AUSTRALIA
COMMONWEALTH
PATENTS ACT

CONVENTION APPLICATION

We, AUTOMATION INDUSTRIES, INC, of 1901 Building - Century City, Los Angeles, California 90067, United States of America, hereby apply for the grant of a Patent for an invention entitled "INSULATED FLEXIBLE DUCT."

which is described in the accompanying complete specification. The application is a Convention application and is based on the application(s) for patent or similar protection made in UNITED STATES OF AMERICA on 25th September, 1972 under No. 291,649.

Our address for service is care of DAVIES & COLLISON, Patent Attorneys, of Cromwell Building, 374 Bourke Street, Melbourne, in the State of Victoria Commonwealth of Australia.

Dated this 30th day of July, 1973.

(a) Signature(s) of applicant(s).

If a Company, form to be executed in a manner binding on the Company according to its Articles of Association or the laws of the country.

(b) Seal of Company (if any).

Note: Initial all Alterations.

To:
THE COMMISSIONER OF PATENTS
COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952-1962

DECLARATION IN SUPPORT OF CONVENTION APPLICATION
FOR A PATENT OR PATENT OF ADDITION

(The declaration shall be made by the applicant, or, if the applicant is a body corporate, by a person authorized by the body corporate to make the declaration on its behalf.)

In support of the Convention Application made for a patent for an invention entitled

INSULATED FLEXIBLE DUCT

I, JOHN A. WHITE, Executive Vice President
AUTOMATION INDUSTRIES, INC.
1901 Building - Century City
Los Angeles, California 90067,
UNITED STATES OF AMERICA.

Do solemnly and sincerely declare as follows:-

1. I am the applicant for the patent or patent of addition.

or (b) I am authorized by AUTOMATION INDUSTRIES, INC. the applicant for the patent to make this declaration on its behalf.

2. The basic application, as defined by Section 141 of the Act was made in the U.S.A. on the 25th of September 1972 by MARVIN ALFRED KOERBER in _______________ on the _______________ in _______________ on the _______________ in _______________ on the _______________ in _______________ on the _______________ by _______________ by _______________ by _______________ by _______________.

3. (a) I am the actual inventor of the invention and the facts upon which the applicant is entitled to make the application are as follows:-

Assignment of all rights throughout the entire world dated September 18, 1972, whereby the said actual inventor assigned the said invention to the said applicant company.

(b) MARVIN ALFRED KOERBER
213 Ferry Street
Abbeville, South Carolina, United States of America.

is the actual inventor of the invention and the facts upon which the applicant is entitled to make the application are as follows:-

Assignment of all rights throughout the entire world dated September 18, 1972, whereby the said actual inventor assigned the said invention to the said applicant company.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

Declared at Los Angeles this 25th day of June, 1973.

JOHN A. WHITE, Executive Vice President
AUTOMATION INDUSTRIES, INC.

TO:
The Commissioner of Patents
Devies & Collison, Patent Attorneys, A.M.P. Building, Hobart Place, Canberra, A.C.T.
The following statement is a full description of this invention, including the best method of performing it known to us :-

"INSULATED FLEXIBLE DUCT".

AUTOMATION INDUSTRIES, INC.
BACKGROUND OF THE INVENTION

In a building having a centralized air-conditioning system, the air is cooled, filtered, etc., by centrally located air-conditioning machinery. The conditioned air is then distributed throughout the building by a suitable distribution system. Historically, such distribution systems have utilized rigid sheet metal ducts. Because of the high thermal conductivity of metal if the exterior of the duct is exposed to the surrounding warm air, there is a very substantial warming of the otherwise cool air and a considerable amount of moisture condenses on the exterior of the duct. Accordingly, a suitable insulating material has normally been applied to the exterior of the sheet metal duct. This is of necessity normally occurred subsequent to the installation.

Because of the rigid nature of sheet metal ducts, they must be precisely cut to the correct dimensions and precisely mounted and installed. Since the installation in any given building is an essentially customized project, it does not lend itself to any significant degree of standardization. Moreover, the installation requires a considerable amount of time by a very skilled and highly paid operator, such as a sheet metal worker. As a result, such ducts are very expensive to assemble and install.

