

[54] **INTERNALLY SUPPORTED THIN WALLED DUCT**

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Related U.S. Application Data

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[52] U.S. Cl. **138/103**, 161/DIG. 5, 161/168

[51] Int. Cl. **F16I 55/00**

[58] Field of Search 138/103, 39, 40, 112, 113,
138/148; 161/DIG. 5, 168; 55/513; 210/483,
484, 570

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Primary Examiner—William T. Dixon, Jr.

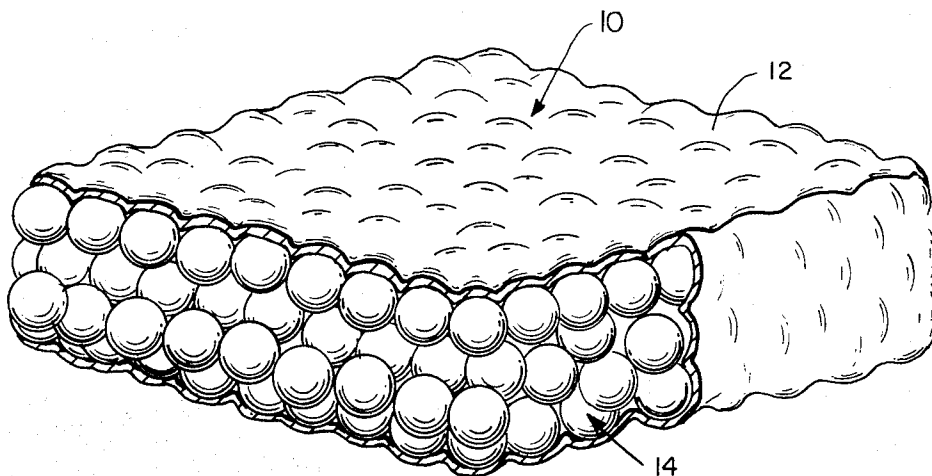
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[57] ABSTRACT

A thin walled duct, operating at reduced pressure, is maintained rigid by an internal packing of particles that does not materially affect low velocity fluid flow through the duct.

