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DIAPHRAGM FOR FUEL PUMPS

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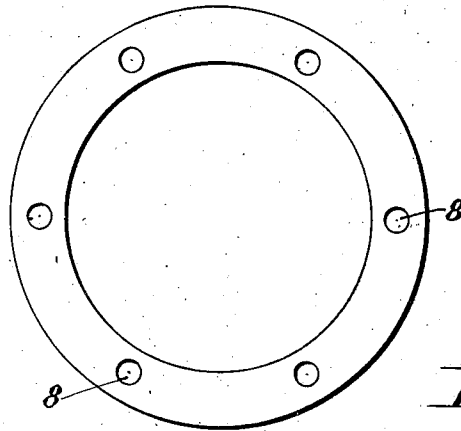


Fig. 2

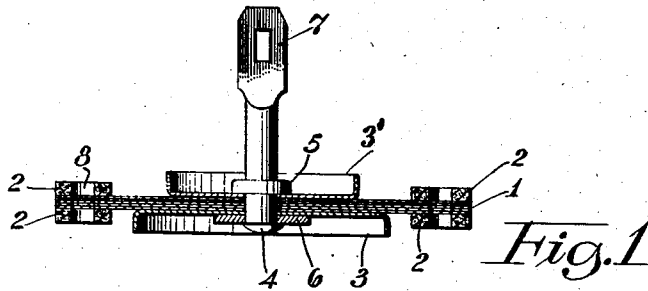


Fig. 1



Fig. 3

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DIAPHRAGM FOR FUEL PUMPS

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1 Claim. (Cl. 137-157)

This invention relates to pump diaphragms and more particularly to diaphragms such as are used in pumps for feeding gasoline and similar liquids to internal combustion engines.

In the manufacture of diaphragms for fuel pumps it has been proposed to coat fabric materials with certain coating compositions to obtain properties which are conducive to long life. These properties include sufficient strength to withstand millions of repeated flexings at a high rate, and also imperviousness to air as well as gasoline or other liquid fuels used in internal combustion engines. The coating or impregnant must withstand repeated flexings at temperatures as low as -20° F. and as high as 220° F. without breaking or cracking. Furthermore, the impregnating or coating composition must be insoluble in any liquid fuel such as gasoline, benzol, alcohol, etc. or mixtures thereof. The pliability of the coated fabric must not stiffen appreciably upon prolonged use and must have a minimum of change in flexibility at the extreme operating temperatures.

It has been proposed to employ drying oil compositions and blends thereof as the film-forming material in the manufacture of fuel pump diaphragms. While this type of coating has some of the desired properties for application as fuel pump diaphragm material it is not completely satisfactory. Such coatings have a tendency to crack when subjected to flexing in cold weather. As a result of this behavior the fuel pump diaphragm failure occurs on starting the motor in cold weather. It is also common practice to employ a plurality of layers of drying oil coated fabric to assemble a fuel pump diaphragm. Such a laminated assembly is objectionable in that at the upper temperature range of operation the coating on the individual plies has a tendency to soften and become adhesive thereby fusing the individual plies into a composite or combined structure. The multi-ply diaphragm is thereby greatly stiffened and results in unsatisfactory behavior of the fuel pump.

A primary object of this invention is to provide a fuel pump diaphragm which will retain its original pliability at the extreme operating temperatures after prolonged use. A further object of this invention is to provide a fuel pump diaphragm having a coating material which is insoluble in liquid fuels, such as, e. g., gasoline, benzol, and the like. A still further object is to provide a fuel pump diaphragm consisting of a plurality of fabric layers impregnated with a composition which will not coalesce at high temperatures, and cause the separated layers to become fused or amalgamated into a composite article. These and other objects as well as a

general advance in the art which will appear hereinafter are also contemplated.

The objectives of this invention are accomplished by treating a closely woven textile fabric with a plasticized polyvinyl alcohol composition or molding an unsupported film of plasticized polyvinyl alcohol to the desired shape.