More recently, it has been proposed to overcome the foregoing difficulties by utilizing essentially standardized flexible ducts. Ducts of this nature normally have an inner supporting structure or core. By way of example, the core may include a flexible spring or similar
member. An insulating material such as a blanket or mat of fiber glass surrounds the core and is supported thereby. An outer wrapper or a vapor barrier surrounds this insulating blanket.

When a flexible duct of the foregoing variety is installed, it is easily cut to the desired length and quickly installed. Because of the flexible nature of the duct, it is not absolutely essential the duct be precisely cut to the exact length nor that the mountings, supports, fittings, etc., be precisely positioned.

Instead, a considerable amount of latitude is possible in its dimensions and positions. Moreover, the easy cutting and handling of the flexible ducts and the loose tolerances in their installation allow the use of workmen having very little specialized skill and a minimum amount of tools and equipment.

These ducts are now capable of being manufactured by a fully automatic and continuous process in virtually unlimited lengths with a minimum amount of human labor. A machine and method particularly suitable for manufacturing this type of insulated flexible duct is described in United States Patent No. 3,627,615, assigned to the assignee of the present invention.

The mass production of the highly advantageous insulated flexible ducting having been solved by the aforementioned patented machine, there still remains a certain serious problem in the installation of such ducting. Flexible, insulated duct has in the past and is currently being suspended by circumferentially wrapped metal wire.
metal strapping, fabric strips, rope, and tacking or stapling wire, etc., to overhead construction beams. Such techniques have proven to be highly disadvantageous in that circumferential wrapping of wire, etc. cuts into the duct's outer wrapper or moisture barrier causing failure of its capacity to carry air and also destroys the barrier's moisture permeance properties. Further, these suspending methods provide no predetermined spacing of the suspension apparatus along the duct to support the load bearing properties of the duct, often resulting in failure of suspension. In order to overcome these disadvantages and limitations, highly-skilled and well-paid installers are required in order to lessen the chance of causing the destruction of the integrity of the vapor barrier and suspension failure. This, of course, significantly reduces the advantages of using flexible duct over rigid sheet metal duct.

SUMMARY

The present invention provides means for overcoming the foregoing limitations and difficulties. More particularly, the present invention provides insulated flexible duct for use in air-conditioning, heating, and ventilating systems, and the like, which duct includes means for suspending the duct from overhead building structure.

In an embodiment of the invention disclosed herein, insulated flexible duct is provided which includes a central flexible reinforcing core surrounded by an inner layer of insulation that is in turn surrounded by an outer protective wrapper or a vapor barrier having a longitudinal
integral seam extending the length of the wrapper. The duct also includes support means associated with the seam for suspending the duct at predetermined points along the seam.

The inner reinforced core may include a semi-rigid helical steel wire, and the support means may include a plurality of spaced metal grommets and wire threaded through the grommets to effect suspension of the duct to overhead building structure.

The invention and specific embodiments thereof will be described hereinafter by way of example and with reference to the accompanying drawing in which like reference characters refer to like elements in the several views.

RESUME OF THE DRAWING

FIG. 1 is a schematic elevation illustrating one exemplary installation of the insulated flexible duct constructed in accordance with the present invention;

FIG. 2 is a fragmented sectional view of the insulated flexible duct shown in FIG. 1; and

FIG. 3 is a sectional illustration of the duct of FIG. 1, showing a duct suspension arrangement.

DETAILED DESCRIPTION OF THE DRAWING

Referring to the drawing in more detail and particularly to FIG. 1, there is shown a length of insulated flexible duct 11, constructed in accordance with the invention, installed between and carrying air from a
conventional distribution duct or plenum chamber 13 of a central air-conditioning system. The outlet end of the duct is connected to a conventional diffuser outlet 15 in a false ceiling 17. In a typical configuration, the diffuser directs the air through the ceiling 17 in the room below. The plenum chamber 13 may be suspended from a runner 29 in the overhead structure 31. The air-conditioning duct 11 is shown supported at several points along its length by wire hangers 21 threaded through grommets 23. The grommets 23 are mounted in an "up-standing" or longitudinal seam 25 forming an integral part of and extending from an outer wrapper 27. The wire hanger 21 is attached to and suspended from an angle iron runner 29 attached to a convenient building structure such as a rafter, beam 31, etc., forming a part of the ceiling structure.

