

# Fireproofing Fabrics\*

## Treatment of Sack Materials, Tent Cloths and Balloon Fabrics

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THE methods used in fireproofing various fabrics consist in impregnating the fibers with solutions of different chemicals or in covering them with coatings which either evaporate or melt in the heat. Complete non-inflammability cannot of course be obtained as long as the fibers themselves are of an organic origin. The chemicals, which are used most generally for this purpose, are the easily fusible borates, phosphates, stannates (tin salts), tungstates, molybdates and titanates. Frequently, ammonium salts are also added.

Of all the various substances which can be used to fireproof fabrics, the most important and most efficient are ammonium sulphate and ammonium phosphate. While borax, boric acid, water glass, aluminum salts, stannates, tungstates, or the salts used for wood impregnation, iron, copper or zinc sulphate solutions, mixed with calcium or barium chloride, are all very useful and valuable, none of them can surpass the ammonium salts in the effectiveness of its action.

The technology of the fireproofing of textiles and other combustibles has been discussed in great detail by P. Lochtin in *Dingler's Journal*, Vol. 290, p. 230. A great many salts are described and classified according to their action in this respect, that is, whether they promote, hinder or are indifferent to the propagation of the combustion phenomenon in combustible materials. It was found that the following salts render cellulose non-inflammable, viz.: ammonium phosphate, ammonium sulphate, sal ammoniac ( $\text{NH}_4\text{Cl}$ ), the chlorides of calcium, magnesium and zinc, tin sulphate, tin salts in general, alum, borax, boric acid and aluminum hydrate.

### THE SILICATES AS FIREPROOFING AGENTS

Lead orthosilicate ( $\text{Pb}_2\text{Si}_2\text{O}_7$ ) was used for the first time by Abel in fireproofing textile fabrics. A mixture of glycerin and asbestos or graphite is used to coat fabrics so as to render them fire-resistant. The fiber is soaked in a linseed oil varnish either before or after being treated with the glycerin mixture and is finally painted with an oil color. (German patent 102,314.) Another method is to apply an undercoat of a composition, consisting of kieselguhr, chalk and linseed oil and a top coat of a molten mixture of water-glass, calcium chloride and common salt (German patent No. 108,723).

A Swedish patent (No. 25312, 1907) has been issued on a method of fireproofing fabrics by impregnating them with a concentrated solution of alum, which is mixed with potash, common salt and a suspended solution of turpentine and asbestos in muriatic acid. Before using, the mixture is diluted with twice its weight of water and mixed with a little flour and water glass. A mixture of sodium silicate and soap together with small amounts of glycerin, sodium tungstate and oleic acid, saponified by means of calcium carbonate, is also used according to British patent No. 717, 1909.

### BORAX AND AMMONIUM SALTS

Very good results have been obtained with the use of these salts in conjunction with other substances. As an example, 80 kg. of aluminum sulphate, 25 kg. of sal ammoniac, 30 kg. of boric acid, 17.5 kg. of borax and 25 kg. of starch are dissolved in 1,000 liters of water. Separate solutions of 50 kg. of alum or ammonium phosphate, or 150 kg. of borax and 110 kg. of magnesium sulphate are also advocated, each solution being used in succession. Another mixture consists of 20 kg. of borax, 60 kg. of alum and 10 kg. of sodium tungstate. It is best to impregnate the cloth with the phosphate solution first,

then to treat it with a dilute solution of ammonia, containing magnesium chloride and finally to wash it with very dilute ammonia. English patent No. 15382, 1887, advocates the use of calcium chloride and ammonium phosphate. Still another method is to impregnate the fabric with an aqueous solution of calcium ammonium salts, then to apply a solution of soda and to paint it with a mixture, containing alumina, talc, kaolin and colored varnish, ground in alcohol.

A very effective fireproofing composition, patented in Norway (No. 17803, 1906) consists of 5 to 15 parts of phosphate and 85 to 95 parts of tungstate (50 to 75 parts of phosphate-tungstate can also be used) in one liter of water. The impregnated material is washed thoroughly and the process is repeated. An aqueous solution of equal parts of calcium acetate and calcium chloride has also been used for this purpose.

