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COMPOSITION FOR A COMBUSTIBLE CARTRIDGE CASE

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No Drawing. Original application Mar. 11, 1958, Ser. No. 720,800. Divided and this application Mar. 9, 1965, Ser. No. 452,428

4 Claims. (Cl. 106—177)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalties thereon.

This application is a division of application Serial No. 720,800, filed March 11, 1958 and now abandoned.

The present invention relates to combustible cartridge cases and to a method of making same. More particularly the invention is concerned with laminated cellulosic cartridge cases which posses the required physical strength and which will burn completely when fired in conventional weapons.

The advantages of conbustible cartridge cases will be apparent to those skilled in the art. The elimination of the conventional metal case results in a considerable saving in weight; the problem of disposal is eliminated and there is a saving of metals which might become critically short in supply during times of emergency. Furthermore the firing rates of weapons in which combustible cartridge cases are used may be increased substantially due to elimination of the ejection operation which would also result in a saving of weight and space at the rear of the weapon. An additional advantage of combustible cartridge cases may involve the possible reduction in gun erosion. Prior methods and materials used for the manufacture of combustible cartridge cases were disadvantageous for maintaining stability, strength and ballistic properties of the combustible material and also in devising cartridge cases to which primers and projectiles may be properly affixed.

Accordingly, a primary object of the present invention is the provision of a combustible cartridge case having the necessary strength characteristics and which will burn completely when fired in conventional weapons.

It is a further object of the invention to provide a cellulosic fabric impregnated with a resin and a solid oxidizing agent which is suitable for use in the manufacture of combustible cartridge cases having superior strength, stability and ballistics properties.

A further object of this invention relates to the making of combustible cartridge cases of cellulosic fabrics which have been impregnated with resin and an oxidizing agent.

Other objects and advantages of the present invention will become apparent to those skilled in the art from a study of the accompanying disclosure.

A study of accumulated firing data obtained as a result of work done on the instant invention has led to the conclusion that two different methods may be employed for the production of combustible cartridge cases which will operate successfully and burn completely when fired in conventional weapons. One of these methods involves the nitration of cellulosic fabric materials with commercial anhydrous nitric acid and the subsequent formation of the cartridge case by lamination, with or without the aid of organic solvents as fully disclosed in a copending application by Keith F. Beal and Walter D. Schmidt, Serial No. 732,781, filed April 29, 1958, which has matured into Patent 2,982,211. The second method, which forms the subject matter of my divisional application Serial No. 452,429, filed March 9, 1965, is concerned with the impregnation of cellulosic or silk fabric materials with an appropriate oxidizing agent dispersed in a resinous binder.

In general, the method of this invention contemplates the treatment of fibrous organic materials, preferably fabrics such as cotton gauze, with a slurry of solid oxidizing agent in a solvent solution of a resin. Impregnation or coating of the fabric material, which is generally in strip form, may be accomplished by any suitable apparatus. For the purposes of the work done in the development of this invention, however, an arrangement was used whereby a bolt of the cellulosic fabric was mounted on a reel at one end of the impregnating machine. The material was advanced through the slurry bath, threaded through a slit coater to regulate the thickness of the film on the fabric, passed through drying means in which a blast of heated air was directed parallel to the fabric, and finally the finished fabric was wound on a reel at the other end of the machine.

In general, any cellulosic or synthetic fiber which will burn completely and which may be conveniently treated and formed into cartridge cases may be utilized for the purposes of this invention.

For example, either cotton, rayon, silk, or polyvinylidine chloride fabrics have been found suitable. However, the use of cotton-gauze mesh is to be preferred from both the standpoint of ready availability, superior quality and ease of shaping into cartridge cases.

A number of synthetic resinous materials have been found suitable for use in achieving the objects of this invention, among them being; polyvinyl chloride-acetate, polyvinyl chloride, polyvinyl acetate, polyvinyl butyral, copolymers of polyvinyl chloride and polyvinyl acetate, glyceral esters of hydrogenated rosin, ethyl cellulose, polyvinyl formal, cellulose acetate-butyrate, resins derived by combining dibasic acids and the pentaerythritol ester of rosin.

The following substances are examples of those solvents found suitable for use in the preparation of resin-oxidant slurries; methyl ethyl ketone, methylene chloride, ethyl acetate, n-butyl acetate, acetone, petroleum ether, toluol, methanol, ethanol, benzene, isopropanol and trichloroethane. In some instances, preferred results were obtained by combining two or more of the above solvents. Also the addition of modifiers or plasticizers to the resin-oxidant slurry was found to result in an improved product in some instances. For this purpose, compounds such as 2-biphenyl-diphenyl phosphate, phthalyl glycolates, butyl phthalyl-butyl glycolate, mono-cresyl diphenyl phosphate and toluene sulfonamides proved to be advantageous.

Ammonium perchlorate and potassium perchlorate are among those oxidizing agents which have been found suitable for use.

