Aug. 27, 1957 H. G. SCHAUENBURG 2,804,095

AIR DUCTS FOR MINES AND THE LIKE

Filed May 4, 1953

2 Sheets-Sheet 1

Fig. 1

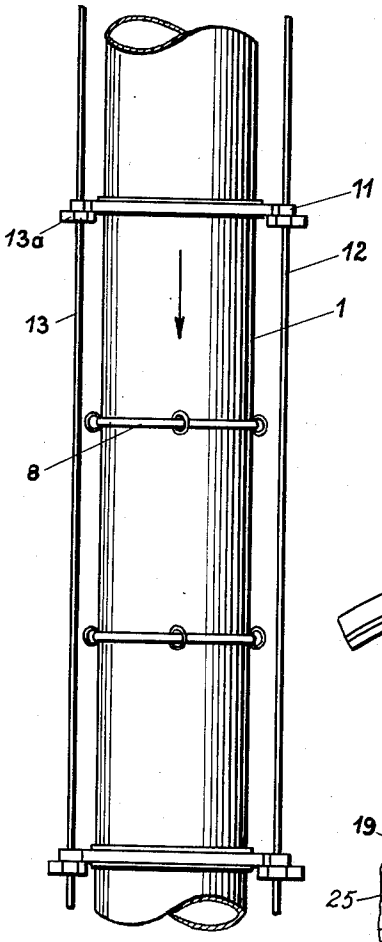
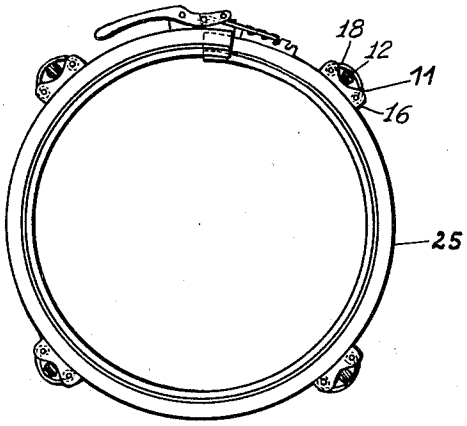