An embodiment of the present invention is illustrated in more detail in FIGs. 2 and 3. Here, a flexible and easily bent duct 11 is shown to have a central flexible reinforcing core 41. The core includes a helical spring 43 of a semi-rigid steel wire. The spring 43 is an essentially self-supporting structure having sufficient strength (particularly in its radial direction) to insure the duct 11 being maintained in its normally cylindrical shape. However, the shape of the duct is optional, and the spring 43 is normally of a rigidity to allow the finished product to be bent and distorted as may be required for installation.

Although a bare of synthetic (vinyl) coated wire spring may be used alone for the core 41, in the present instance a so-called "scrim cloth" 45 is wrapped around the wire spring 43 and attached thereto by any suitable bonding means. A cloth of this type is a light-weight,
coarse, loosely-woven material. For example, it may have on the order of 10 to 20 threads or strands per inch with a corresponding number of openings per inch.

This "scrim cloth" will, to some degree, limit the extent to which the spring can be axially expanded but will not materially effect the bending or axial compression of the core. Another advantage of the "scrim cloth" is that the helical spring cannot ravel when the duct is cut to length by an installer.

The duct also includes one or more layers of thermal insulation which may be of any desired material. For example, the insulating layer is formed of a flexible material, such as a blanket of fiber glass mat. This blanket is normally of sufficient thickness to insure a minimum amount of heat being transferred between the outside and inside of the duct, particularly when cold air is flowing through.

The exterior of the duct, as seen in FIG. 1, is covered by an outer wrapper. The wrapper is intended to protect the duct from damage during normal handling and use. Accordingly, the wrapper should be a tough material which is not easily torn, punctured, etc. Generally, the wrapper is also intended to act as a vapor barrier to keep moisture, etc., which may condense on the exterior of the duct from entering into the duct. Accordingly, the wrapper may be waterproof (nonporous) by way of example, a thin sheet or sheets of plastic material, reinforced paper, or woven fiber glass reinforced metalized Mylar®/hypalon laminate of low
permeability, have been found to be very well suited for this purpose (*Mylar is a registered trademark of DuPont).

The vapor barrier or outer wrapper 27 is formed with an elongated seam 25 extending the entire length of the duct. As best seen in FIGs. 3 and 4 the seam 25 is preferably of the "stand-up" variety.

The duct 11 is preferably manufactured by a machine of the variety disclosed and claimed in the above-identified U.S. Letters Patent No. 3,627,615. A production machine of this variety is effective to inherently create a "stand-up" seam of this variety while it is forming the outer wrapper 27 around the insulating layer 47.

The outer wrapper 27 is a long strip of material which extends longitudinally of the duct 11. The width of the strip is wrapped circumferentially around the insulating layer 47. The two edges 51 and 53 of the strip are brought together and joined. The width of the strip is slightly greater than the circumference around the insulating layer 47 whereby the opposite edges 51 and 53 overlap each other.

The first edge 51 is initially folded so as to extend substantially radially to the duct. The second edge 53 is then folded against the inside surface of the first edge 51 so as to also be disposed radially. The two edges may be fastened together by any suitable means such as stapling, etc. However, they are preferably bonded together with some form of glue, cement, etc. It has been found desirable for the second edge 53 to be about double the width of the first edge 51. This permits the upper
portion of the second edge 53 to be folded over the first edge 51 and bonded to the outside thereof.

This forms a strong, airtight seam which has a thickness equal to three plies of the wrapper. It should be noted that this folded-over arrangement provides a certain amount of rigidity and results in a "stand-up" seam 25. In other words, the seam 25 which extends the entire length of the duct projects outwardly from the duct and is essentially self-supporting.

In order to mount the duct between the overhead ceiling structure 29 and the false ceiling 17, fastening means may be provided in the seam 25. In the present instance the fastening means includes a plurality of grommets 23 and a plurality of hangers 21. The grommets 23 are inserted into the seam 25 so as to extend completely therethrough. The grommets 23 are then cinched or clamped into the seam 25 whereby a rolled over metal rim or periphery is insured. Although the grommets may be constructed of any desired material, they are preferably fabricated from a metal or some other substance capable of withstanding a certain amount of abuse and stress. The grommets 23 have an opening 57 which extends completely through the seam 25. Although the grommets 23 are shown as being round, it has been found that elongated or oblong ones may be preferable for some applications.

