

[54] **STRETCHABLE REINFORCED WRAPPER FOR INSULATED FLEXIBLE DUCT**

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[75] Inventors: **Marvin A. Koerber**, Abbeville;  
**Charles G. Richitelli**, Greenwood,  
both of S.C.

*Primary Examiner*—Jerry W. Myracle  
*Attorney, Agent, or Firm*—Dan R. Sadler

[73] Assignee: **Automation Industries, Incorporated**, Los Angeles, Calif.

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[57] **ABSTRACT**

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A stretchable but reinforced wrapper or moisture and air barrier is used in the fabrication of insulated flexible duct for air conditioning, heating, and ventilating systems. The wrapper is a laminate of one or more films having an inherent stretch or elongation characteristic in both axial and bi-axial directions, and a reinforcing material of fabric or fiber for reinforcing the film layer or layers while still allowing bi-axial stretch or elongation of the wrapper and duct.

[52] U.S. Cl. .... **138/128; 138/131; 138/172**

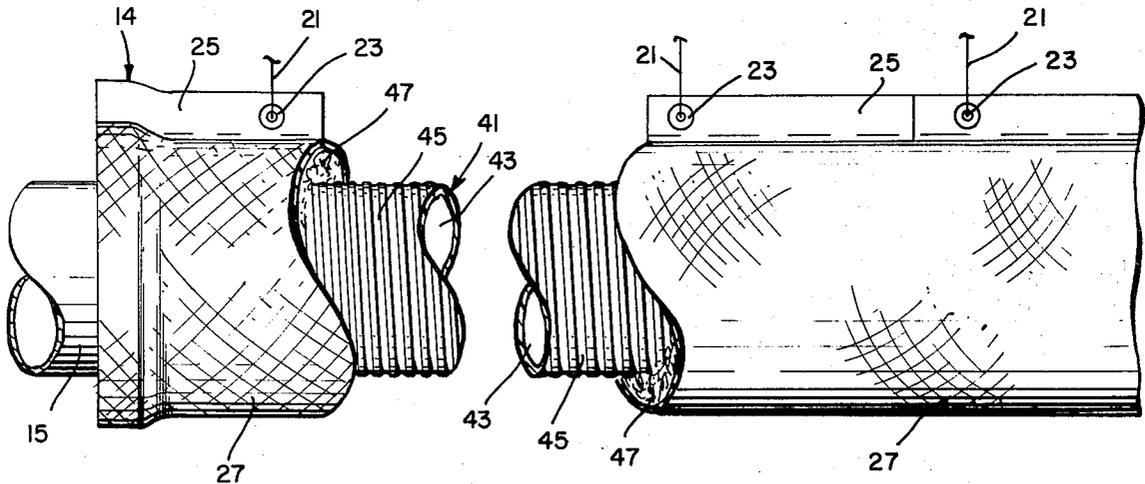
[51] Int. Cl. .... **F16l 11/12**

[58] Field of Search ..... 138/118, 119, 122, 133,  
138/138, 107, 129, 130, 131, 137, 139, 128,  
138/172

[56] **References Cited**  
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**27 Claims, 7 Drawing Figures**



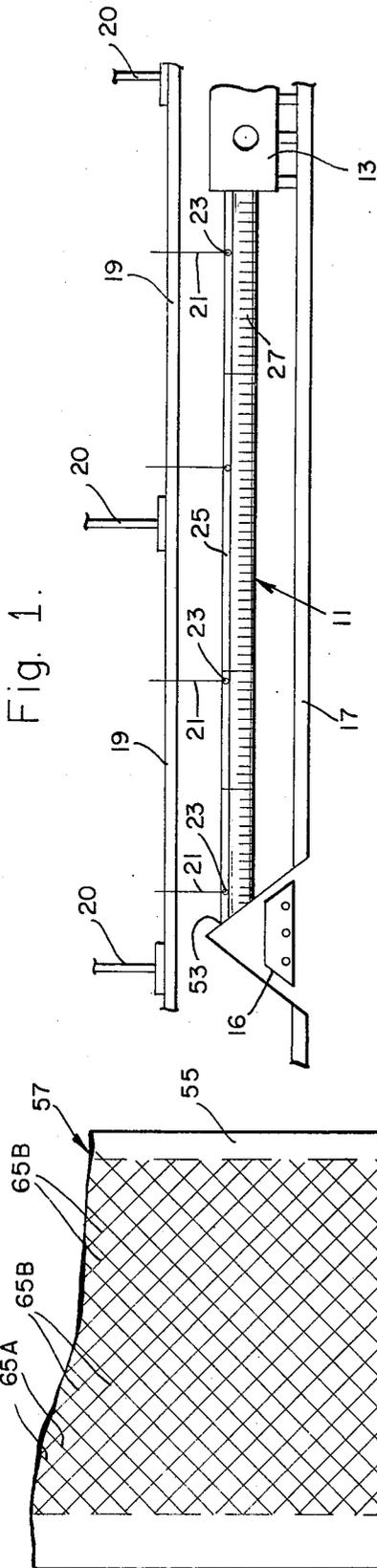


Fig. 1.

