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CARBURETOR DIAPHRAGM

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This invention relates to an improved carburetor diaphragm and more particularly to a carburetor diaphragm which is resistant to hydrocarbon fuels high in aromatic hydrocarbon content.

The preparation of carburetor diaphragms particularly for use in aircraft engines where requirements are unusually severe has presented a perplexing problem. In such utility the carburetor diaphragm must be resistant to humidity changes and to aircraft fuels containing appreciable amounts of aromatic hydrocarbon. Also, flexibility must be maintained at the very low temperatures encountered in the higher flying altitudes. Earlier carburetor diaphragms based on the use of high quality cotton fabrics were quite susceptible to changes in humidity and became distorted due to shrinkage or expansion. Improvements in this respect were achieved by the use of a fabric base of nylon fibres but conventional coatings of synthetic rubbers such as neoprene which are quite resistant to the ordinary gasoline fuels, were not satisfactory for use with fuel blends containing aromatic hydrocarbons. Attempts to substitute aromatic hydrocarbon resistant coatings containing Hycar or Perbunan synthetic rubbers failed because of lack of satisfactory adhesion.

The improved diaphragm of the present invention, however, overcomes the deficiencies of previously available diaphragms and has demonstrated its marked superiority under extensive service in aircraft engines operating under the most stringent conditions.

This invention has as an object the provision of a coated fabric which is highly resistant to fuels containing appreciable amounts of aromatic hydrocarbon. Another object is the provision of a coated fabric which is resistant to extreme humidity changes. A further object is the provision of a coated fabric which maintains excellent flexibility at extremely low temperatures. A still further object is the provision of a coated fabric which exhibits a high degree of adhesion between the coating and the base fabric. A still further object of the invention is the provision of an improved carburetor diaphragm particularly adapted for use in carburetors for aircraft engines. Other objects will become apparent as the description of the invention proceeds.

These objects are accomplished in accordance with the present invention by means of a special treatment of a nylon fabric base with an intermediate or primer coating comprising essentially a copolymer of butadiene and acrylonitrile and a

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thermosetting resin such as phenol-formaldehyde resin followed by the application of a coating of an aromatic hydrocarbon resistant composition, for example, a coating containing Hycar, Perbunan or Buna N which are copolymers of butadiene and acrylonitrile.

The following examples are given by way of illustration only and no limitations are intended thereby except as indicated in the appended claims.

Example 1

	Percent by weight
Phenol formaldehyde resin.....	13.3
Buna N (butadiene-acrylonitrile copolymer)	6.7
Methyl ethyl ketone.....	80.0
	100.0

This intermediate or primer coating was applied to both sides of #911 nylon parachute fabric with a conventional doctor blade and dried by passing the coated fabric through a convection drying tunnel at 160° F. The final total coating weight (including both sides) was about 0.1 oz. per square yard.

An aromatic hydrocarbon resistant coating consisting of the following composition was applied over the primer coat on both sides of the fabric by means of a conventional rubber spreader.

Example 2

	Percent by weight
Hycar OR-15.....	45.00
Dibutyl "Cellosolve" sebacate ¹	12.00
Zinc oxide.....	3.75
Neozone A ²	0.38
Stearic acid.....	0.38
Gastex (semi-reinforcing carbon black) ..	15.00
Superfine whiting	22.10
Zenite A ³	0.64
Sulfur	0.75
	100.00

¹ Sebacic acid ester of ethylene glycol monobutyl ether.

² Phenyl-alpha naphthylamine (anti-oxidant).

³ Zinc salt of mercaptobenzothiazole activated with tetramethyl-thiuram-monosulfide (accelerator).

The Hycar OR-15 used in this example is a butadiene-acrylonitrile copolymer manufactured by the Hycar Chemical Co. of Akron, Ohio and contains about 60% by weight of butadiene and 40% by weight of acrylonitrile.

This composition was dissolved in an agitator churn in the following volatile solvent mixture to spreader viscosity using about 40 parts by

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weight of the above composition to 60 parts by weight of the solvent mixture.

	Percent by weight
Methyl ethyl ketone.....	50
Ethylene dichloride.....	25
Commercial xylene.....	25
	100

Ten coats of the thinned composition were applied to each side of the nylon fabric base carrying the previously described primer coat giving a total coating thickness (both sides of fabric) of the aromatic fuel resistant coating of about 13 mils. Satisfactory results may be obtained with a total topcoat thickness of between about 4 mils and about 30 mils.

The coated fabric was then cured by winding tightly on a smooth drum with a Holland cloth liner and placing in an oven for 4 hours at 260° F.

This coated fabric remained flexible at temperatures as low as -40° F.