The hangers 21 may be formed of any desired material and may have any convenient shape. By way of example, they may be formed of a fairly stiff wire and have a central portion or shank 55, an upper section 61...
and a lower section 59. The upper section 61 may be of any desired variety suitable for being quickly attached to the overhead structure, such as the runner 29. By way of example, this may be some form of screw fitting or hook, etc. The lower section 59 is adapted to fit the grommet 23 and pass through the opening 57. By way of example, the lower section 59 is usually just a hook which may be quickly attached to the grommet 23 without any tools, etc.

This form of suspension for the duct 11 takes into account the load-bearing properties of the duct 11 and the various parts thereof. The grommets 23 are preferably uniformly spaced along the seam 25 at predetermined distances. The spacing should be proper to insure the stresses, etc., being distributed throughout an adequate area to prevent failure. The load-bearing properties of the duct 11 should be considered in selecting the spacing of the grommets. Also the length of duct which can be unsupported without sagging materially should be considered. It is desirable for the duct to be as straight as possible whereby the air flow loses are minimized. Accordingly, the distance between the grommets 23 should not be great enough to allow sagging.

By way of example, it has been found as a "rule of thumb" a spacing ratio of about 2 to 1 is generally suitable (i.e., the space between the grommets 23 is about double the diameter of the duct). However, as a practical matter it has been found that a spacing of about 2 feet may be used for ducts 12 inches in diameter and larger. However, a spacing of 1 foot for ducts 12 inches or less is adequate.
In order to use the present invention, the duct 11 is cut to a length corresponding to the distance between the plenum chamber 13 and the diffuser 15. The hangers 21 are then attached to the grommets 23 and the overhead ceiling structure, such as the runner 29. This is effective to suspend the duct 11 from the ceiling structure in an essentially level position free from any sags, etc. The ends of the duct 11 are then attached to the plenum chamber 13 and the diffuser 15.

From the foregoing it should be evident that the invention constitutes a significant advancement of the art. It has the advantages of being flexible, economical to produce and install, and is useful in both high and low velocity air-conditioning, heating, and ventilating systems. Further, it lends itself to installations around obstructions as well as on straight runs. It of course has no problems with misalignment and reduces the need for close measurements on the job, exacting shop layouts, and the fabrication and handling of expensive and bothersome fittings. The flexible duct 11 also reduces or eliminates the mechanical vibrations transmitted by rigid ducts, and insures the suspension in relation to the load-bearing properties of the duct. Since no wire or straps are circumferentially wrapped about the duct 11, no puncture of the outer wrapper or failure of the vapor barrier can result. This insures the air-carrying capacity and moisture permeance properties of the duct.
CLAIMS
The claims defining the invention are as follows:

1. Insulated flexible duct for use in air-conditioning, heating, and ventilating systems, and the like, the duct including the combination of:
   - insulated flexible ducting;
   - an outer wrapper surrounding said ducting,
   - an integral longitudinal seam extending the length of said ducting; and
   - support means associated with said seam for suspending said ducting at predetermined points along said seam.

2. The insulated flexible duct according to Claim 1, wherein said outer wrapper is a relatively tough material to protect the integrity of the ducting during normal handling and use, said outer wrapper having longitudinal edges, and wherein said seam is formed by overlapping said longitudinal edges.

3. The insulated flexible duct according to Claim 2, wherein said outer wrapper is of a material constituting a vapor barrier, and wherein the overlapping edges of said outer wrapper are bonded together whereby said seam is moisture-tight.

4. The insulated flexible duct according to Claim 1, wherein said support means includes spaced grommets mounted in said seam.

5. Insulated flexible duct for use in air-conditioning, heating, and ventilating systems, and the like, the duct including the combination of:
   - insulated flexible ducting;
   - a vapor barrier surrounding said ducting,
a longitudinal seam being formed by overlapping longitudinal edges of said vapor barrier; and

support means associated with said seam for suspending said duct at predetermined points along said seam.