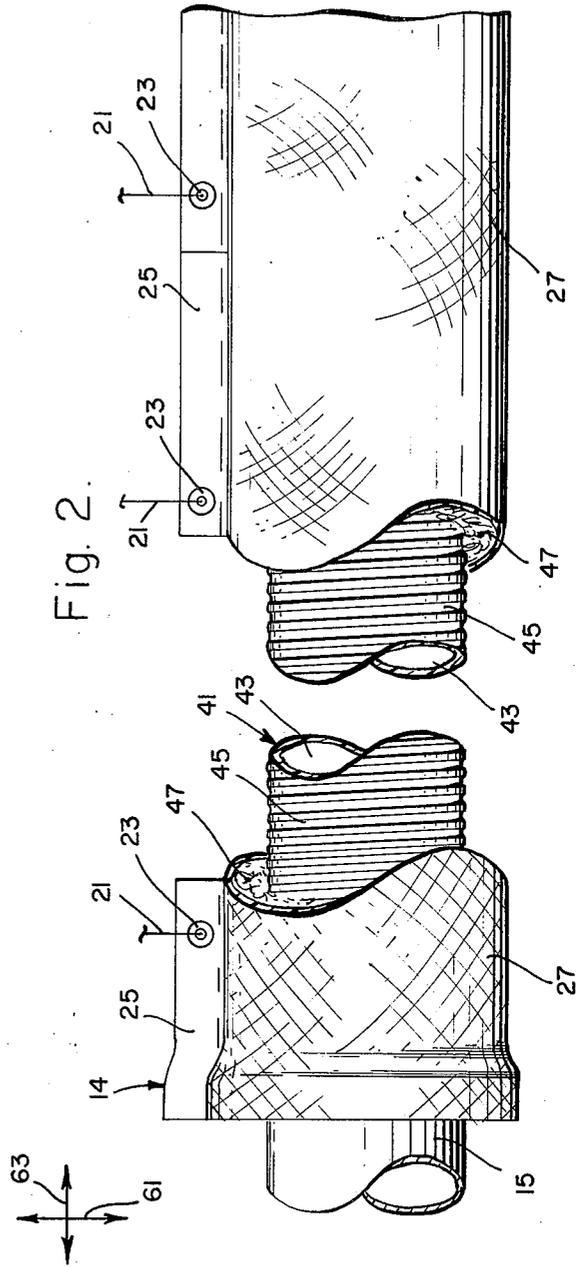
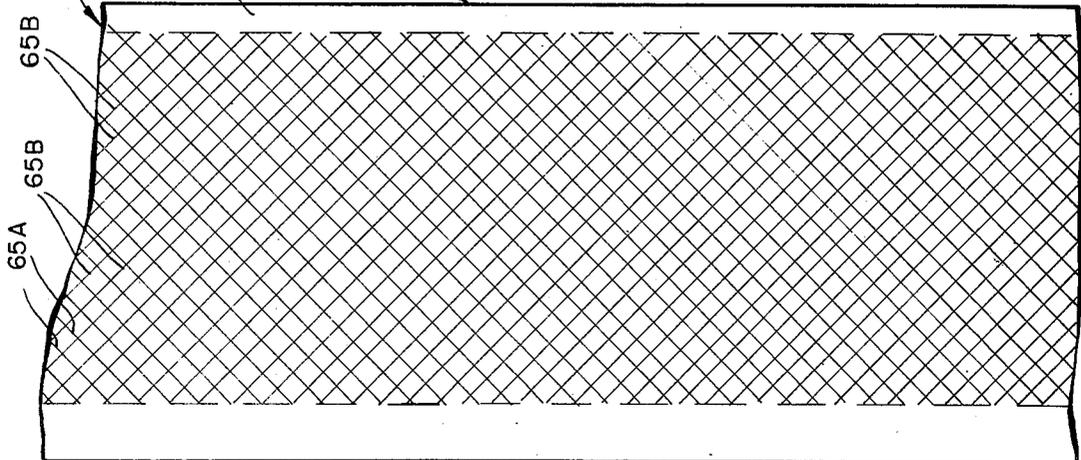


Fig. 2.

Fig. 3.