In the *Seifenseider Zeitung*, 1911, page 955, there is described a method of fireproofing fabrics by the use of a mixture, consisting of one kilogram each of sodium hyposulphate, maize starch, common salt, talc and 500 grams of borax. The materials are dipped for 2 to 3 minutes into the lukewarm pasty mass and then dried. French patent No. 456589 describes a method for fireproofing fabrics of all sorts by immersing them first in a 65 per cent solution of alum, then drying and submerging them in a 50 per cent ammonia sulphate solution, wherein they are allowed to remain over night. They are then dried slowly. A novel process for rendering textiles resistant to heat is revealed in U. S. Patent No. 1048912, wherein a caoutchouc solution containing ground mica and pulverized asbestos, is used.

### FIREPROOFING COTTON FABRICS. "NON-FLAM"

It is often necessary to wash fabrics and it is desirable that they do not lose their fire-resistant properties after they are washed. W. H. Perklin has invented a process of treating flannel so that it is possible to wash the goods without any danger of their becoming inflammable again. This is done by steeping the pieces of flannel completely in a 45° Tw. solution of sodium zincate. The excess solution is squeezed out and the material is dried in copper drums. When the cloth is thoroughly dry, it is impregnated with a 15° Tw. solution of ammonium sulphate, pressed again and dried once more. The cloth is then washed to remove the sodium sulphate, whereat it is dried for the third time and is then ready for use. It has been established by means of numerous tests that the colors in the flannel are not injured in any way; that the insoluble tin salts precipitated on the fiber do not attack the skin; that the tensile strength of the flannel is increased about 20 per cent and that the non-inflammability of the treated fabric remains intact after 25 washings by hand and 35 washings with a washing machine. This cloth is known as "Non-Flam" in the trade.

### USE OF STANNATES

According to German patent No. 150465, a 22° Bé. solution of sodium stannate is used to impregnate fibers to render them fireproof. The material is dried after this treatment and then passed through a 16° Bé. solution of zinc acetate. It is well to wash the size out of the cloth before putting it through the fireproofing process. Furthermore, the material is generally soaked in olein, soap or glycerin after being washed, which renders the action of the metallic salts more effective.

In a similar manner, wood, paper or textile fabrics can be made fire-resistant (German Patent No. 151641) by passing them through a bath of sodium stannate after a preliminary washing (sp. gr., 1.04 to 1.08) and then through another bath,

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containing 33 per cent titanium sodium sulphate and 7.5 per cent of ammonium sulphate. The last step is to draw the cloth through a solution of water glass (sp. gr. 1.1). Then it is washed and sized in the usual way. It is not necessary to use the stannate solution as the cloth is rendered sufficiently fire-resistant by treatment with the titanium salt alone.

#### CASEIN COATINGS—ELECTRICAL WIRINGS

When fabrics, wood and other similar materials are coated with casein containing compositions, they are made fireproof as well as waterproof. German Patent No. 220860 describes such a pasty mixture, containing 10 parts of zinc oxide, 10 parts of water and the necessary coloring matter, combined with a solution of 10 parts of casein, 10 parts of ammonia and 10 parts of ammonium bromide in 30 parts of water. This composition carbonizes rather readily, when an attempt is made to ignite it, but it does not burn. It is particularly well suited for impregnating the fabrics used in covering electrical conductors.

#### TREATMENT OF JUTE

Jute can be sized and made waterproof at one and the same time by the following process (see *Technisches Rundschau*, 1913, 313). The first step is to steep it in a 3° Bé. solution of acetate of aluminum and then to dry it at 50 to 60° C. The treatment is repeated twice and then the jute is sized either in a solution containing 90 grams of protamol, 5 grams of glycerin, 15 grams of vaseline and 100 ccm. of a 3° Bé. solution of aluminum acetate in 790 ccm. of water, or with a mixture of 90 grams of protamol, 30 grams of magnesium sulphate, 5 grams of glycerin and 15 grams of vaseline in 860 grams of water.

Jute and other coarse meshed fabrics can be waterproofed by impregnation with an emulsion of 10 parts of asphalt and 10 parts of cellulose, 5 parts of glue, 1 part of chrome alum, 8 parts of tar oil, 16 parts of benzol and 50 parts of water. For waterproofing linen, used to make sails, H. Jennings recommends the use of zinc soap.