In Figure 1, which is a cross-section view of a fuel pump diaphragm assembly, 1 represents a laminated polyvinyl alcohol diaphragm, 2 cork gaskets located at the periphery of diaphragm 1, 3 and 3' cup-like metal supports for the diaphragm 1 held in position by washers 5 and 6 and bolt 4, and 7 represents the plunger arm which vibrates the diaphragm. In Figure 2, which is a plan view of the cork gaskets 2, 8 represents openings which register with the top and bottom housing (not shown) for the diaphragm. In Figure 3, 11 represents a fabric and 10 represents a film of polyvinyl alcohol attached to both sides thereof.

The impermeability of a fuel pump diaphragm to air and liquid fuels should be as nearly perfect as possible. This is accomplished by thorough impregnation of a suitable fabric such as grade A airplane cloth with an aqueous plasticized polyvinyl alcohol solution. Such plasticized compositions as disclosed by Watkins in application filed November 17, 1937; S. N. 175,041 have been found advantageous in this connection. The plasticized polyvinyl alcohol composition is squeezed through the pores or interstices of the fabric to give a very complete union between the fabric and polyvinyl alcohol.

Grade A airplane fabric is an example of one that is very suitable and is an unbleached mercerized cotton fabric of two ply yarn having at least 80 warp and 80 filler threads per inch, the weight being 4.5 ounces per square yard. The fabric has a minimum tensile strength of 80 pounds per inch width (strip method). The fabric is impregnated or coated on both sides with a plurality of coats of any one of the examples listed below in such a manner that the composition permeates the fabric and the coating or impregnant meets in the interstices. The fabric is actually imbedded in the polyvinyl alcohol coating. The amount of coating may vary over rather wide limits depending upon how the material is to be used. In the preferred embodiment the amount of coating or impregnant may vary between 6.0 ounces and 9.0 ounces (based on non-volatile components) per square yard; however, some variation is permissible. The diaphragm assembly consists of one or more layers of the treated fabric the thickness of the separate layers being such that the total thickness of the assembly is approximately .045". In

practice it has been found desirable to use three separate layers of the treated fabric, each layer having a thickness of approximately .015". If a single ply diaphragm is to be used the total thickness (coating plus fabric) should be approximately .045".

Further explanation of the invention is given in the following detailed description and illustrative specific examples, in which the parts are given by weight. Throughout the examples the proportions of the ingredients on a solids basis (i. e., in the absence of volatile liquids) is indicated by enclosing the percent of each solid material in parentheses.

Example I

Polyvinyl alcohol	14.0%	(66.7%)
Water	79.0	
Ethanol acetamide	7.0	(33.3%)

Example II

Polyvinyl alcohol	13.2%	(50%)
Water	73.6	
Ethanol acetamide	13.2	(50%)

Example III

Polyvinyl alcohol	12.2%	(40%)
Water	69.5	
Ethanol acetamide	16.3	(60%)

In the case of Examples I, II and III the components of the compositions are added together in a suitable container and subjected to a simple mixing operation until a homogeneous solution is obtained. After the composition has been thoroughly mixed it is applied to both sides of the textile fabric heretofore described by conventional means such as dipping, spraying, doctor coating, etc. It is very important that the first coats on each side of the fabric be driven into the pores or interstices of the fabric for the reason heretofore mentioned. After the coating has been dried the diaphragm is die cut to the desired shape and is then ready for use.

It has been found that if the fabric has been wetted with a 10% aqueous solution of saponin and dried, a single application of plasticized polyvinyl composition may be applied and it will penetrate the interstices of the fabric and even run out on the other side although the position of the doctor knife or the method of applying the vinyl alcohol is usually controlled so that this does not take place, although complete impregnation is desirable.

Example IV

Polyvinyl alcohol	50.0	Per cent
Ethanol formamide	50.0	

These ingredients are milled together and molded at a temperature at about 135° C. and under a pressure of 300 pounds per square inch for about ten to fifteen minutes. The film so produced is suitable for a fuel pump diaphragm. The polyvinyl alcohol in this example had a saponification number of 200.