Fig. 2



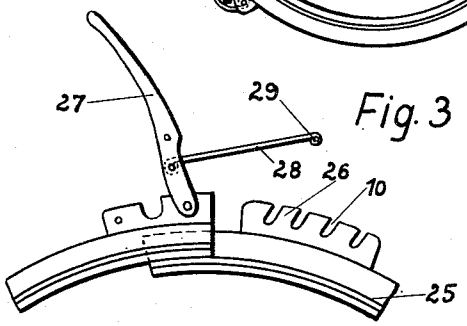


Fig. 3

Fig. 4

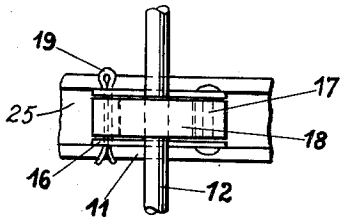


Fig. 5

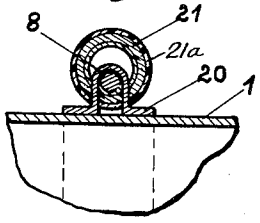


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Fig. 6

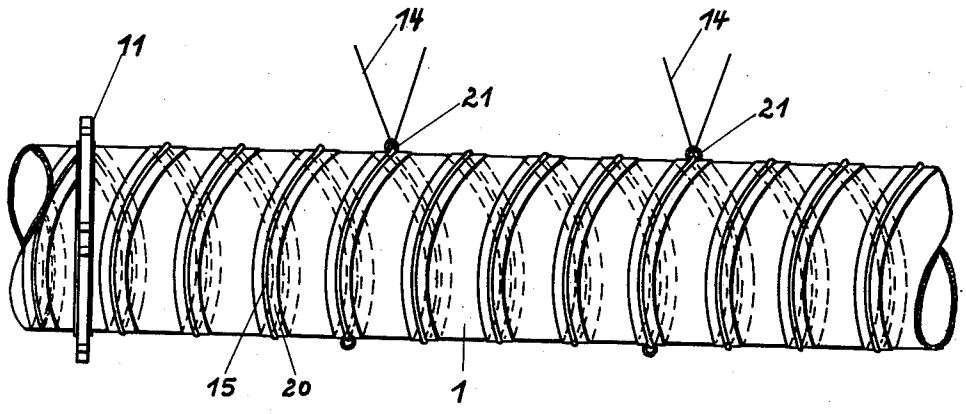
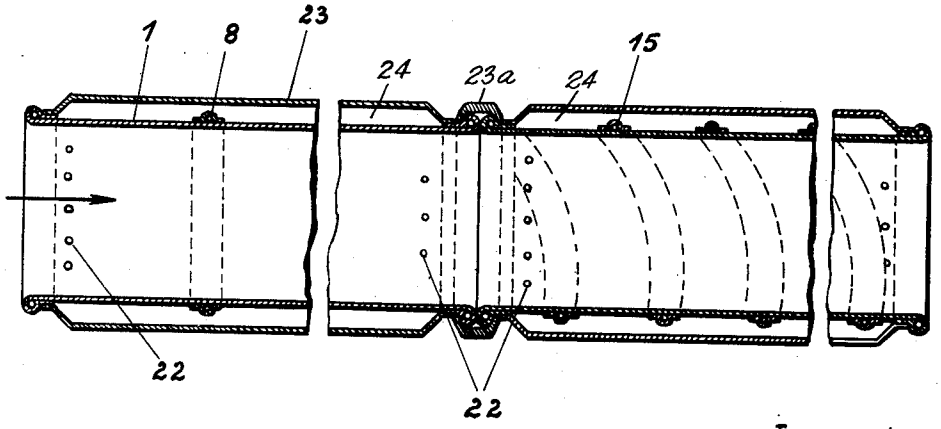


Fig. 7



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AIR DUCTS FOR MINES AND THE LIKE

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4 Claims. (Cl. 138—54)

This invention relates to collapsible air ducts and more particularly to air ducts for mines and the like. The most common type of mine air ducts consists of a galvanized iron pipe having a diameter of from about 10 to 30 inches and a length of around 6 to 8 feet, the individual lengths being connected by sealing collars. Mine air ducts of this kind are relatively costly and are awkward to handle during transportation to and installation in mines.

In order to facilitate transportation and installation, it has been proposed to make mine air ducts of foldable textile fabrics, such as cellulosic fabrics, as for example, cotton fabrics, but air ducts made of cellulosic fabrics or of other fabrics have not proved successful due to considerable leakage of air and/or gases. For this reason mine air ducts made from impregnated canvas have occasionally been arranged at the ends of relatively long lines of metal pipes, since these canvas ducts can be relatively readily withdrawn during blasting from the regions of the mine being worked. Due to the roughness of the canvas and the increased air resistance thereby caused, these canvas ducts are, however, unsuitable except for short lengths. Moreover it is, in principle, true of all mine air ducts made of fabric, whether coated or not, that they rot prematurely because the formation of condensate, which leads to destruction of the fabrics and more particularly of the seams thereof, cannot be avoided in mine air ducts due to the frequent changes between hot and cold temperatures. Moreover, most fabrics are inflammable so that fabric air ducts can only be used for short distances in mining operations.