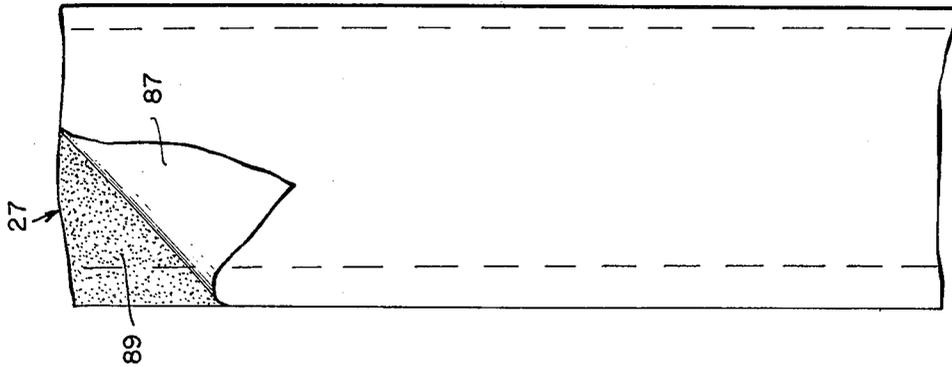


Fig. 7.

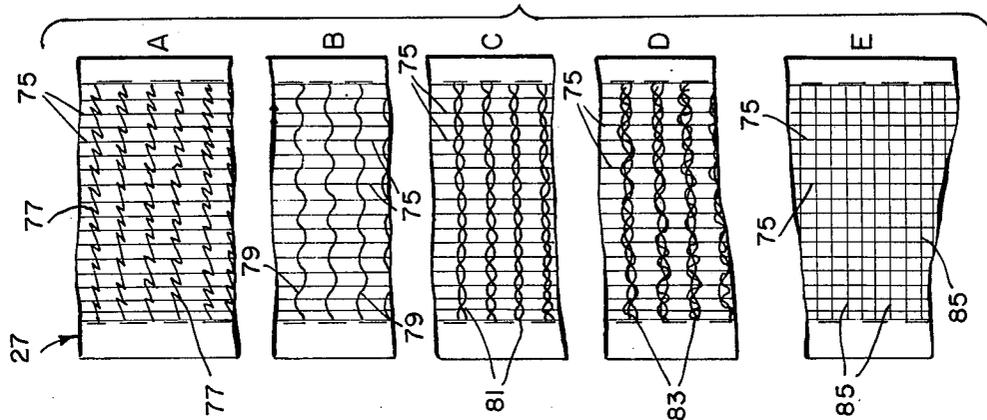


Fig. 6.

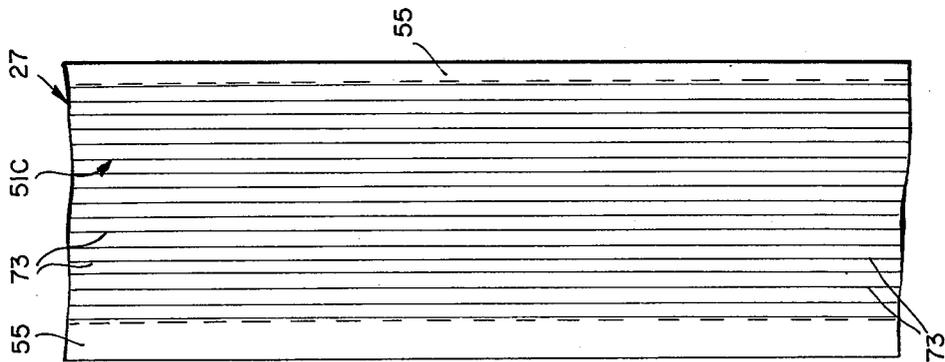


Fig. 5.

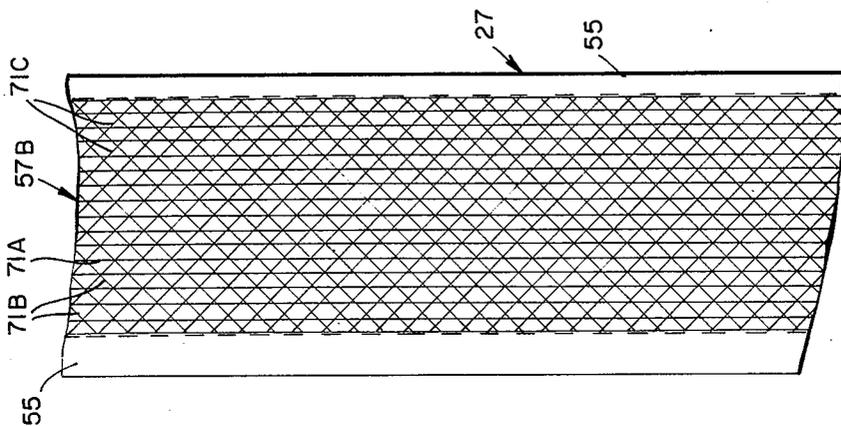


Fig. 4.

## STRETCHABLE REINFORCED WRAPPER FOR INSULATED FLEXIBLE DUCT

### BACKGROUND

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 installing material has normally been applied to the exterior of the sheet metal duct. This, of necessity, normally occurs 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 fiberglass 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 that 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 U.S. Pat. No. 3,627,615, entitled "Machine for Manufacturing Ducting" filed in the name of Wesley L. Guiles and Marcus A. Hall and assigned of record to Automation Industries, Inc.