#### COTTON SAIL CLOTH

The first step in the process of waterproofing cotton sail cloth is to remove the sizing by treatment with wort (malt extract) or caustic potash solution. The cloth is then hung up to dry in a drying loft and further impregnated with a clear 5° Bé. solution of alum at 30° C., made by dissolving 30 kg. of alum in 180 liters of boiling water, which contains 12½ kg. of calcium pyrolignite. After 2 to 3 immersions, the cloth is dried at 40 to 45° C. and, after the vapors of acetic acid have been removed, it is fixed by six successive immersions in a solution of 500 grams of 66 per cent water glass in 150 liters of water, maintained at the boiling point.

#### WATERPROOFING TENT AND AWNING CLOTH

The waterproofing process consists in painting the cloth with a solution of 2 kg. of alum, 1 kg. of isinglass and 0.5 kg. of white soap in 50 liters of water and then applying a coating, consisting of a water solution of 2 kg. of lead acetate in 50 liters of water. In this way a completely insoluble lead soap is formed in the pores of the cloth, closing them up entirely. (For further details see *Farbe und Lack*, 1912, 24.)

#### WATERPROOFING SAIL OR TENT LINEN

According to German Patent No. 187027, the waterproofing composition is made as follows. One part of a solution of asphalt in coal tar is cooked for five minutes with 1.5 parts of spirit varnish containing lampblack (black varnish), 2.5 parts of wood tar and 2.5 parts of coal tar. One part of varnish and one part of airproof varnish are added to the cooled mass. The latter is made by dissolving 33 grams of white shellac and 750 grams of sandarac (or realgar, a type of resin, resembling mastic very closely) in 2,000 grams of 95 per cent alcohol and 500 grams of venetian turpentine.

This absolutely permanent preparation is painted on both sides of the linen cloth in as thin a coat as possible and is rubbed into the material by means of a hard brush.

Calcium acetate and sulphate of aluminum are used to render linen impervious to water. (For details, see *Oesterr. Woll. u. Lein. Ind.*, 1907, 1379).

An easy method of waterproofing sail cloth (linen) consists in steeping the linen in a 7 per cent gelatine or glue solution, warmed to 40° C. After the cloth is air-dried the gelatinous coating is hardened by means of a 4 per cent solution of alum. The cloth is dried again and washed with pure water. (*Techn. Rundschau*, 1911, 311.)

#### AGGLUTINANT FOR SAIL LINEN OR WAGON COVERINGS

In the *Seifus Zeitung*, 1911, 314, there is described an adhesive which can be used on sail linen and the coverings for wagons and which consists of 18 parts of gutta-percha, cut up in fine pieces, dissolved in 20 parts of carbon disulphide, 10 parts of benzol and 10 parts of turpentine. After several days, especially if the mixture is heated slightly, complete solution takes place. Then 42 parts of finely powdered asphalt or rosin are dissolved in the solution and the adhesive is ready for use. According to another recipe, 15 parts of finely cut up gutta-percha are dissolved in 45 parts of warm turpentine, benzol or carbon disulphide and 40 parts of a quick drying varnish, mixed with about 10 per cent of manganese drier, are added.

#### IMPREGNATION OF COARSE FIBERS

A mixture suitable for this purpose consists of 15 liters of boiled linseed oil, 5.5 kg. of pine soot, 0.5 kg. of yellow wax and 0.5 liter of rapid drying oil. After drying, it is covered with a similar mixture; finally the mixture is allowed to dry slowly for four weeks at the room temperature.

Tubes and pipes, made out of sail cloth, can be impregnated with a mixture, consisting of boiled linseed oil varnish, which is obtained by careful heating of raw linseed oil to 150° C. and several hours' cooking at 220 to 230° C. After cooling to 150° C. an addition of 3 to 4 per cent of lead resinate or lead manganese resinate is made.

#### FIRE HOSE MADE OF SAIL CLOTH

The inside of fire hose made from sail cloth and used under moderately high water pressure is impregnated with a mixture of 11 liters of linseed oil, boiled with 130 grams of ground litharge and 130 grams of umber. (H. Brand in *Farbe und Lack*, 1912, 16). After heating for 24 hours (this must not be done over the open fire), the mixture is ready for use. Two coats are applied as a rule.