It is an object of the present invention to provide immine air ducts which are substantially free from these disadvantages. According to one aspect of the invention the collapsible air duct consists of fabricless films of synthetic material e. g. of films of polyamide, polyvinyl chloride, other polyvinyl resins, urethane, silicone or other films of synthetic materials which are not readily inflammable. Thus, collapsible air ducts of film thickness, i. e. less than 1 millimeter in thickness, may be formed from from such synthetic materials by spraying liquid dispersions of such a material onto a cylindrical mandrel, solidifying the sprayed film and stripping off the seamless tubular film, or by extruding seamless air ducts of film thickness from a die utilizing well known extension processes for making tubes of film thickness, or by joining the longitudinal margins of a rolled flat film in a butt weld by application of heat to the abutting margins of the film to form a tubular duct, or by joining the longitudinal margins of a rolled flat film to each other in abutting relation by adhesive strips. In any case, there is formed a collapsible cylindrical air duct having a smooth inner surface, offering little or no resistance to the flow of air therethrough. The collapsible air duct is supported by diameter-holding devices such as wire rings or wire coils, rings of synthetic material, or the like being attached thereto in a corrosion-proof manner by being encased therein without affecting the smooth inner wall, by the use of heat-welding or adhesive strips without a thread-stitched seam or other stitched seam.

In order to heat-weld fabric-free flexible thermoplastic synthetic films along their longitudinal seam and to weld in a diameter-holding means, instead of the application of heat, adhesive strips may alternatively be stuck on, which may carry suspension rings, suspension hooks, or clamping devices, which permit the collapsible air ducts to be held taut without the arrangement of diameter-holding means, for example on rigging ropes.

The advantages obtained by the invention are considered to reside in the fact that the collapsible airtight air ducts are made from mirror-smooth flexible fabric-free synthetic film, which ducts can be folded for transportation and have little weight. In addition to the advantages of low air-flow resistance due to the smoothness of the walls and the airtight connection to form air duct lengths with the possibility of attachment of the diameter-holding means on the outer wall or surface without interrupting the smooth inner wall or surface, further advantages consist in high tearing strength against falling stones and complete imperviousness to moisture and cheapness in manufacture.

The collapsible mine air ducts according to this invention can be made in any desired size of diameter and length. Spaced apart at distances of approximately 3 feet, there may for example be provided at the outer side steel wire rings or wire coils of approximately ½ inch thickness, more or less, which serve as supports for diameter-holding means. These diameter-holding means may be secured to the outer surface of the air duct by any suitable means, provided the inner surface of the air duct is not penetrated or otherwise modified to interfere with the flow of air or other media therethrough. For example, the wire rings or wire coils may be secured to the outer surface of the air duct by laying a strip or strips of non-inflammable moisture-impervious film over the ring or coils and adhering the strips to the outer surface of the air duct by heat welding or by a suitable adhesive. Such attachement means will hold the diameter of the mine air duct even during suction within the air duct, that is to say, when the mine air duct is used as a suction duct. The rings may at the same time be utilized for carrying suspension means for the suspension of the mine air ducts. The air ducts may be laid at any angle and even at right angles without any difficulty. The flexible mine air ducts according to this invention may be advantageously manufactured in lengths of around 12 to 16 feet. The connection of lengths of air duct may be effected by means of a ring having tensioning means, which is slipped over a thickened part of the air duct.

It is by no means necessary for the air ducts to be made of thermoplastic synthetic materials adapted to be connected to each other by heat welding. On the contrary, films of other synthetic materials may also be used, the opposite longitudinal edges of the sheets being connected by adhesive strips to form a cylindrical air duct, the cylindrical ends of which are adapted to be slipped into a band to which the ends of the air ducts may be secured by any suitable means, as by pressure or by adhesion.

A further feature of the invention consists in a particularly advantageous construction of the connection between two abutting lengths of air ducts by means of a clamping ring which is open at one side and which is placed around the diameter-holding elements secured at the ends of the air duct sections by rolling in or turning over the ends of the air duct and welding or sticking. As shown in Figs. 2, 3 and 4, one end of said clamping ring engages a toothed rack of the other end and is tightened by means thereof in such manner as to connect the lengths or sections of the air duct.