The machine disclosed in the above mentioned patent has solved or eliminated many of the problems associated with the production of insulated, flexible ducting whereby the use of such ducting is becoming more wide spread. However, there still remain certain problems relating to the use and/or installation of such ducting. When the flexible duct is installed, at least one end of the duct is attached to a rigid sheet metal duct such as one from the plenum chamber and/or on the outlet

fitting such as a distribution box. Normally the outer vapor barrier of the flexible duct has been a non reinforced sheet of film of a plastic such as Mylar, PVC or CPE. Such a vapor barrier possesses a certain amount of stretch whereby it can be circumferentially expanded to fit over the sheet metal duct or fitting. This greatly facilitates installation and/or servicing. However, if the vapor barrier is not reinforced, it tends to rip and tear readily. If the barrier is punctured, the resultant hole will grow into a tear which eventually results in a useless duct.

In order to overcome the foregoing difficulties, some of the flexible duct manufacturers have attempted to find a vapor barrier which has greater durability, strength, puncture-resistance, and tear-resistance. This has normally been accomplished by using a vapor barrier which has one or more plastic films or sheets laminated or bonded onto some form of fabric. The fabric has included a set of threads which extend longitudinally of the plastic sheet and a second set of threads which extend transversely of the plastic sheet. When this sheet is wrapped around the duct, the threads in the resultant vapor barrier extend circumferentially and axially of the duct. These threads have been effective to reinforce the vapor barrier and thereby increase the durability, puncture and tear-resistance of the barrier. However, they have also limited the amount of circumferential and axial stretch of the duct. As a consequence, it has been difficult to stretch the duct over and onto a sheet metal duct. It has also made it difficult to stretch the duct axially to extend from one point to another when the duct has been cut a little too short.

### SUMMARY

The present invention provides means for overcoming the foregoing limitations and difficulties. More particularly, the present invention provides a stretchable reinforced protective wrapper or vapor barrier for insulated flexible ducts used in air-conditioning, heating, and ventilating systems and the like.

In an embodiment of the invention disclosed herein, a flexible insulated duct is provided which has a stretchable reinforced protective vapor barrier. The barrier includes at least one moisture and air impervious film barrier having in hand an elongation or stretch in both the axial and circumferential directions. The barrier also includes reinforcement means having reinforcing material laminated to the film layer for reinforcing the film layer while still allowing axially and circumferential elongation of the vapor barrier.

The invention and a limited number of specific embodiments thereof are described hereinafter by way of example and with reference to the accompanying drawings in which like reference characters refer to like elements in the several views.

### DRAWINGS

FIG. 1 is a side view of a type installation of insulated flexible duct having a stretchable reinforced or vapor barrier constructed in accordance with the present invention;

FIG. 2 is a fragmentary view of a portion of the insulated flexible duct of FIG. 1 with an end stretched over a standard rigid end fitting;

FIG. 3 is a view illustrating a section of the vapor barrier on the duct, said vapor barrier reinforced in accordance with an embodiment of the present invention;

FIG. 4 is a view similar to FIG. 3 but of a section of vapor barrier having a reinforcement in accordance with another embodiment of the present invention;

FIG. 5 is a view of a section of a vapor barrier having another form of reinforcement;

FIG. 6 is a sequence of view of parts of several vapor barriers having several different types of reinforcement; and

FIG. 7 is a view of a section of a vapor barrier using a still further form of reinforcement.

### DESCRIPTION

Referring to the drawings in more detail and particularly to FIG. 1, there is shown a length of insulated flexible duct 11 constructed with a stretchable reinforced outer wrapper or vapor barrier in accordance with the present invention. One end of the duct is connected to a runout fitting in the side of a conventional distribution duct or plenum chamber 13 of a central air-conditioning system. A portion of the air in the plenum chamber 13 flows into the duct to be carried thereby.

The outlet end 14 of the duct 11 is connected to a standard end fitting 15 of a conventional diffuser outlet 16 in a false ceiling 17. In a typical configuration, the diffuser directs the air through the ceiling 17 into the room below. The plenum chamber 13 may be suspended from a runner 19 in the overhead structure 20.

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 "upstanding" longitudinal seam 25 forming an integral part of the outer wrapper or vapor barrier 27. The seam 25 is formed by folding the mating edges of the vapor barrier 27 and sealing them together. The grommets 23 are then punched through the seam and clinched therein. The wire hangers 21 are attached to and suspended from the angle iron runner 19 attached to a convenient building structure such as a rafter or beam 20, 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 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 or synthetic (vinyl) coated wire spring may be used along 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 lightweight, 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" 45 will, to some degree, limit the extent to which the spring 46 can be axially expanded but will not materially affect the bending or axial compression of the core 41. Another advantage of the scrim cloth is that the duct spring cannot "escape" or unravel when the duct is cut to lengths by an installer.