6 Claims, 7 Drawing Figures



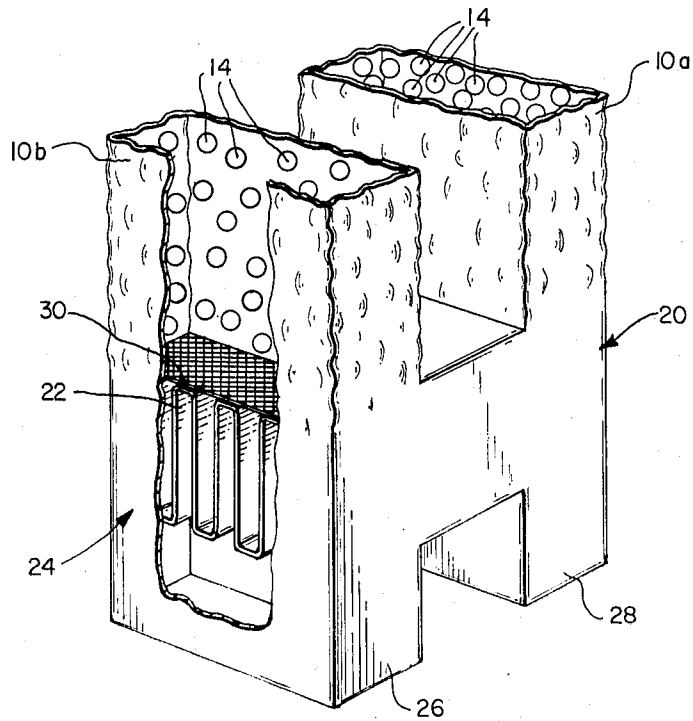


FIG. 1

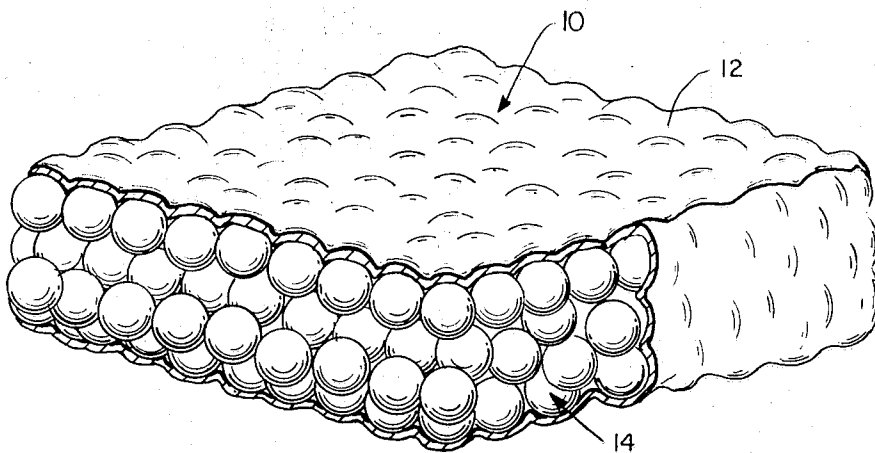


FIG. 2

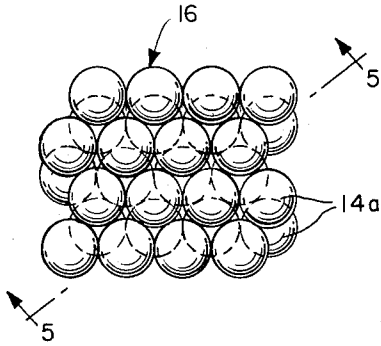


FIG. 4

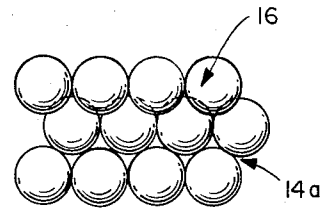


FIG. 5

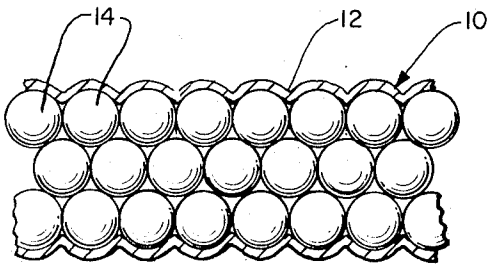


FIG. 3

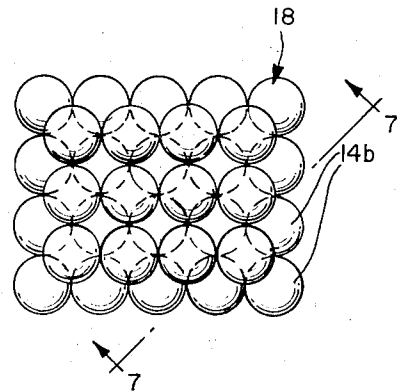


FIG. 6

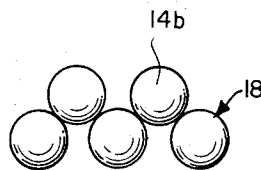


FIG. 7

INTERNALLY SUPPORTED THIN WALLED DUCT CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my earlier application Ser. No. 51,650, filed July 1, 1970, for "Heat Exchanger" and now U.S. Pat. No. 3,732,919, issued May 15, 1973.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

The present invention generally appertains to new and novel improvements in carriers or conduits by means of which fluid or other substances are conducted or conveyed, and, more particularly, relates to new and novel improvements in the construction and formation of a duct designed to operate at a reduced pressure.

2. Description Of The Prior Art

Conventional and standard low pressure ducts, pipes, conduits, tubes and the like carriers or conveyors of fluid or other substances must have walls that are at least thick enough to prevent collapsing during their intended use. Consequently, for each configuration there is a set minimum wall thickness for various materials. This means that the conventional ducts (used in the generic sense to encompass all fluid carriers or conveyors) are costly, both in initial fabrication and in maintenance and repair.

SUMMARY OF THE INVENTION

In my earlier above-identified application, a heat exchanger is disclosed that comprises wall means defining an enclosed space with at least one thin wall extended surface heat transfer sheet member defining in cooperation with the wall means at least two flow channels, one of the flow channels constituting a condenser channel normally operating at a lower pressure than the pressure in the enclosed space, with means supporting the thin wall sheet member and maintaining the flow channels including the low pressure condenser channel in rigid formation, such supporting means comprising contiguous particles packed in at least the low pressure condenser channel while permitting the fluid flow through the channels.

The present invention embraces such concept, in that an important object of the present invention is to provide a thin walled duct operating at a reduced pressure and internally supported and maintained rigid by a packing of particles that does not materially restrict or interfere with low velocity fluid flow through the duct.