According to another very simple method of connecting the air duct sections, resilient steel wire rings may be embedded at the ends of the individual sections of the flexible

air duct by turning the ends of the air duct over a ring, the rings being embedded for example by heat-sealing, sticking or adhering by spraying on an adhesive material and then rolling the ends back over the rings. The resilient steel wire ring at one end of each section is of slightly greater diameter than the resilient steel wire ring at the other end of each section. The metal ring of larger diameter is compressed to an oval shape and, while so deformed, is slid into the end of the adjacent section which has the metal ring of smaller diameter, so that on release of deforming pressure on the larger ring and on tensioning the air duct sections the two rings lock one with the other and with the film of the tubular body portion to form a fluid-tight joinder of the sections. This joinder is so strong that it will carry the weight of several men suspended on the lengths of pipe thus joined without separating the same.

The invention further provides a method for the manufacture of air ducts for mines or like purposes from flexible films, preferably made from polyvinyl chloride flexible plastic films or from films of other synthetic material.

By this invention, collapsible airproof ducts for the conduction of air, or heating or other media in mining operations are produced which can during transportation be pushed together and packed in a minimum of space, and which can be installed in an extremely simple manner for use as suction or pressure ducts. The inner wall surfaces of such ducts will remain mirror-smooth throughout and thus avoid any impediment to the free movement of the medium being conveyed through the airproof ducts.

Moreover, the collapsible air ducts according to this invention, whether made of films of flexible synthetics or produced by spraying or by extrusion, are not only non-inflammable but are adapted to be held taut under very high tension and are accordingly adapted to be installed rigidly like a metal pipe without, however, losing the advantage of being collapsible for transportation and adaptable to curved paths.

According to another embodiment of the invention, a flexible air duct may be composed of two tubular shell elements, the inner shell being formed of synthetic material, for example as a seamless sprayed, extruded or welded synthetic-plastic tube, or of a synthetic-plastic tube made of foil or film, while the external shell may consist of metal such as aluminum or may likewise consist of synthetic-plastic material. Between the two shells of the air duct a space is preferably provided, which, as an air space, effects insulation of the inner shell, thus preventing the substances conveyed through the tube from assuming the temperature obtaining outside the tube. The space between the inner and the outer tubes may be inflated.

In the drawing an air duct made according to the invention is schematically illustrated by way of example.

Fig. 1 is an elevation showing an air duct made of lengths of flexible tubing with a tensioning device, as installed in a shaft.

Fig. 2 is a view of a clamping ring in the tightened position.

Fig. 3 is a similar fragmentary view drawn to a larger scale and showing part of an open clamping ring.

Fig. 4 is a plan view of the tilting loops on the clamping ring.

Fig. 5 illustrates the manner in which a diameter-holding ring is secured on the air duct, and shows the suspension device in section.

Fig. 6 shows a suction air duct with helical diameter-holding means, and

Fig. 7 shows an insulated air duct.

Referring now to the drawings, a flexible air duct **1** is formed in any of the ways hereinabove described, as by spraying on a mandrel, or by extrusion from a die, or by heat-welding or otherwise adhering the opposite longitudinal edges of a film of synthetic-plastic material, for example, a polyvinyl chloride. Air ducts produced by any of these processes are in reality seamless, and the term "seamless" is used in this generic sense in the specification and claims of this application.

Secured on the outer surface of the collapsible air duct **1** in mutually spaced relation are steel rings **8** which serve as diameter-holding means. The rings **8** are enveloped by bands **20** of synthetic material and are thus hermetically sealed between the air duct **1** and the bands **20**. Hence, they are on the one hand protected against corrosion and on the other hand secured on the outer surface of the air duct **1**. The bands **20** are joined to the outer surface of the air duct **1** by electric welding or by other means of adhesion so that the inner surface of the air duct has no projections or recesses interfering with the free flow of air or other media through the air duct. The diameter-holding devices or bands **20** carry at their circumference suspension rings **21** which consist of steel rings that are encased with synthetic resin so as to be corrosion-proof. At the end of each length of the air duct steel rings **8** are embedded in the plastic material of the air duct **1** by wrapping the open ends of air duct **1** around the rings **8** and hermetically sealing them in the plastic material to form butt rings.

