48** into the heat exchanger or passageway **44** which by its inherent large surface area due to the plurality of capillary passages **54** removes heat and hence internal energy from the air. The gas then passes through check valve **50** into the chamber **24**. During a tension stroke the connecting rod **32** moves piston **36** so as to compress the air or other gas in chamber **24** which after passing through check valve **64** has heat removed in the exchanger **60** before continuing to chamber **22** through valve **62**.

As is readily apparent to those skilled in the art, the self-centering feature of the present device is accomplished by the dual-piston arrangement in cooperation with the flange **26**. As the piston rod **32** moves from its center position the gasses compressed by the moving piston flow to the chamber at the opposite end of the spring-damper and function to hold the unmoved piston securely against the flange **26**. Since this action takes place upon movement of the piston rod in either direction, both of the pistons are constantly urged by pressure of the gas to remain in a rest position against the flange **26**.

Although not essential to operation of the present device, additional advantages may be obtained by the use of

air or other gas under pressure of several atmospheres. As is well known a gas under high pressure has higher density and correspondingly increased viscosity and internal energy. An increase in the density of a gas allows for greater loss of internal energy by both loss of pressure through orifices and by heat transfer than is possible with the same gas at a lower density. Thus, by providing air at high pressure, greater spring and shock absorbing actions may be accomplished. In situations where it is necessary to support heavy objects such as guided missiles, pressure of several atmospheres is usually necessary in order to provide a device with sufficiently strong spring and damping characteristics to function satisfactorily.

From the foregoing description it is evident that the device of the present invention provides a very beneficial development in the field of self-centering spring dampers. By use of the present device, the highly desirable heavy load handling ability of hydraulic shock absorbers is combined with the advantageous soft cushion spring characteristics of a pneumatic spring. The subject apparatus has the further advantage of eliminating the necessity of a fluid filled device.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A gas filled shock absorber for use in damping the relative movement of two members comprising, a housing enclosing a working chamber wherein is contained a piston in slidable engagement having a connecting means attached thereto and extending through an end of said housing, a heat exchanging passage external of said chamber forming a connection between the opposite ends of said working chamber, a second chamber surrounding said heat exchanging passage having means for circulating a heat absorbing fluid around said heat exchanging passage whereby damping is effected by absorption of internal energy within the gas.

2. A self-centering pneumatic spring comprising a housing enclosing a working chamber wherein is contained a first piston and a second piston, each of said pistons being in slidable engagement within said housing, a flange extending laterally from the internal wall of said working chamber separating said working chamber into two cavities so that the first of said pistons will lie in one cavity and the second of said pistons in the second cavity, a connecting rod means extending through one end of said housing and so arranged as to move the first of said pistons when the rod is moved in one direction and the second of said pistons when the rod is moved in the opposite direction, an external passageway connecting the ends of said working chamber so that upon movement of the connecting rod the fluid compressed by one of said pistons will move toward the chamber containing the other of said pistons whereby a self-centering pneumatic spring is provided.

3. A self-centering pneumatic spring damper for resiliently mounting a first tube within a second tube, the combination comprising, a cylindrical housing having a first closed end and an attaching member affixed thereto and a second closed end having a port axially therethrough and forming a gas filled cylindrical working cavity therewithin, an internal flange extending laterally from the walls of said cylindrical cavity forming a first and a second working chamber, said flange having a hole aligned with the longitudinal axis of said cavity for permitting passage of a connecting rod means, a first and a second piston in said housing on opposite sides of said flange, a connecting rod means extending through the port in the end of said housing and the said flange and in operable engagement with said first and said second piston in such a manner that movement of the connecting rod in one direction moves the first of said pistons and movement of the rod in the other direction moves the second of said pistons, a plurality of capillary passageways connecting the first of said working chambers to the second of said working chambers, a heat sink surrounding said capillary passageways for removing the heat from the gas compressed by movement of one of said pistons whereby continuous damping is provided by removal of internal energy from the gas.

4. A gas filled shock absorber for use in damping the relative movement of a plurality of members comprising

a housing enclosing a working chamber wherein is contained a first piston and a second piston in slidable engagement therewith,

connecting means abuttingly connected to said first piston and slidably supporting the second piston, said connecting means extending through an end of the housing;

means on the housing and disposed within the working chamber for providing a pair of cavities, one cavity of said pair of cavities receiving the first piston and the other cavity of said pair of cavities receiving the second piston;

a heat exchanging conduit external of and surrounding said cavities;

a plurality of tubes disposed within said heat exchanging conduit in fluid communication with said cavities for porting compressed gas into and out of said cavities according to the movement of the pistons within their respective cavities;

means including a plurality of passageways in fluid communication with the cavities and the plurality of tubes for controlling the flow of gas through the tubes and into and out of the cavities; and

heat absorbing fluid disposed within the heat exchanging conduit and contacting the tubes for removing heat therefrom thereby to effect spring damping.

5. In a self-centering pneumatic spring damper, the combination comprising

a cylindrical housing closed at one end and having an attaching means affixed thereto, the other end of said cylindrical housing having a hole axially therethrough;

a first piston in slidable engagement with said housing and having a connecting rod operably connected thereto and extending through said hole;

a second piston within said housing and slidably supported on said rod;

means within said housing forming a first piston chamber and a second piston chamber;

a quantity of working gas in said chambers and alternately compressible and expandable therein according to the movement of said pistons;

a plurality of tubular passageways external of said chambers in fluid communication therewith for porting gas to and from the chambers according to said movement of the pistons;

orifice means in fluid communication with the first and second chambers and the plurality of tubular passageways;

control means cooperating with said orifice means for controlling the flow of gas through the tubular passageways and to and from the chambers;

a fluid chamber external of said piston chambers;

a heat absorbing fluid disposed within said fluid chamber in contact with said tubular passageways for removing heat therefrom whereby damping is effected by absorption of internal energy.

6. In a self-centering pneumatic spring damper, the combination comprising

a cylindrical housing closed at one end and having an attaching means affixed thereto, the other end of said cylindrical housing having a hole axially therethrough;

a first piston in slidable engagement with the housing and having a connection rod in operable engagement therewith and extending through said hole;

a second piston slidably mounted on said rod and cooperating with said first piston;

means disposed within the housing and forming a first piston chamber and a second piston chamber, said first chamber receiving the first piston and second chamber receiving said second piston;

a quantity of highly compressed working gas in said chambers and compressible and expandable therein according to the movement of the piston within said chambers;

a plurality of passageways external of said chambers in fluid communication therewith whereby compressed gas may be alternately passed to and from the first and the second piston chambers according to the movement of the pistons therein;

orifice means in fluid communication with said chambers and the plurality of passageways;

means in said passageways for controlling the flow of gas through said passageways and to and from said chambers; and

chamber means surrounding said piston chambers and having a quantity of heat absorbing fluid therein in contact with the plurality of passageways for removing heat therefrom whereby the internal energy generated in said gas during the movement of said pistons may be reduced by both heat dissipation and pressure reduction.

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