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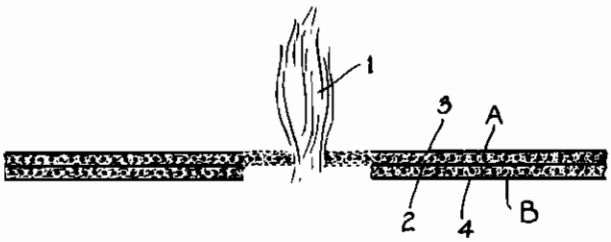

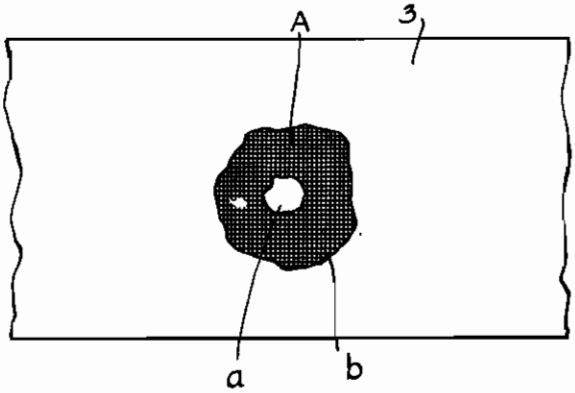

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MANUFACTURE OF FLEXIBLE ENVELOPES OR THE LIKE

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The present invention relates to the manufacture of flexible pieces or walls which must have, simultaneously, qualities of resistance against fire, and some other qualities, such, for instance, as fluidtightness against the passage of gases (and in particular hydrogen), mechanical strength, and so on. The invention is more especially, although not exclusively, concerned, among these articles, with flexible envelopes or reservoirs intended to contain a fluid, and in particular a gaseous fluid under pressure, and, more specifically, balloon envelopes.

The essential object of the present invention is to provide an article of this kind which is better adapted to meet the requirements of practice than those used for the same purpose up to this time.

According to an important feature of the present invention, in order to obtain a flexible article of the type above referred to, we have essentially recourse, on the one hand, to a structure, such as a fabric, of asbestos or any other which is relatively flexible and is incombustible in itself, and, on the other hand, to means (such for instance as another fabric, for instance of a textile material, either combustible or not) intended to give the desired various properties to the whole; the combination thus obtained is such that, if the asbestos structure happens to be bared by a local fire, it constitutes a kind of screen which tends to prevent the propagation of fire, while it maintains, at the place where it has been injured, a certain mechanical resistance, which prevents the tearing of the whole.

Another feature of the present invention relates to hollow bodies having a flexible wall and which are liable to be endangered by fire, such, in particular, as balloon envelopes; It consists in reinforcing the resistance of said flexible wall at the lower part of the body, that is to say in the portion thereof where the propagation of fire is to be most feared, due to the fact that the flames escaping from the injured body have a tendency to curve back upwardly toward the wall thereof.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 is a diagrammatic cross-sectional view of a composite fabric adapted to be used as a balloon envelope, illustrating what takes place when a hole has been made in said envelope and ignited gas is escaping through said hole from the inside of the balloon;

Fig. 2 is a partial plan view corresponding to Fig. 1.

In the following description, it will be supposed that the invention is applied to the manufacture of a fabric intended to be used for constituting a balloon envelope, and more especially of a balloon intended to be inflated with an inflammable gas.

First, it should be noted that various methods have already been imagined for endeavouring to give a fabric to be used for this purpose in addition to the different properties corresponding to its function (which is to constitute, under a relatively small weight, a gas-tight envelope), as good a resistance to fire as possible.

It seems that this fabric should comply with all of the following conditions, to wit:

a. Resistance to fire, that is to say at least resistance to the quick propagation of fire, after ignition of the gas escaping through a hole made in the envelope;

b. Mechanical resistance, that is to say the fact of maintaining a suitable resistance, after perforation and inflammation of the envelope, in order to avoid the tearing off thereof and the consequent explosion;

c. Fluidtightness against gases, and especially hydrogen;

d. Relatively small weight;

Then, accessorily:

e. Sufficient flexibility, in order to permit all deformations; and

f. A good ageing, that is to say, in particular, a suitable resistance to the action of sun rays and external agents;

As a matter of fact, the essential object of the present invention is to provide a structure which complies with all of these conditions.

It has already been suggested to constitute it by means of fabrics consisting chiefly of matters such as asbestos.

Now, after many experiments, we have found that it is possible to make, for the purpose above indicated, a structure including asbestos which, although it comprises matters which are relatively combustible, makes it possible to resist the action of fire, asbestos having this unexpected effect of delaying the propagation of fire.

This phenomenon, on which the principle of the present invention is based, seems to be explainable in the following manner: Considering an envelope made of a structure, for instance a fabric includ-

ing an asbestos texture, and supposing that the ignited gas is in the form of a jet *f* issuing from a hole *a* (Figs. 1 and 2), ignition of the combustible matters included in said fabric is delayed by the fact that asbestos, bared as the combustion proceeds in a zone such as *b*, acts as a kind of metallic wire net tending to delay the propagation of fire.

Furthermore, this asbestos, during and after combustion, constitutes a resistant support which prevents tearing.

Therefore, the envelope or the like, according to the present invention, includes the following elements:

a. On the one hand, a layer of a matter which is little or not combustible, preferably asbestos as it will be supposed in the following description; however, it should be well understood that any other incombustible matter, either mineral or not (such, for instance, as slag wool, glass silk, metallic wire net, and so on) might be used, either alone or in combination with asbestos; and

b. On the other hand, means combined with this layer and adapted to give the whole the various conditions required from such an article; the choice and adaptation of these last mentioned means becoming relatively easy, in view of the fact that their eventual combustion is in no way a serious obstacle.