In carrying out the process of this invention the resin is dissolved in a suitable solvent and a slurry is prepared by adding the required amount of oxidizing agent. Proportions of oxidizing agent ranging from approximately 15 percent to 90 percent have been found to be suitable, while the preferred range of perchlorate oxidant has been found to be from about 40–65 percent. Slurries having a lower perchlorate content tend to leave residues when the cartridges are fired while slurries having a greater perchlorate content result is undesirably high peak pressures.

The following specific examples are given as illustrating the various processes employed in the treatment of cellulosic materials for use in the production of combustible cartridge cases according to the present invention.

Example I

A resin-ammonium perchlorate slurry was prepared by dissolving 800 grams of Staybelite 10 (glyceryl ester of hydrogenated rosin) in 2400 grams of methyl ethyl ketone. To this was added, with mixing, 4200 grams of ammonium perchlorate followed by 1000 grams of Vinylite XYHL (polyvinyl butyral resin) dissolved in 960 grams of methyl ethyl ketone. The solid material in this slurry consisted of 70.0% ammonium perchlorate, 16.7% Vinylite XYHL, and 13.3% Staybelite 10. A commercially available coating machine was used to impregnate a strip of cotton gauze with this resin-perchlorate slurry. The apparatus was equipped with heaters, blowers and a variable speed reel winder. An aluminum trough for holding the slurry was fitted with an adjustable doctor blade to regulate the flow of the slurry onto the gauze and the consequent thickness of the coating. Immediately prior to the coating operation, the slurry was mixed thoroughly and run through a colloid mill to insure completely uniform dispersion. By proper control of the heat it was found possible to coat the gauze at a fairly rapid rate (in excess of 1.5 feet per minute) with complete evaporation of the solvent and without scorching the coated fabric. Excellent results were obtained with cartridge cases fabricated from this material. It has been found that fabrics coated with compositions having the same components, in different relative proportions (i.e. with oxidizer contents as low as 50% and with each of the resinous materials varying inversely from 0 to 50%) provided material from which cartridge cases having suitable burning characteristics could be made.

Example II

Cotton gauze impregnated in a manner similar to that described in Example I and having the following composition was found to be suitable for use in forming cartridge cases having highly desirable characteristics.

	Percent
Ammonium perchlorate (NH_4ClO_4)	64.3
Ethyl cellulose	10.3
Neolyn 23 [1]	6.7
Dow plasticizer 5 [2]	4.0
Cotton gauze (36 x 44 mesh)	14.7

[1] An alkyd resin made by the union of phthalic anhydride with glycol or glycerine.
[2] 2-biphenyl diphenyl phosphate.

Example III

An excellent product was obtained using a slurry having a solids content consisting of

	Percent
Ammonium perchlorate	80
Ethyl cellulose	11
Dow plasticizer 5	1
Staybelite 10	8

Satisfactory results were also obtained using a slurry of the above composition but without the plasticizer.

Each of the following slurry compositions were found suitable for use in coating cellulose gauze material in the manner described in Example I. Cartridge cases made from such coated fabrics possessed satisfactory burning and other physical characteristics. In these examples as elsewhere in the specification all proportions are given in terms of weight unless specifically stated otherwise.

Example IV

	Percent
Ammonium perchlorate	75.0
Ethyl cellulose	12.3
Staybelite 10	11.1
Dow plasticizer 5	1.67

A slurry was prepared having a solids content as above. Cotton gauze was impregnated with coatings of this slurry varying from about 25 to 35 grams per square foot for a total gauze content of between 12 and 17 percent.

Example V

	Percent
Ammonium perchlorate	35
Potassium perchlorate	35
Ethyl cellulose	14.5
Neolyn 23	9.3
Dow plasticizer 5	6.2

Cotton guaze was treated with a slurry having the above solids content in the manner described in Example I. Depending on the weight of slurry coating applied, the total percent gauze in the final product varied from about four to eight percent.

Example VI

Cotton gauze was treated in the manner of Example I with a slurry composed of ammonium perchlorate and VYHH resin, using methylene chloride as the solvent. The resulting product contained

	Percent
Cotton gauze	11.9
VYHH resin	26.4
Ammonium perchlorate	61.7

Example VII

	Percent
Potassium perchlorate	70.0
Ethyl cellulose	14.5
Neolyn 23	9.3
Dow plasticizer 5	6.2

Cotton gauze was coated in the manner described in Example I. The resulting product contained a total percent gauze ranging from four to seven percent depending on the weight of slurry coating applied.

In order to establish the effect of inert additives on combustible cartridge case ballistics, inorganic salts were incorporated in the slurry. Three coating runs were carried out using ammonium perchlorate and sodium chloride in ratios of 1:3, 1:1 and 3:1, respectively. The coated materials were fabricated into cartridge cases having the following weight compositions:

Example VIII

	Percent
Gauze	9.3
VYHH resin	30.4
Ammonium perchlorate	45.3
Sodium chloride	15.0

The weight of the coated fabric was 47.1 grams per square foot.