The duct 11 also includes one or more layers 47 of thermal insulation. The insulation may be of any desired material. Normally the insulating layer 47 is formed of a flexible material, such as a blanket of fiberglass. This blanket is normally of sufficient thickness to insure a minimum amount of heat being transferred between the outside and inside of the duct 11 particularly when cold air is flowing there through. By way of example, the insulation may be on the order of about 1/2 inch to about 2 inches or more in thickness.

As noted previously, the duct 11, as seen in FIG. 1, is covered by an outer wrapper or vapor barrier 27. This is vapor barrier 27 intended to enclose or cover the duct 11 and protect it from damage during normal handling and use. Accordingly, the outer cover or vapor barrier 27 should be a tough material which is durable, strong, not easily torn, punctured, etc. The vapor barrier 27 is also intended to prevent the air inside of the duct 11 escaping outwardly through the insulating material and to keep moisture, etc., which may condense on the exterior of the duct, from being absorbed in the insulating material and/or entering radially into the interior of the duct.

As clearly seen in FIG. 2, the end portion 14 of the duct 11 is stretched circumferentially to fit over the end of the standard fitting such as a sheet metal tube 15 on the diffuser 16 or the run-out fitting in the side of the plenum chamber 13. This illustrates still another and very desirable characteristic of the present invention, its circumferential flexibility without loss of outdoor weathering, permeability, strength, and puncture and tear-resistance qualities.

The vapor barrier 27 shown in FIG. 2 and more clearly in FIG. 3, encloses and protects all of the various parts of the duct 11 including particularly the insulating material such as fiberglass. The vapor barrier 27 should also be effective to prevent the loss of air by its flowing radially out through the insulating material and to prevent any moisture which condenses on the outside of the duct 11 working its way into the insulation.

It has been found there are a large variety of plastic sheets or films which are readily commercially available that are well suited for this purpose. For example, thin films of materials such as PVC, Mylar, (Mylar is a registered trademark of DuPont), and CPE, etc., are well suited for this purpose.

These films have inherent stretch or elongation in all random directions. Films of this nature are impervious to air and moisture and can be readily stretched in any random direction. However, they can be easily punctured by any sharp object. They can also be easily ripped or torn, particularly once there is an initial opening, such as a puncture. As a consequence, any hole will rapidly grow to a very large size.

In order to avoid this difficulty, the vapor barrier 27 is reinforced. However, the reinforcement does not impair the ability of the vapor barrier 27 to stretch so as to accommodate the installation of the duct. Normally the reinforcement includes members such as one or more sets of threads. The film 55 and the reinforcing are bonded or laminated together by any suitable process.

The reinforcing material 57 is arranged in such a manner that it does not restrict the inherent stretching or elongation qualities of the film 55, at least these qualities are not effected in a way which will materially or adversely alter the circumferential and axial stretch-

ing of the finished duct 11 or the parts thereof such as required for installing the duct 11.

In the embodiment of the invention illustrated in FIGS. 2 and 3 the reinforcing material 57 includes two separate sets of threads. All of the threads 65A in one set are parallel to each other while all of the threads 65B in the other set are parallel to themselves. Moreover, all of the threads 65A in the first set are orthogonal to all of the threads 65B in the other set. However, all of the threads 65A and 65B in both of the sets are oblique to the edges of the original strip of plastic. Normally the threads 65A and 65B are set at approximately 45° to the edges of the strip of plastic substantially as shown in FIG. 3. In other words, all of the threads are at approximately 45° to both the length and width of the strip. Conversely there are no threads which extend either longitudinally or transversely of the strip.

The threads 65A and 65B may be bonded and/or laminated onto the plastic film by any suitable means. The threads or sets of threads may be individually applied to the film or they may be in the form of a fabric. The threads 65A and 65B usually are fairly strong and not capable of being stretched to any great extent. The number and spacing of the threads are not believed to be particularly critical. By way of example they may be spaced in a range of about ten per inch to about one per inch.

During the final phases of constructing the duct 11 (i.e., after the layer of insulation 47 has been placed around the flexible core 41) the strip of reinforced plastic is positioned to extend the length of the duct 11. The strip is then wrapped around the outside of the insulation and the two edges are brought together. The edges are then folded over each other and bonded together to form the stand-up seam. Following this a series of grommets may be punched into the seam 25.

It may be seen that since the threads 65A and 65B extend diagonally across the plastic strip, when the strip is cylindrically wrapped around the layer of insulation to form the vapor barrier 27 the threads 65A and 65B form two sets of helical reinforcements. In other words, the threads 65A and 65B extend helically or spirally around the duct 11 in two opposite directions.

There are no threads which extend either axially of the duct or circumferentially around the duct. As a result, the vapor barrier 27 can be stretched in both the axial and circumferential directions.