This principle may be applied in many different manners, and in particular as follows:

Concerning first the part of the structure which is made of asbestos or another equivalent material such as above mentioned, it is preferably made in the form of at least one sheet of a fabric A (Figs. 1 and 2), which is to be both light and strong, therefore relatively close-woven, the spaces between the warp and weft threads being as reduced as possible.

For instance the threads will be of a thickness corresponding to 10.000 to 20.000 meters per kilogram, their number ranging from 8 to 20 per centimeter, but it should be well understood that these values are given merely by way of indication and have no limitative character. According to an embodiment of our invention, the thickness of the fabric ranges from $\frac{3}{10}$ to $\frac{4}{10}$ of a millimeter.

Concerning now the above mentioned means (intended to give the whole the various properties that the asbestos fabric cannot have when taken alone) they are made as follows:

a. either merely by means of one or several coatings capable, in particular, of making the layer or layers of asbestos or asbestos fabric gas-tight;

b. or, preferably, by means of at least one other fabric B, forming at least one layer, and preferably combined with one or several coatings.

Considering the case of the second mentioned means, and concerning first the choice of this fabric B, we may make use of a fabric of a vegetal animal, or other type, for instance made of cotton, wool, silk, artificial silk and so on. But it should be well understood that we do not exclude fabrics made of incombustible materials (such as asbestos, glass silk, a metal net, and so on) and that this second fabric B might even be identical with the first fabric A.

The second fabric will be preferably woven very close, and with tightly juxtaposed threads, so as to ensure as good a fluidtightness as it is possible.

Concerning the choice of the coating or coatings, it may be advantageous to make use of mixtures containing plastic materials, such as those known in the rubber industry and, in particular, in the manufacture of rubberized fabrics.

However, it seems preferable to make use of coatings consisting chiefly of synthetic rubber, which has very valuable properties of ageing (non-alteration by sun rays).

Preferably, we make use of a synthetic rubber consisting chiefly of "neoprene."

Now, having, for instance, at least two layers of fabric, which may be constituted, as above stated, either by the same material, or rather, as it will be hereinafter supposed, by two different materials A and B, we proceed, for instance, for the incorporation of the coating or coatings, in one of the following manners:

First, such a coating is advantageously used for causing the two fabrics A and B to adhere to each other at 2 (Fig. 1), this result being obtained in any manner known in the manufacture of rubberized fabrics.

Furthermore, the composite fabric thus obtained is provided, either on one of its external faces or on both of these faces, as shown at 3 and 4 in Fig. 1, with one or several layers of this coating this operation being effected in any suitable manner, for instance by impregnation on the loom or by calendering.

These layers may be all of the same thickness or on the contrary of different respective thicknesses, the whole being such that the total thickness of the fabric obtained remains sufficiently small for maintaining the desired qualities of flexibility and light weight, such a thickness ranging preferably from $\frac{1}{10}$ to $\frac{4}{10}$ or even $\frac{10}{10}$ of millimeter.

These layers serve chiefly to ensure fluidtightness and good ageing qualities (resistance to the action of sun rays and of external agents) owing to the very nature of these coatings.

Furthermore, they have a relatively considerable resistance to the action of fire, it being well understood however than, in any case, asbestos is brought into play for delaying the action of fire on the adjoining surfaces, in the conditions above stated, and also for ensuring a good mechanical resistance.

Eventually, the whole might be completed, on the outer side, by a fluidtight varnish impervious to gases and resisting the action of atmospheric agents. This varnish might be superposed to one of the layers 3 and 4, and it might even wholly replace it.

Finally, it should be noted that, to at least some of the various constitutive elements above specified (fabrics, coatings, varnishes) we may eventually adjoin fire-proofing products. By way of example, these products might consist at least partly of ammoniaco-magnesium phosphates, of boron-phosphates of ammonium, and so on.

Whatever be the particular embodiment that is chosen, we obtain fabrics which are well adapted to be used for the purposes above mentioned and comply with many combined conditions, the chief of which are the following:

Resistance to fire, owing to the special action of asbestos, which delays the propagation of fire;

Mechanical resistance, asbestos also having, from this point of view, the property of opposing tearing off after a local fire; gas-tightness; light weight; flexibility; and resistance to the action of atmospheric agents.

Of course, the application of our invention to

the manufacture of envelopes for balloons has no limitative character.

For instance, the invention might be also applied, among other uses:

a. To the construction of flexible tanks or reservoirs adapted to contain liquids or gases, either inflammable or not;

b. To the manufacture of fabrics for home decoration (curtains, wall coverings and so on), for clothes of all kinds, etc.

c. To the construction or external covering of pipes, either flexible or not, for liquids or gases, etc.

When the invention is applied to the construction of balloons, another feature of our invention consists in reinforcing the qualities of resistance to the action of fire of the envelope in the lower portion of said balloons.

In this portion of the balloon, the jet of ignited gas issuing from a hole made in the envelope, as illustrated at *i* in Fig. 1, is, at its base directed downwardly. But as the gas is lighter than air, this jet tends to curve upwardly and to come into contact with surrounding portions of the envelope, which increases the damage caused by the flames.

In order to improve the resistance of this lower portion of the balloon, we may proceed in any suitable manner, acting for instance on at least one of the following characteristics, to wit: number of layers of fabric, thickness of these layers, thickness of the coatings, addition of fire-proofing products, etc.

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