Aircraft fuels containing aromatic hydrocarbons have no apparent effects on the coated fabric after indefinite immersion in such fuel blends whereas in tests using the same nylon fabric base to which the coating of Example 2 had been applied direct, there was failure as evidenced by severe blistering within 24 hours of immersion. In fact, with the improved coated fabric no blistering was observed after immersion in straight benzene for a period of five months.

The superior adhesion which may be attributed directly to the use of the primer coat of Example 1 is shown by pull tests in a Scott tensile tester where the adhesion of the nylon fabric to Hycar using the Example 1 primer coat was shown to be almost 5 times that obtained when the nylon fabric was joined directly to the Hycar compound (see table below).

Example 3

	Percent by weight
Perbunan ¹	36.0
Dibutyl sebacate.....	7.2
Tributoxyethyl phosphate.....	7.2
Zinc oxide.....	2.4
Neozone A.....	0.4
Channel black.....	18.7
Superfine whiting.....	27.3
Zenite A.....	0.4
Sulfur.....	0.4
	100.0

¹ This material is of the type disclosed in U. S. Patent 1,973,000.

This composition was dissolved in the following volatile solvent mixture to spreader viscosity using 40 parts by weight of the composition to 60 parts by weight of the volatile solvent.

	Percent by weight
Methyl ethyl ketone.....	66.7
Commercial xylene.....	33.3
	100.0

It was applied to #911 nylon parachute fabric over the primer coat of Example 1 in accordance with the procedure shown in Example 2. The curing treatment also followed the description given in Example 2.

In this instance, it was found that the coated fabric maintained desired flexibility in temperatures as low as -65° F. Resistance to gasoline fuel blends containing aromatic hydrocarbon and to benzene was similar to that obtained with the

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primer coated fabric using as a top coat the composition of Example 2. In this instance, the adhesion strength when using the primer of Example 1 was more than 3 times that obtained when the nylon fabric was joined directly to the compound of Example 3.

The following table includes results of bond strength tests of nylon fabric coated with Hycar and Perbunan over the primer of Example 1 and for comparison, similar tests with the same type of nylon fabric attached directly to the synthetic rubber compound.

Primer coat	Type compound	Bonding strength ¹
None.....	Hycar OR-15.....	Pounds 2.9
Example 1 primer.....	do.....	14.0
None.....	Perbunan.....	2.0
Example 1 primer.....	do.....	6.8

¹ A 1 inch strip of #911 nylon parachute fabric with and without the primer coat of Example 1 was placed on a slab of compound of the types indicated and press cured for 40 minutes at 287° F. The bond strength was measured on a Scott tensile tester at a speed of 1 inch per minute.

In Example 1 which shows the primer or intermediate coating in the finishing system of the invention, the proportion of the thermosetting resin, i. e., the phenol-formaldehyde resin to the butadiene-acrylonitrile is given as 2:1. This represents the preferred proportions but the invention is also operative when this proportion varies between about 0.1 part and 10.0 parts by weight of thermosetting resin to 1 part of butadiene-acrylonitrile copolymer.

Other thermosetting resins alone or in admixture, for example, with the phenolic resin suggested above, including urea-formaldehyde, vinyl, acrylic acid resins and alkyd resins, may also be employed in the primer composition.

The Buna N given in Example 1 may be replaced wholly or in part by other types of butadiene-acrylonitrile copolymers such as Hycar and Perbunan. In general, it is preferred to use a copolymer consisting of about 40% to 70% of butadiene by weight to about 60% to 30% by weight of acrylonitrile.

The concentration of the thermosetting resins and the butadiene-acrylonitrile copolymer may be varied considerably but the application viscosity must be kept low in order to secure a partial impregnation of the fabric base so as to afford maximum anchorage for the top coat. For best results this viscosity has been found to be between about 20 and 30 seconds in a Parlin 10 cup. (Reference: Physical and Chemical Examination of Paints, Varnishes and Lacquers, H. A. Gardner, 1939, p. 224.) Other solvents such as ethyl acetate may also be employed with satisfactory results.

In some instances, it may be desirable to include a plasticizing material in the primer composition and for this purpose, such materials as the sebacic acid ester of ethylene glycol monobutyl ether, tricresyl phosphate, triphenyl phosphate and dibutyl phthalate are satisfactory.

Although the examples illustrate the invention by the use of nylon #911 parachute fabric, satisfactory results have also been secured with heavier nylon fabric designated as #908 cargo parachute type.

In diaphragms, such as air diaphragms for intercommunication systems in high altitude aircraft, that are not subject to exposure to aromatic hydrocarbons, the primer coat has also proven useful in providing an improved adhesion

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of neoprene (polymerized chloroprene) to nylon fabric base where the bond strength was shown to be almost 3 times that obtained when the neoprene is attached directly to the nylon base.