In order to install the duct 11 in an air conditioning system (i.e., to extend from the plenum chamber 13 to the diffuser outlet 16) the duct 11 is cut to a length corresponding to the distance between chamber 13 and the outlet 16. This should be cut as accurately as reasonably practical. If the duct 11 is cut too long it will have trends or undulations which reduce the air flow. Next the duct 11 is suspended from the overhead structure by means of the suspension hooks or hangers 21 extending from the runner 19 and the grommets 23.

After the duct 11 is in position and its weight is fully supported by the hangers 21, the opposite ends of the duct 11 are attached to the run out fitting in the side of the plenum chamber 13 and to the fitting 15 on the diffuser outlet 16. In order to attach the end of the duct 11 to the fitting 15, the end 14 of the duct 11 is circumferentially stretched so as to expand it enough to fit over and encompass the fitting 15.

In order to attach the end of the duct to the fitting the end portion of the cover or vapor barrier 27 is normally

folded back on itself for a distance of several inches. This forms a cuff in the end of the vapor barrier 27 and exposes the end portion of insulating layer and the core structure. It can be appreciated that in order to fold the vapor barrier 27 back on itself, it is essential that it have a considerable amount of circumferential stretch. Without the stretch it is extremely difficult to fold the barrier 27 back upon itself without tearing it.

Next the core structure is worked onto fitting 15. In order to do this it may be necessary or at least desirable to fold or work the insulation back so as to expose the core structure. After the end of the core structure is properly seated upon the fitting, the insulating material is worked back around the core structure. It is also worked around the exposed portion of the fitting 15. This is effective to provide insulation for the fitting.

The cuff originally formed in the vapor barrier 27 is now worked forward and back over the insulating material. This is normally accomplished by grasping the end of the barrier 27 and jerking it forwardly. It can be appreciated that this necessitates a stretching of the material in the vapor barrier 27. If there is no stretch, it is highly probable the barrier 27 will be ripped.

Once the vapor barrier 27 is unfolded it may be pulled axially to extend over and even slightly beyond the insulating material. This will permit the vapor barrier 27 to be disposed on the fitting. The vapor barrier 27 can be stretched axially to a limited extent. Accordingly an adequate amount of the barrier 27 can normally be worked onto the fitting to facilitate covering the fitting 15 and/or securing the duct 11 thereto.

Under some circumstances the fitting 15 may belong with a substantial area exposed. In this event it is usually desirable to insulate the fitting 15 and/or to provide a vapor barrier. To accomplish the end of the vapor barrier 27 may be folded back on itself for a distance in excess of the length of the fitting 15. The exposed end of the duct (i.e., the insulating layer and core structure) is then cut-off. When the vapor barrier 27 is again pulled forward, it will extend beyond the end of the duct. Accordingly, it can be used to cover up at least a portion of the duct.

Since the reinforcing threads are all disposed in helical or spiral arrays they will not materially interfere with this stretching of the vapor barrier 27. As a consequence, the vapor barrier 27 can be stretched circumferentially essentially according to the stretching characteristics of the plastic film prior to its being reinforced by the threads 65A and 65B.

It should also be noted that there are no threads extending in an axial direction of the duct 11. As a consequence the duct 11 and its reinforced vapor barrier 27 can be stretched axially. This advantage is particularly important in these instances where the duct is cut somewhat too short to freely reach between the fittings. Under these circumstances, the duct 11 can be stretched (i.e., within the limits of the core structure 41 and the layer of insulating material 47) to reach to the fitting 15.

After the terminal end 14 of the duct 11 is stretched over and around the fitting 15, it may be secured thereto by suitable fastening means such as a clamp, tape, etc.

It may be observed that the reinforcing threads do not materially or adversely effect the stretching of the vapor barrier 27 and/or the duct 11 in either the circumferential and/or axial directions. However, the re-

inforcing threads **65A** and **65B** are effective to prevent or at least severely limit any ripping, tearing, puncturing of the vapor barrier.

Under some circumstances the installer may rip or tear the vapor barrier **27** adjacent the end **14** while trying to stretch it over the fitting **15**. Also, he may puncture the vapor barrier **27** by snagging it on a sharp object while handling the duct. It is also possible to snag and rip the barrier **27** after the duct **11** has been installed, while installing other equipment next to the duct **11**.

However, in the event, the vapor barrier **27** should happen to be ripped, torn, punctured, etc., the resultant opening will not propagate beyond the first reinforcing thread or two. Thus, even if the reinforcing threads are relatively widely separated (for example an inch or so) the puncture, rip, or tear, etc., will normally not extend beyond a size of about one or two inches. An opening of even this limited size is not a desirable feature. However, the losses resulting therefrom are relatively nominal and not large enough to totally destroy the effectiveness of the duct. Moreover, since the opening will be retained within relatively narrow dimensions, it can be readily repaired with a patch.