6. The insulated flexible duct according to Claim 5, wherein said seam is moisture-tight and rectilinear along the length of said duct.

7. The insulated flexible duct according to Claim 6, wherein said support means includes spaced grommets mounted in said seam.

8. The insulated flexible duct according to Claim 7, wherein said support means also includes hanger members having a hook end portion adapted to engage said grommets.

9. Insulated flexible duct for use in air-conditioning, heating, and ventilating systems, and the like, the duct including the combination of:

a central flexible reinforcing core;

an inner layer of insulation surrounding said core;

an outer protective wrapper enclosing said layer of insulation, said wrapper being formed with a longitudinal moisture-sealed integral seam extending the length of said wrapper; and

support means associated with said seam for suspending said duct at predetermined points along said seam.
10. The insulated flexible duct according to Claim 9, wherein said core includes a semi-rigid helical wire.

11. The insulated flexible duct according to Claim 10, wherein said core also includes a coarse woven liner surrounding said spiral-wound wire between said wire and said layer of insulation.

12. The insulated flexible duct according to Claim 10, wherein said spiral-wound wire is coated with a synthetic moisture impervious material.

13. The insulated flexible duct according to Claim 10, wherein said support means includes spaced grommets mounted in said seam.

14. Insulated flexible duct for use in air-conditioning, heating, and ventilating systems, and the like, the duct including the combination of:
   an elongated, helical semi-rigid wire core;
   insulative material disposed about said helical wire core;
   a vapor barrier layer disposed about said insulative material, said barrier layer being formed with moisture-sealed overlapping longitudinal edges defining a longitudinal seam; and
   support means associated with said seam for suspending said duct at predetermined points along said seam.

15. The insulated flexible duct according to Claim 14, wherein said seam is essentially rectilinear for
the length of said duct and extends radially outwardly from said vapor barrier layer.

16. The insulated flexible duct according to Claim 15, wherein said support means includes a plurality of grommets based along and in said seam.

17. The insulated flexible duct according to Claim 14, wherein the semi-rigid wire of said wire core is vinyl-coated.

18. The insulated flexible duct according to Claim 17, wherein the extent that said helical wire core may be expanded is limited by a scrim cloth liner disposed about and bonded to said helical wire core.

19. The insulated flexible duct according to Claim 16, wherein said grommets are spaced in accordance with the load bearing properties of said duct.

20. The insulated flexible duct according to Claim 19, wherein said grommets are metallic and wherein said support means also includes wire threaded through said metallic grommets to effect suspension of said duct to overhead building structure.

21. The insulated flexible duct according to Claim 19, wherein the spacing of said grommets is predetermined to support the load bearing properties of said duct at a ratio of approximately 2:1.
22. The combination of:
   a flexible duct;
   an outer wrapper surrounding said ducting;
   a seam extending the length of said duct,
   said seam being formed by securing the adjacent edges of
   said wrapper together;
   support means in said seam for suspending
   said ducting, said support means being spaced at predeter-
   mined points along said seam.

23. A system for suspending an insulated flexible
   air-conditioning duct from an overhead ceiling structure.
   said system including the combination of:
   an outer wrapper surrounding said duct and
   having a longitudinal seam formed by the overlapping
   longitudinal edges of said vapor barrier;
   a plurality of grommets in said seam spaced
   therealong at predetermined points; and
   a plurality of supports adapted to be
   attached to said grommets for suspending the duct from said
   overhead structure.
24. The combination of:
   a central flexible reinforcing core;
   a layer of insulation surrounding said core;
   a vapor barrier enclosing said layer of insulation, said vapor barrier being formed by a strip of flexible material extending longitudinally of the duct;
   a seam extending longitudinally of the duct, said seam being formed by bonding the adjacent edges of said strip together; and
   a plurality of grommets disposed in said seam therealong, said grommets being effective to suspend and support the duct.

25. The parts, elements, steps and features referred to or indicated in the specification and/or claims and/or drawings of this application, individually or collectively, and any and all combinations of any two or more of said parts, elements, steps or features.

Dated this 30th day of July, 1973.

AUTOMATION INDUSTRIES, INC.
by its Patent Attorneys
DAVIES & COLLISON.
DRAWINGS
END