A solution of an aluminum soap in turpentine can also be used for this purpose. Instead of painting the hose, the dipping process can be used as well. Another method of treatment consists in an initial immersion in a soap solution and then in a solution of a metallic salt, whereat a water-insoluble metallic soap is precipitated in the pores of the fabric. The first solution, according to *Farbe und Lack*, 1912, 32, contains 4 kg. of alum, 2 kg. of isinglass and 1 kg. of white soap, dissolved in 100 liters of water. The second solution is made by dissolving 2 kg. of lead acetate in 50 liters of water. To dry the coating and to prevent the soap from becoming sticky, a current of cold air is blown through the hose.

#### TREATMENT OF HEMP FIRE HOSE

Hemp hose, which is to be used at pressures up to 10 atmospheres, must be treated so as to be watertight and also to prevent rotting of the fabric. For this purpose, a tannin solution is used to impregnate the fiber and an inner coating of a solution of gum is applied.

#### TREATMENT OF BALLOON AND AEROPLANE CLOTH

The fireproofing of balloon and aeroplane cloth is described in *Kunststoffe*, 1913, 438 (see also the work by A. Rost, entitled "A New Use for Cotton"). The manufacture of gas-tight and

water-tight balloon fabrics is covered in British Patent No. 2064-1911. The fabric is made of several layers of goldbeater's skin, cemented together with a gelatine solution and impregnated on both sides with a solution, containing 5 parts of collodion, 5 parts of castor oil and 10 parts of amyl acetate dissolved in 100 parts of an acetone-celluloid solution. The treated fabric is then provided with a layer of silk or wool on one or both sides.

Good results have been obtained by the use of the following mixture, from the standpoint of gaseous impermeability of the fabric. The mixture contains 4 kg. of Para rubber, 30 grams of paraffine (melting at 66° C.), 400 grams of sulphur and 170 grams of magnesium oxide. This preparation is suitable for cloth to be vulcanized at an elevated temperature, while for vulcanization in the cold, the mixture need contain only 4 kg. of Para rubber and 50 parts of paraffine. The tensile strength of the fiber can be increased by impregnation with a mixture of 4 kg. of Para rubber, 40 grams of paraffine, 2.6 kgs. of magnesium carbonate, 360 grams of magnesium oxide and 400 grams of finely powdered sulphur.

According to French Patents Nos. 427818 and 14044, absolute impermeability is obtained by treating balloon fabrics with a varnish, containing a solution of acetyl cellulose and some caoutchouc in tetrachlor-ethane together with an alcoholic solution of a dyestuff.

A newer process of treating balloon fabrics consists in gumming them on the inner side and dusting them with powdered cork. The entire cloth is then cemented fast together by vulcanization. In this way several distinct advantages are gained. In the first place, the layer of cork increases the impermeability of the shell of the balloon, reducing thereby the loss in gas. Then, rapid changes in temperature within the gaseous volume of the balloon are avoided because of the low heat conductivity of the cork covering. Finally, the chemical action of the gases on the material of the balloon is averted. This last fact is of considerable importance, although it has been given scarcely any attention at all.

F. Frank mentions in *Gummistry*, 1912, 801, that copper and iron have the most deleterious action on balloon materials, as they act as catalysts even in the minutest quantities and cause the formation of acids by the reaction between the sulphur, used in vulcanization, and the oxygen of the air. The best measures of prevention are to paint the fabric with a preventive paint and to impregnate the material with indifferent dyestuffs and metals.

According to German Patent No. 262005 after the balloon cloth is impregnated with a liquid, containing oil, it is covered with "syndeticon" and the sticky fabric is dusted with metallic powder. An impregnating solution, consisting of celluloid dissolved in amyl acetate and admixed with castor oil and wax, is described in German Patent No. 266384.