Example V

Polyvinyl alcohol	80.0	Per cent
Ethanol formamide	20.0	

The ingredients in this example are the same as in the previous example and are milled together and molded at a temperature of 135° C. and under a pressure of 1000 pounds per square inch for ten to fifteen minutes.

Example VI

Polyvinyl alcohol	79.0	Per cent
Ethanol formamide	19.8	
Water soluble dye	0.2	
Carbon black	1.0	

The polyvinyl alcohol in this example has a saponification number of 250. A diaphragm film was prepared from this material in the same manner as indicated in the previous example.

Example VII

Polyvinyl alcohol	50.0	Per cent
Ethanol acetamide	50.0	

The polyvinyl alcohol in this example is the same as in the previous example and the materials were milled together and molded at a temperature of 135° C. under a pressure of 750 pounds per square inch.

Example VIII

Polyvinyl alcohol	60.0	Per cent
Ethanol acetamide	40.0	

The polyvinyl alcohol and the method of procedure in this example is the same as in the previous example.

Example IX

Polyvinyl alcohol	70.0	Per cent
Ethanol acetamide	30.0	

In this example the ingredients and the method of molding a film are the same as in the previous example.

Example X

Polyvinyl alcohol	68.8	Per cent
Ethanol acetamide	30.0	
Water soluble dye	0.2	
Carbon black	1.0	

The polyvinyl alcohol in this example had a saponification number of 80 and a film was molded from this composition at 140° C. under a pressure of 1000 pounds per square inch. Otherwise the method of procedure is the same as in the previous examples.

Example XI

Polyvinyl alcohol	74.8	Per cent
Ethanol formamide	20.0	
Dye	0.2	
Ferric oxide	5.0	

The polyvinyl alcohol in this example is the same as in the previous example and the method of mixing and preparing a film is the same except that a slightly lower temperature may be used in molding if desired.

In the above examples the polyvinyl alcohol is prepared by saponifying polymerized vinyl acetate. Widely different properties may be imparted to the alcohol by controlling the degree of saponification. For example the maximum water solubility of polyvinyl alcohol is observed in one having a saponification number of 130 and which is saponified to an extent that the amount of acetate converted to alcohol is about 88%. In the above examples the polyvinyl alcohol having a saponification number of 200 represents a polymer which has been converted to the extent of 81.5% alcohol. In the case of the alcohol having a saponification number of 250, the conversion is 76.0% and in the case of the

alcohol having a saponification number of 80, the conversion is 93.2%. In Examples I, II, and III the polyvinyl alcohol had a saponification number of 8 which represents a conversion of 99.5% to the alcohol. In the present invention it is preferred to use polyvinyl alcohols having a saponification number below 300.

While the preferred embodiment of this invention employs a textile fabric base for the diaphragm, it is also within the purview of this invention to make a fuel pump diaphragm from an unsupported film of plasticized polyvinyl alcohol. It is sometimes desirable to mold a supporting gasket of dissimilar material, such as a cork composition, around the edge of the diaphragm to prevent "cold flow" of the film around the edges when under pressure. In this case the dry polyvinyl alcohol and plasticizer are mixed together and placed in a mold, then subjected to heat and pressure whereby a homogeneous film of plasticized polyvinyl alcohol is obtained. A film of approximately .045" thickness is satisfactory for this purpose. However, films of greater or lesser thicknesses may be used, depending upon the operating conditions of the pump.

The plasticized polyvinyl alcohol compositions may also be calendered onto the textile fabric base, which may or may not be previously impregnated with a polyvinyl alcohol composition in a manner similar to that employed in the rubber industry. In this case the polyvinyl alcohol and plasticizer are subjected to a mixing operation at an elevated temperature until a doughy plastic mass is obtained and then calendering the plastic mass on each side of the fabric, squeezing the said mass into the pores or interstices of the fabric.