The foregoing embodiment is reinforced so as to prevent it ripping, tearing etc., without materially restricting circumferential and/or longitudinal stretching of the duct **11**. Under some circumstances, it may be desirable to prevent or at least limit the axial stretching of the duct. It has been found that a limited amount of axial stretching can be accommodated by the ducting. However, if the duct **11** is stretched beyond the elastic limits of any of the elements in the duct (i.e. the core structure and/or of the layer of insulation) there may be a structural failure of one or more of these elements.

Therefore, in order to control the axial stretch, the embodiment of FIG. 4 may be employed. In this embodiment a tri-directional reinforcement **57B** is bonded or laminated onto the film **55**. This is effective to limit the elongation or stretch of the vapor barrier **27** in the axial or warp direction. However since there are no transverse reinforcing threads it still allows an elongation or stretch in the fill direction.

This type of reinforcement utilizes three separate sets of threads. The threads in each set may be parallel monofilament or twisted yarns **71A**, **B** and **C** placed in three different directions. One set **71A** of axial or warp threads is placed to limit longitudinal stretch or elongation of the laminate. The other two sets **71B** and **71C** of threads are disposed oblique to the axial or warp yarn set **71A**. By way of example an angle of 45° may be used.

The threads in the axial set **71A** may be totally inelastic whereby the vapor barrier **27** cannot be stretched. However, these threads may also have a small amount of stretch whereby the barrier **27** may stretch slightly, i.e., within the stretch limits of the core structure and the insulating layer.

As a further alternative, the embodiment of FIG. 5 may be used. This embodiment of the invention controls or essentially eliminates axial stretch or elongation of the vapor barrier **27** and the duct **11**. The film **55** is laminated to a reinforcement **57C**. The reinforcement **57C** includes a plurality of parallel monofilament or twisted yarns **73** disposed in the axial direction only. This pattern or array of reinforcements limits the stretch of the duct **11** in its longitudinal direction. How-

ever, it still allows stretch or elongation of the vapor barrier **27** (due to inherent film stretch) in the circumferential direction.

As a further alternative, the embodiments of FIG. 6 may be used. In this embodiment a fabric having transverse and longitudinal threads is laminated to the plastic sheet or film. There are five versions (**6A** to **6E**) of this embodiment shown. Each of the versions includes a laminate using special square-woven or special square non-woven fabric. The reinforcements in the fabric limit elongation in the axial (Warp) direction and allow elongation or stretch in the circumferential (fill) direction.

In each version, an axially yarn pattern or set **75** of parallel yarns is utilized. Along with this axially oriented pattern, as seen in FIG. **6A**, is a crimped or taslan type yarn set **77** disposed in the fill direction. FIG. **6B** shows a sinusoidal type placement of a fill yarn set **79**. A yarn set **81** of high-twist yarns (greater than six turns per inch) in an S or Z direction is illustrated in FIG. **6C**. In FIG. **6D**, a yarn set **83** is shown wherein the plurality of yarns are twisted in only one direction, S or Z for example, to yield an unbalanced construction of high-elongation in the fill direction. Finally, FIG. **6E** shows a version wherein a conventional yarn set **85** having an inherent elongated characteristic of approximately 15% is woven or disposed in the fill direction.

In yet a further embodiment of the invention, the wrapper **27** takes the form of a film or films **87**, similar to film **55**, laminated to a spunbonded non-woven reinforcement **89** of such material as polyester, polypropylene or polyolefin, which has inherent stretch qualities similar to that of the film **87**.

It should be evident from the foregoing that the invention constitutes a significant advancement over the art in that by selection of any of the above-described laminate wrapper constructions, a moisture and air barrier can be produced which has the advantage of durability, strength, and puncture and tear-resistance without the loss of bi-axially elongation or stretch and subsequent loss of circumferential stretch to the finished duct.

Having thus described embodiments of the invention, what we claim is:

1. An insulated flexible duct for being interconnected with a rigid cylindrical fitting in an air-conditioning, heating, and ventilation systems, said duct including the combination of:
  - a hollow central reinforcing core, said core including an elongated, helical, semi-rigid wire spring, forming a cylindrical passage for air to flow therethrough;
  - a layer of insulating material disposed about said cylindrical core to limit the radial flow of heat through said duct;
  - a thin film of plastic wrapped about the layer of insulating material to form a vapor barrier on the exterior of said duct, said film being impervious to the flow of moisture and air and stretchable in random directions;
  - a first set of reinforcing threads in said vapor barrier extending helically around said duct in a first direction; and
  - a second set of reinforcing threads in said vapor barrier extending helically around said duct in a second direction, said first and second directions being at substantially right angles to each other