#### MANUFACTURE OF WATERPROOF CLOTHING

An article in *Seifens. Ztg.*, 1911, 1177, details the manufacture of waterproof clothing by immersing the cloth in a dilute solution of glue in the first place, which contains about 10 to 20 per cent of linseed oil varnish. Then, after drying, the fabric is impregnated with a decoction of linseed oil varnish with 10 per cent of manganese drier. The elastic properties of the mass can be increased by the addition of 5 per cent of paraffine. Another method consists in impregnation with a mixture of 60 parts of a 15 per cent caoutchouc solution and 40 parts of linseed oil varnish. For dark cloth, a solution containing 15 parts of hard asphalt and 5 parts of paraffine, all mixed with 15 parts of asphalt tar, 10 parts of rosin oil and 30 parts of linseed oil varnish in 25 parts of benzol can be used. Oiled cloth, which has become sticky, must be rubbed with turpentine or benzine until the stickiness has disappeared. After several days, the cloth is varnished.

German Patent No. 65349 describes a method of avoiding stickiness in the oiled coating by coating the cloth with a mixture of linseed oil varnish, petroleum ether, litharge and ammonia.

#### THE PROGRESS OF CHEMICAL RESEARCH IN TEXTILE FIBERS

EXTRACTS from the annual reports of the Society of Chemical Industry on the subject of chemical research in textile fibers appear in the October issue of the *Color Trade Journal*.

These abstracts show the work divided into cotton, wool, silk, artificial silk, paper yarns, balloon and airplane fabrics, flax, hemp and miscellaneous fibers.

Notwithstanding the large amount of work being done on cotton materials much of the work continues to be applied to yarns and cloth and far too little of it to the ultimate cotton fiber upon which all else depends. One investigator has found that considerable improvement in physical properties such as elasticity, may be obtained by treating the cotton yarns with a solution of caustic soda to dilute for mercerizing. Another finds that mercerizing with, or without, tension tends to increase yarn strength but with a decrease in fiber strength. This latter investigator believes that processes up to the stage of spun yarn have no detrimental effect on the individual fibers. A number of valuable papers have appeared on the subject of purifying cotton and the effect of such an extraction agent as benzol, alcohol, water, ammonia, formic acid, hydrochloric acid, lime and caustic soda, has been examined with special reference to the nitrogen content of the fiber. The total extract amounts to about 4 per cent, and nitrogen from .2 to .26 per cent of the weight of the yarn. Boiling with lime or soap removes less than 50 per cent of the nitrogen present but no other single treatment was so successful as the caustic soda which removes 80 per cent.

On wool, investigations continue into the influence of atmospheric moisture on electrical phenomena and the most suitable conditions for drawing and spinning. In the case of worsted, the degrees of humidity were 77 per cent for drawing, and 50 per cent for spinning. The effect of dry heat on wool has been examined with result that the fall in strength even at 150°C. is only about 3 per cent, but at higher temperatures the sulphur naturally in the wool becomes oxidized to sulphate and in the presence of moisture causes rapid decomposition.

Scouring continues to be a live topic for research including the absorption of soap by the wool in aqueous solutions. It has been found that from 3 to 6 per cent of fatty acid may be absorbed by cross-bred serge, and that the cloth may retain from .4 to nearly 1 per cent even after boiling in water.

The resistance of wool to weather has previously been discussed and it will be recalled that fiber treated with chromium salts is much more resistant to the destroying action of the weather.

Most of the work in silk has to do with boiling off processes, the possibility of using enzymes to destroy the natural silk gum and the question of grading and classifying raw silks. Notwithstanding the increasing popularity of artificial silk, there appears to be less and less literature concerning it excepting in an occasional item on distinguishing natural from artificial silk.

The use of paper yarns for clothing textiles in Germany has lessened with the appearance of cotton as was to be expected. In Japan interest is being shown in the possibility of weaving paper with hemp, silk, and cotton fibers. "Oriental Panama" is of Japanese origin and is produced by coating twisted papers with solutions of nitro cellulose or nitro celluloid.

Balloon and airplane fabrics continue to hold interest and involve the development of tests for such fabrics, methods of determining their probable rate of deterioration in advance, and permeability to various types of gases, methods for rendering them rainproof and ways of using cotton fabric to substitute for linen fabrics on wings.

Under flax, hemp, and miscellaneous fibers may be mentioned researches designed to produce improved strains of flax and investigations into the problem of retting. It appears that the principal agent which retards bacterial retting is acidity which is constantly removed when flax is retted in running water. Based upon this a process has been intro-