Example IX

	Percent
Gauze	8.8
VYHH resin	30.4
Ammonium perchlorate	30.4
Sodium chloride	30.4

Coated fabric weight=49.6 grams/ft.^{2}.

Example X

	Percent
Gauze	8.4
VYHH resin	30.5
Ammonium perchlorate	15.3
Sodium chloride	45.8

Coated fabric weight=52.3 grams/ft.^{2}.

The ballistics results from cases made of fabrics given in the last three examples showed significant decreases in maximum pressure, rate of pressure rise, and time to peak. Other inorganic salts including potassium chloride and barium chloride were also tested.

In all of the above examples equal molar quantities of potassium perchlorate may be substituted for the ammonium perchlorate with no resulting adverse ballistic effects to be noted. On the contrary, a distinct reduction

in flash was noted when potassium perchlorate was used in place of the ammonium salt.

Fabrication of cartridge cases from fabrics treated according to the process of this invention may be accomplished satisfactorily by any one of the various means. Generally, however, the coated gauze is formed into tubular case walls and flat end plates by the application of heat and pressure. A variety of metal mandrels may be used in fabricating tubular case sidewalls from fabric coated with thermoplastic compositions. The tubes are formed by wrapping the impregnated fabric under pressure against a heated, non-rotating, metal surface. To facilitate removal of the completed case it is advantageous to use a mandrel of the collapsible type.

Lamination strength and case density during wrapping are determined by (1) sealing surface temperature, (2) wrapping speed and (3) pressure. The coated material is stiff and somewhat brittle at room temperature. It will drape readily at 200° F. but cannot be heat-sealed well at temperatures below 260° F. Sealing temperatures for the VYHH composition have been varied between 260° F. and 400° F. A minimum of 300° F. is needed, however, to obtain a good seal. Wrapping speed has been varied from 7 to 41 inches per minute with a standard speed of 23.5 in. per min. for 105 mm. cases. Sealing pressure has been varied from 10 to 165 lbs. per inch of case length. At high sealing temperatures and low wrapping rates, pressures above 40 lb. per square inch have resulted in an undesirably high density in the finished case.

In most instances, cartridge cases formed according to the above described methods exhibited good moisture resistance. However, if desired, further waterproofing of such cases may be accomplished by any of several methods. For example, according to one method, the cartridge cases were coated with a commercially available phenolic resin lacquer. Water would no longer wet the surface of cases treated in this manner. Also, it was found that these cases could not be readily ignited by a glowing cigarette and when fired, they burned completely and exhibited no change in ballistic properties.

Other satisfactory methods of waterproofing combustible cartridge cases include; dip coating the cases in a hot melt of a commercially available microcrystalline wax; coating with a halogrease which may if desired have aluminum powder incorporated therein and jacketing the cases in a film of polyethylene or rubber

One of the most desirable methods for protecting a case against water penetration consisted of covering the case with Du Pont Mylar film having a thickness of approximately 0.005 in. A heat sealable adhesive resin is applied to one side of the film by spraying or other suitable means. The adhesive coated film is then applied to the case during the mandrel wrapping operation. This system gave excellent protection against water penetration.

It will thus be seen, that in the foregoing description, we have disclosed various methods of producing combustible cartridge cases by treating cellulosic or silk fabrics with a resin-oxidant-solvent slurry and forming the resultant coated fabric into cartridge cases which satisfactorily accomplish all of the objects of the invention listed above. In the foregoing description I have disclosed preferred embodiments of my invention. However, it is not intended that this invention be limited to the specific examples set forth above, as it will be apparent to those skilled in the art, that the proportions of the ingredients may be varied over a wide range and a variety of equivalent substances may be employed without departing from the spirit of the invention or exceeding the scope of the appended claims.

Having thus described the invention, what is claimed as new is:

1. A coating composition for impregnating a cellulose fabric in the manufacture of a combustible cartridge case, said composition consisting essentially of a slurry of an oxidizing agent in a solvent solution of resinous binder, said oxidizing agent being selected from the group consisting of ammonium perchlorate and potassium perchlorate in an amount in the range of about 15 to 90 percent by weight of said slurry, said resinous binder being selected from the group consisting of polyvinyl chloride, polyvinyl acetate, polyvinyl chloride-acetate, polymers of polyvinyl chloride and polyvinyl acetate, polyvinyl butyral, glyceryl esters of hydrogenated rosin, ethyl cellulose, polyvinyl formal, and cellulose acetate-butyrate, and said solvent being selected from the group consisting of methyl ethyl ketone, methylene chloride, ethyl acetate, n-butyl acetate, acetone, petroleum ether, toluene, methanol, benzene, isopropanol and trichloroethane.

2. The coating composition of claim 1 which includes 2-biphenyl diphenyl phosphate as plasticizer therein.

3. The coating composition of claim 1 which includes sodium chloride therein as an inert additive, the weight ratio of said perchlorate to said additive being from 1:3 to 3:1, respectively.

4. A coated fabric suitable in the manufacture of combustible cartridge cases, said fabric being coated with the composition of claim 1.

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