- whereby said vapor barrier may be circumferentially stretched.
2. An insulated flexible duct for use in air-conditioning, heating, and ventilating systems, said duct including the combination of:
    - a central flexible core structure for reinforcing the duct, said core structure having a resilient spring forming a cylindrical passage for the flow of air therethrough;
    - a cylindrical layer of insulation surrounding said core, said insulation being effective to insulate said passage against thermal losses;
    - an outer vapor barrier enclosing and covering said cylindrical layer of insulation, said vapor barrier including at least one film impervious to moisture and air, and,
    - reinforcing means in said film, said reinforcing means including a plurality of inelastic threads said threads being constructed and arranged in said film to prevent ripping and tearing of the vapor barrier but not effect the axial and circumferential stretching of the duct.
  3. An insulated flexible duct, comprising:
    - an elongated, helical, semi-rigid, wire core;
    - insulating material disposed about said wire core;
    - a vapor barrier disposed about said insulating material;
    - reinforcement means in said vapor barrier, said reinforcing means being constructed and arranged to protect said vapor barrier against rips and tears while still allowing circumferential stretching of said vapor barrier,
    - said vapor barrier including at least one moisture and air impervious film with inherent elongation in both axial and circumferential directions, and
    - said reinforcement means includes reinforcement material arranged to increase the durability, strength and puncture and tear-resistance of said vapor barrier without the loss of axial elongation thereof.
  4. The duct according to claim 3, wherein said reinforcement material is disposed as a plurality of spaced parallel reinforcing yarns in said axial direction only.
  5. The duct according to claim 4, wherein said reinforcing yarns are monofilament strands.
  6. The duct according to claim 4, wherein said reinforcing yarns are twisted yarns.
  7. The duct according to claim 3, wherein said reinforcement material is disposed as a tri-directional array having a set of spaced parallel reinforcing yarns lying in said axial direction, and two intersecting spaced parallel reinforcing yarn sets each disposed at an angle of less than 90° to said axial direction.
  8. The duct according to claim 7, wherein said angle is 45°.
  9. The duct according to claim 7, wherein said reinforcing yarns are monofilament strands.
  10. The duct according to claim 7, wherein said reinforcing yarns are twisted yarns.
  11. The duct according to claim 3, wherein said reinforcement material is disposed as a bi-directional array having two sets of spaced parallel reinforcing yarns, said sets intersecting each other and being at an angle less than 90° to said axial direction.
  12. The duct according to claim 11, wherein said reinforcing yarns are monofilament strands.

13. The duct according to claim 11, wherein said reinforcing yarns are twisted yarns.
14. The duct according to claim 3, wherein said reinforcing material is essentially a bi-directional array having an axial set of spaced parallel reinforcing yarns and a bi-axial set of spaced and essentially parallel reinforcing yarns, said axial set preventing axial elongation of said vapor barrier while said bi-axial set being configured to allow biaxial elongation thereof.
15. The duct according to claim 14, wherein said bi-axial set of yarns is in a crimped pattern.
16. The duct according to claim 14, wherein said bi-axial set of yarns is in a taslan pattern.
17. The duct according to claim 14, wherein said bi-axial set of yarns is in a sinusoidal pattern.
18. The duct according to claim 14, wherein said bi-axial set of yarns is in a high-twist pattern having greater than a six turns per inch in an S direction.
19. The duct according to claim 14, wherein said bi-axial set of yarns is in a high-twist pattern having greater than a six turns per inch in an Z direction.
20. The duct according to claim 14, wherein said bi-axial set of yarns is a spaced plurality of groupings of yarn twisted in only one direction in an unbalanced construction.
21. The duct according to claim 14, wherein said bi-axial set of yarns is a plurality of spaced yarns having inherent elongation of approximately 15%.
22. The duct according to claim 14, wherein said bi-axial set of yarns is woven into said axial set of yarns.
23. The duct according to claim 14, wherein said bi-axial set of yarns is in a non-woven relation with said axial set of yarns.
24. The duct according to claim 3, wherein said reinforcement material has an inherent stretch similar to that of said film and is in a spunbonded non-woven configuration.
25. 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, said wrapper including at least one moisture and air impervious film layer having inherent elongation in both axial and circumferential directions,
  - reinforcement means including reinforcement material laminated to said film layer for reinforcing said film layer while still allowing axial elongation of said wrapper.
26. Insulated flexible ducts 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 vapor barrier enclosing said layer of insulation, said vapor barrier having at least one moisture and air impervious film with inherent elongation in both axial and circumferential directions, and
  - a plurality of fibers in said film for reinforcing said film, said fibers being oriented relative to the axis of said duct while still allowing axial and circumferential elongation of said vapor barrier.
27. Insulated flexible ducts for use in air-conditioning, heating, and ventilation systems, and the like, the duct including the combination of:
  - an elongated, helical, semi-rigid wire core;

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insulative material disposed about said helical wire core;  
a vapor barrier layer disposed about said insulative material, said barrier layer having at least one moisture and air impervious film with inherent elongation in both axial and circumferential directions, and

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reinforcing threads, said threads being inelastic and laminated to said film in a direction oblique to the axis of the duct for reinforcing said film while still allowing axial and circumferential elongation of said vapor barrier.

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