These rings may be placed at the butt ends of each section of the air duct **1**. The clamping ring **25** is open at each side in such manner that two butt rings of two adjacent sections of the air duct **1** may be placed side by side and held together by the clamping ring **25** to form an airtight connection between the sections of the air duct **1**. The clamping ring **25** embraces the butt rings and, as can be seen from Fig. 3, is provided at one end with a series of teeth **26** and at the other end with a pivoted locking lever **27** to which eccentrically to its pivot axis there is pivotally connected a tension lever **28** with a holding pin **29** adapted to be hitched in a rack **10** whereby tilting of the lever **27** will cause the clamping ring to be adjustably tightened. The clamping ring **25** additionally carries hooks or eyelets **11** which are adapted to be attached to ropes or other supporting means.

When the air ducts are to be vertically suspended, wire ropes **12** and **13** are suspended under tension in suitable positions. The eyelets **11** are placed round these wire ropes **12** and **13** and thereafter the air duct is tensioned and anchored under tension by rope clips **13***a* on the wire ropes **12** and **13** so that the air duct is suspended in the tensioned condition (see Fig. 1). As shown in Fig. 4, the wire rope **12** passes through eyelets **11** each attached to a clamping ring **25**, each eyelet **11** being constructed of a base member **16** welded or otherwise secured to clamping ring **25**, a pivoted cover member **18**, pivotally attached to base member **16** at one side by bolt **17** and at the other side, removably secured to base member **16**, by a cotter pin **19**. When installed horizontally, according to Fig. 6, the air ducts are suspended by means of the rings **21** and suspension means **14**. In this case, too, the eyelets **11** may serve as tensioning devices, in which case a tensioning of the line of air ducts **1** is readily accomplished.

In suction air ducts, which are subject to low internal pressures, a coil **15** may be provided which is secured on the outer surface of the air duct **1** by means of strips similar to the diameter-holding devices **8**, above described.

In Fig. 5 part of an air duct **1** having a steel ring **8** as a diameter-holding device, an adhesive strip **20**, and steel suspension eyelets **21** provided with a synthetic-resin covering **21***a*, is shown to a larger scale.

Fig. 6 shows a suction air duct in which a wire **15** is helically placed on to the outer side of the tubular synthetic-resin air duct **1** and connected by adhesive strips **20** to the outer surface of the air duct **1** so that the inner diameter of the air duct is maintained substantially constant even when suction is applied to the air duct. Small suspension rings **21** are provided on the helical ring **15**

to enable the air duct **1** to be suspended by means of a tension means **14**.

Fig. 7 shows the diameter-holding means in the form of rings **8** or wire coils **15** placed on and joined to the outer surface of the air duct **1**. The air duct **1** further carries a second outer insulating tube **23** which reaches in each case to the ends of the sections of the air duct **1** and provides an insulating space **24**. Each section of the air duct **1** has a circumferential series of holes **22** disposed near each end of the air duct section, whereby the space **24** between the air duct **1** and the outer insulating tube **23** is in communication with the interior of air duct **1**. As a result, the media being conveyed by the air duct is permitted to flow into and out of space **24**, the differential pressures of the fluid passing through the air duct at the ends of each section facilitating such flow. The insulating shell is interrupted at the joinder of two contiguous sections of air duct **1** by a means **23***a* connecting the individual sections or lengths of the air duct **1**, and at these places the connecting means **23***a* serves as an insulation.

It is obvious that numerous modifications and variations may be made in the constructions hereinabove disclosed without departing from the scope and spirit of this invention as defined in the appended claims.