Throughout the specification and claims the term "low velocity" for gases means flow in the range of about 5 to about 30 feet per second. In respect to "low velocity" flow of liquids, the velocity would be below 1 foot per second.

In accordance with the present invention, the duct can be fabricated from extremely thin sheet material that does not have to meet stringent yield, ductility and high strength requirements. A variety of materials, some of which are not presently usable, can be employed in the fabrication of ducts in accordance with this invention. For example, plastic materials, such as polypropylene, can be fabricated to provide the skin for the duct. These and similar materials, which have special attributes such as corrosion resistance or very low cost, can be used. Such materials have additional special qualities because of their low cost and simplicity of fabrication.

The duct of the present invention has very thin, on an order of 2 to 20 mils, walls or skin and is internally braced or packed with a packing of contiguous particles that serve a structural function in maintaining the duct rigid under reduced pressure conditions. Such particles may be any available pellets that would be unaffected by the fluids flowing through the duct and would be strong enough to resist crushing and erosion. The particles are preferably packed in any random array but can be packed in ordered pitch arrangement within the duct than about its external surface. The particles generally are not mechanically attached to the duct or to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a duct constructed in accordance with the present invention and, as an exemplary environment, shown with the core structure of a heat exchanger.

FIG. 2 is a fragmentary sectional perspective view of the duct.

FIG. 3 is a fragmentary enlarged side view of a portion of the packed interior of the duct showing the packing particles in elevation.

FIG. 4 is a detailed elevational view of the packing particles arranged in a triangular pitched pack.

FIG. 5 is a sectional view taken on line 5—5 FIG. 3.

FIG. 6 is a detailed elevational view of the packing particles arranged in a square pitched pack.

FIG. 7 is a sectional view taken on line 7—7 of FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the accompanying drawings, and initially to FIGS. 2 and 3, the numeral 10 generally designates a duct that is fabricated, constructed and intended for usage as a fluid carrier, in accordance with the present invention. The duct 10 comprises thin wall extended surface sheet 12 that is shaped into a rectangular cross-sectional configuration; however, it may be of any desired cross-sectional shape. The duct 10, rather than being formed from sheet material, whether metal or plastic, as illustrated, can be extruded or otherwise formed from suitable plastic materials such as polypropylene or polyethylene, for example. The selection of the composition of the material for forming the walls or skin of the duct will be based upon particular service or field parameters and operating conditions, such as the type and nature of the fluid being conveyed by the duct and the structural and operational environmental usage of the duct.

The thickness of the wall or the skin of the duct will generally be based on pressure differential, cost strength, handling ease and corrosion and erosion requirements. Typical thickness of the wall sheet material or skin may be on the order of about 2 to 20 mils with a preferred thickness being on the order of 3 to 10 mils. A mil is equal to one one thousandth of an inch.

Since strength of the material forming the walls or skin of the duct is less important than is wall strength in conventional ducts or the like fluid carriers, it may be more feasible from an economical standpoint to use a thinner but more noble material. For example, it may be desirable to use thin titanium sheets when dealing

with desalting equipment. Under certain temperature and pressure conditions, plastic sheet material, such as Teflon sheet, may be more feasible because of its high corrosive services. On the other hand, a duct fabricated from polyethylene or polypropylene or the like plastics materials may be more desirable under certain other operating conditions.

The duct 10 is intended to operate at reduced pressure and the walls or skin of the duct are not pressure carrying elements but simply transfer pressure to supporting and packing particles 14 which are packed within the interior of the duct in a way to maintain the duct rigid but not to materially restrict or interfere with low velocity flow of a low pressure fluid through the duct. The particles 14 rigidify the walls or skin of the duct on its inside against the external atmospheric pressure on the outside of the duct with the low pressure fluid unobstructedly flowing through the duct. It is envisioned, for example, that the duct could be a vacuum vessel.

The particles 14 are spherical in shape and are packed in a contiguous random or orderly packed formation. The particles preferably are solid ball elements formed from ceramic or concrete but the material of the particles depends upon availability. Such particles as coarse sand, smooth gravel or spherical pellets or beads of concrete, plastic or ceramic may be used providing they are not affected by the chemical nature of the fluid or the temperature thereof and they are strong enough to resist crushing and erosion. As shown, the particles are preferably generally spherical and of a uniform size. In this respect, non-uniform size particles will tend to pack more solidly and reduce the porosity or flowability characteristic of the duct. Glass or plastic beads may be used as well as screened coarse sand, particles and pebbles. The size of the particles is not critical but, in general, particles of one-tenth to one-half inch in diameter are preferred.