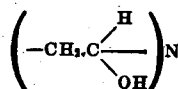
In still another embodiment of the invention the plasticized polyvinyl alcohol composition may be formed into sheets. A layer of textile fabric is sandwiched between two sheets of the plasticized polyvinyl alcohol and the assembly subjected to the influence of heat and pressure, whereby a composite integral union is obtained with the fabric embedded in the plasticized polyvinyl alcohol sheets. It is also contemplated to use other than cotton fabric where a supporting base is desired. In this connection finely woven wire fabrics having the proper degree of suppleness may be used as the supporting base for the polyvinyl alcohol.

The polyvinyl alcohol treated fabrics and moulded sheets herein described find their greatest utility where a material is required which is insoluble in benzene, gasoline, alcohol, or mixtures thereof as well as other hydrocarbons, both aliphatic and aromatic, chlorinated hydrocarbons, esters, ketones, carbon disulfide and most other organic solvents. For example, the diaphragms of the invention are ideally suited for use in diaphragm-valves of the type where the diaphragm is exposed to the action of organic solvents. In addition, polyvinyl alcohol coated fabrics are useful as "draw sheets" for rotary printing presses. The polyvinyl alcohol compositions may also be applied to unwoven felts to produce a "Printer's Blanket" for the rotary type printing presses. In addition to being resilient the polyvinyl alcohol fabrics are non-penetrable by printing inks and ink removers (such as hydrocarbons, carbon tetrachloride, etc.) and possess a non-cracking, non-peeling flexible surface capable of withstanding millions of pressure applications of great magnitude (by the plate

cylinder), which properties are extremely important for "draw sheets" and printer's blankets employed in rotary printing presses. For this purpose fabric or felt is usually coated on one side only and the polyvinyl alcohol is applied in sufficient quantity to obtain a smooth uninterrupted, continuous film.

An important advantage of this invention is the provision of a fuel pump diaphragm which will retain its original flexibility after prolonged use and further advantage is the absence of any substantial variation of flexibility at the extreme operating temperatures. A still further advantage is the fact that the coatings described are so completely insoluble in fuel liquids such as gasoline, benzol, and other hydrocarbons that they do not exhibit any swelling upon prolonged exposure thereto. A still further advantage is that with a fuel pump diaphragm consisting of a plurality of separate layers the coating on the separate layers does not coalesce under operating conditions and become stiff.

The term polyvinyl alcohol as used herein and in the appended claim denotes not only the compound



but it also includes derivatives thereof in which the hydroxyl groups have been partially substituted by other groups such as ester, ether, or acetal groups in proportions insufficient to render the compound insoluble in water. Such derivatives may be prepared conveniently by the partial saponification of polyvinyl esters, ethers, acetals or other saponifiable vinyl polymers or by the partial reaction of pure polyvinyl alcohol with reagents such as acids or aldehydes which are capable of reacting with hydroxyl groups. In the case of the partial saponification products of polyvinyl acetate it has been found that products having a saponification number of less than about 300 (corresponding to approximately 70 mole per cent conversion of the acetate to the alcohol) are soluble in water and are particularly well suited for the purposes of the present invention.

In the preparation of fuel pumps the impregnated fabric is cut usually by die stamping into a circle which may or may not have a narrow cork gasket at its periphery. A small hole is also cut at the center of the diaphragm through which a metal member is inserted. This may be a rivet or a washer on each side of the diaphragm held in place by means of a small bolt or other suitable means. The arm of the pump which oscillates and produces the undulating motion in the diaphragm bears against this metallic member in the center of the diaphragm. This member also is used to join two or more of the diaphragm laminations when more than one is used.

It is apparent that many widely different embodiments of this 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 claim.

I claim:

A fuel pump diaphragm capable of withstanding repeated flexings at a high rate comprising a textile fabric impregnated with a composition containing polyvinyl alcohol and a plasticizer selected from the class consisting of ethanol acetamide and ethanol formamide.

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