The construction of the present invention while of general utility for purposes where flexibility at extremely low temperatures is required, is of particular utility where products of this type are exposed to aromatic hydrocarbons such as contained in aircraft fuels, thus making the improved coated fabric of outstanding importance as carburetor diaphragms for aircraft engines. Other important uses include fuel pump construction, gasoline hose interior, covering for electric cables and gaskets for sealing fuel tanks.

The invention is characterized by a number of important advantages, chief of which is the complete absence of blistering or other failure of the coated fabric on long exposure to aromatic hydrocarbons and internal combustion engine fuels containing this type of hydrocarbon. Of great importance also is the high degree of flexibility which with the construction of the present invention is maintained at temperatures as low as -65°F . Another advantage resides in the excellent adhesion of the aromatic hydrocarbon resistant coating to the nylon fabric base coat secured through the use of the primer coating of the present invention which has been demonstrated as being several times that secured when the aromatic resistant compound is joined directly to the nylon fabric base. The new construction is also highly resistant to humidity changes and does not become distorted through shrinkage or expansion from such effects as frequently occurs with previously available carburetor diaphragm materials.

It is apparent that many widely different embodiments of the invention may be made without departing from the spirit and scope thereof and, therefore, it is not intended to be limited except as indicated in the appended claims.

I claim:

1. A flexible, aromatic hydrocarbon resistant coated fabric, particularly adapted for use as aircraft carburetor diaphragms, comprising a nylon fabric base, a thin primer coat containing a thermosetting resin and a butadiene-acrylonitrile copolymer and a top coat comprising a copolymer of butadiene and acrylonitrile.

2. Coated fabric of claim 1 in which the primer coat contains a phenol-formaldehyde thermosetting resin.

3. Coated fabric of claim 1 in which the primer coat is applied to a total weight of between about 0.1 and 1.0 ounce per square yard.

4. Coated fabric of claim 1 in which the primer coat contains a thermosetting resin and a butadiene-acrylonitrile copolymer in the proportion of about 2:1 parts by weight.

5. Coated fabric of claim 1 in which the total top coat thickness is between 4 mils and 30 mils.

6. A flexible coated fabric particularly adapted for use as diaphragms comprising a nylon fabric base, a thin primer coat containing a thermo-

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setting resin and a butadiene-acrylonitrile copolymer and a top coat containing a synthetic rubber selected from the class consisting of a copolymer of butadiene and acrylonitrile and neoprene.

7. Process for manufacturing flexible, aromatic hydrocarbon resistant coated fabric comprising applying a solution of a thermosetting resin and a copolymer of butadiene and acrylonitrile to a nylon fabric base, evaporating the solvent and applying a synthetic rubber polymer compound containing a butadiene-acrylonitrile copolymer as the essential and major ingredient and subsequently curing the coatings.

8. Process of claim 7 in which the curing is accomplished by heating at about 260°F . for about 4 hours.

9. Process for manufacturing flexible coated fabric comprising applying a solution of a thermosetting resin and a copolymer of butadiene and acrylonitrile to a nylon base, evaporating the solvent and applying a synthetic rubber polymer compound containing polymerized chloroprene as the essential and major ingredient and subsequently curing the coatings.

10. An aromatic hydrocarbon resistant carburetor diaphragm which remains flexible at extremely low temperatures comprising a nylon fabric base coated on both sides with a plurality of coatings consisting of an intermediate thin primer coat of a thermosetting phenol-formaldehyde resin and a butadiene-acrylonitrile copolymer in the proportion of about 2 parts by weight of said resin to 1 part by weight of said copolymer and a top coat of a synthetic rubber compound containing a butadiene-acrylonitrile copolymer as the essential and major ingredient.

11. A flexible, aromatic hydrocarbon resistant coated fabric, particularly adapted for use as aircraft carburetor diaphragms comprising a nylon fabric base carrying a coating on both sides of a primer consisting of a phenol-formaldehyde thermosetting resin and a butadiene-acrylonitrile copolymer in the ratio of 2 parts by weight of said thermosetting resin to 1 part by weight of said copolymer and a top coat on both sides over said primer consisting of approximately the following composition:

	Per cent by weight
Butadiene-acrylonitrile copolymer (60:40)	45.00
Sebacic acid ester of ethylene glycol monobutyl ether	12.00
Zinc oxide	3.75
Anti-oxidant (Neozone A)	0.38
Stearic acid	0.38
Carbon black	15.00
Superfine whiting	22.10
Accelerator (Zenite A)	0.64
Sulfur	0.75
	100.00

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