Random or various ordered packing arrangements of the particles 14 may be employed. Ordinarily, a packing of several layers of particles would be typical, as shown in FIG. 3. The width of the duct or particle size will vary and, as either varies, so will the number of layers of particles change. With the width of the duct, as shown in FIG. 3, being about one-half inch, the particles would range from about one-fifth inch diameter (giving the three layers as shown) to one-tenth inch diameter which would result in six layers.

Since the particles are maintained rigid by external pressure acting upon the thin wall duct, the particles need not be mechanically attached to the duct or to each other. However, particularly where non-random packing is employed, the particles would preferably be mechanically attached to each other but not to the duct wall, and such attachment may be by fusion or cementing with, for example, an epoxy-type resin.

As shown in FIGS. 4 and 5, the particles or spherical elements 14a are arranged tightly in triangular pitched pack 16. In FIGS. 6 and 7, the particles or spherical elements 14b are packed in a square pitched pack 18. In either of such arrangements or in any other packed arrangement the particles are held tightly against accidental shifting and rigidly supported the walls or skin of the duct, as can be appreciated from FIGS. 2 and 3.

As shown in FIGS. 2 and 3, the walls or skin of the duct may collapse, under the pressure conditions, to

engage the outer rows of particles, so that the walls 12 have a dimpled appearance. This is an indication of the effective supporting function of the particles where the sheet material or skin of the wall surface transfers pressure to the pressure or supporting particles 14. Thus, the supported wall or skin surface of the duct does not have to meet stringent yield, ductility and high strength requirements.

Ducts formed like the duct 10 can be employed as fluid carriers or conveyors in any system or environment. For example, as shown in FIG. 1, the ducts 10a and 10b, which are packed with the particles 14, provide a low pressure gas inlet duct and a low pressure gas outlet duct in their conjoined relation where they define part of a casing 20 for the pleated core structure 22 of a heat exchanger 24. The casing is further defined by the conjoined casing ends of a high pressure gas inlet duct 26 and a high pressure gas outlet duct 28.

In use, the low pressure gases enter the heat exchanger 24 through the low pressure inlet duct 10a and flow through the individual pleats of the core structure 22 and exit through the low pressure outlet duct 10b. High pressure gases enter the heat exchanger through the high pressure inlet duct 26, which is of conventional construction and fabrication, and flow through the individual pleats of the core structure 22 and exhaust through the high pressure outlet duct 28, which is also of conventional construction.

The particles 14 are held in the core ends of the low pressure ducts 10a and 10b by screens or the like end walls 30 which, while maintaining the particles in place at the ends of the ducts and out of the folds of the core structure 22, do not restrict the flow of the low pressure gases.

The pressure differential between the packed interior and the exterior of ducts constructed in accordance with the teachings of the present invention need not be great and pressure differentials as low as from about one-half pound per square inch should be satisfactory to maintain a glass ball packed plastic film duct rigid. The upper limits on the pressure differential between the packed interior and the exterior surface of the duct would be the burst strength of the particular material forming the duct in conjunction with the diameter of the packing material. It will be appreciated that as the diameter of the packing material is increased the greater will be the unsupported area of the duct wall which in turn would decrease the permissible pressure differential between the interior and exterior surfaces thereof.

While such environment has been shown, it is merely for exemplary purposes and it is to be realized that such showing and the further illustrations in the drawings and description herein are merely exemplary and not limitative since the invention is defined only by the terms and spirit of the appended claims.

What is claimed is:

1. A fluid carrier operating under reduced pressure comprising a thin walled duct having a wall thickness on the order of 2 to 20 mils and a plurality of particles packed in said duct to structurally rigidify the same and maintain a flow path through the duct, said particles being contiguously arranged within the duct to support the walls of the duct while not materially interfering with the flow of fluid through the duct.

2. The invention of claim 1 wherein said particles are not mechanically attached to the duct or to each other.

5

- 3. The invention of claim 1 wherein said duct has a preferred wall thickness on the order of 3 to 10 mils.
- 4. The invention of claim 1 wherein said contiguous particles are generally spheroidal and of uniform size.
- 5. The invention of claim 3 wherein said contiguous

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- particles are generally in a square pitch pack.
- 6. The invention of claim 3 wherein said contiguous particles are generally in a triangular pitch pack.

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