What I claim is:

1. In a readily collapsible flexible abrasion- and rot-proof airtight flame-resistant air duct for mining and like operations, in combination, a collapsible airtight cylindrical body portion consisting entirely of a substantially non-inflammable non-corrosive fabric-free flexible plastic film having high tear-resistance, said cylindrical body portion having throughout a mirror-smooth inner cylindrical surface free of projections and recesses, relatively rigid diameter-holding means disposed around said cylindrical body portion and attached to the outer surface of said cylindrical body portion so as to maintain the said smooth interior surface of the cylindrical body portion, the relatively rigid diameter-holding means being attached to the outer surface of the cylindrical body portion by relatively narrow strips of non-corrosive non-inflammable fabric-free flexible plastic film overlying said diameter-holding means and embedding the said holding means between the said overlying plastic film and the outer surface of the cylindrical body portion while maintaining the interior surface of the said cylindrical body portion uniformly smooth and free of projections and recesses, the said relatively rigid diameter-holding means comprising a helical coil of metallic wire having a substantial distance between the convolutions of the coil, the helical coil having a slightly greater inside diameter than the outer diameter of the cylindrical body portion of the air duct.

2. In a readily collapsible flexible abrasion- and rot-proof airtight flame-resistant air duct for mining and like operations, in combination, a collapsible airtight cylindrical body portion consisting of a substantially non-inflammable non-corrosive fabric-free flexible plastic film having high tear-resistance, said cylindrical body portion having throughout a mirror-smooth inner cylindrical surface free of projections and recesses, relatively rigid diameter-holding means disposed around said cylindrical body portion and attached to the outer surface of said cylindrical body portion so as to maintain the said smooth interior surface of the cylindrical body portion, the relatively rigid diameter-holding means being attached to the outer surface of the cylindrical body portion by relatively narrow strips of non-corrosive non-inflammable fabric-free flexible plastic film overlying said diameter-holding means and embedding the said holding means between the said overlying plastic film and the outer surface of the cylindrical body portion while maintaining the interior surface of the said cylindrical body portion uniformly smooth and free of projections and recesses, the said relatively rigid diameter-holding means comprising a

plurality of metallic rings spaced longitudinally along the outer surface of said cylindrical body portion and having an inside diameter slightly larger than the outside diameter of the said cylindrical body portion of the air duct, supporting means running parallel to the axis of the said cylindrical body portion and contiguous but outside the said diameter-holding means, and means for attaching the diameter-holding means to the said supporting means.

3. A collapsible air duct for mining and like operations comprising a plurality of sections, each section having a collapsible airtight cylindrical body portion consisting entirely of a substantially non-corrosive non-inflammable fabric-free flexible plastic film, said cylindrical body portion having throughout a mirror-smooth cylindrical interior surface of substantially uniform cross-section, relatively rigid diameter-holding means attached to the outer surface of said cylindrical body portion, two resilient integral metal rings attached to the said cylindrical body portion of each section, one ring at each open end of each section, the resilient integral ring of one section being inside the adjacent section and in sealing contact with the resilient integral ring at the contiguous end of the said adjacent section.

4. A collapsible air duct for mining and like operations comprising a plurality of sections, each section having a collapsible airtight cylindrical body portion consisting entirely of a substantially non-corrosive non-inflammable fabric-free flexible plastic film, said cylindrical body portion having throughout a mirror-smooth cylindrical interior surface of substantially uniform cross-section, relatively rigid diameter-holding means attached to the outer surface of said cylindrical body portion, two resilient integral metal rings attached to the said cylindrical body portion of each section, one ring at each open end of each section, the resilient integral ring of one section being inside the adjacent section and in sealing contact with the resilient integral ring at the contiguous end of the said adjacent section, the resilient metal rings attached to the ends of each section of the cylindrical body portion being integral rings, the metal ring attached to one end of each of the sections being of slightly greater diameter than the metal ring attached to the other end of each of the sections, the ring of greater diameter of each section when the sections are assembled, being inside the adjacent section and in contact with the ring of less diameter and in sealing contact with the cylindrical body portion of said adjacent section, whereby a fluid-tight juncture between the adjacent sections is obtained without adjustment of the size of either ring.

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