DIAPHRAGM OF FEED PUMPS FOR LIQUID HYDROCARBONS

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Filed July 5, 1957, Ser. No. 670,152
Claims priority, application France July 7, 1956
4 Claims. (Cl. 260—8)

This invention relates to flexible-diaphragm pumps of the type currently utilized for circulating liquids and more particularly supplying fuel to the carburettor of internal combustion engines.

In most cases the diaphragm has its outer peripheral edges clamped between two case halves or shells constituting the pump body. The pump suction and delivery result from the deformation of the diaphragm actuated by a push- or pull-rod having one end secured to the centre of the diaphragm, and also from the operation of suitable valve means, generally a suction valve and a pressure valve.

In pumps of this conventional type the output is seldom easily adjustable to the desired and adequate values proportional for example to the velocity of rotation of the engine; the function of this pump is limited to supplying liquid to a member, in the case contemplated a carburettor, the latter constituting the metering device proper in the fuel feed system.

In these pumps the diaphragm is subjected to substantially uniform deformation and no appreciable strains are applied to it. Thin, multi-layer rubberized-fabric discs are generally suitable for this purpose; the strength is provided by the fabric and the rubber makes the assembly impervious to the liquid drawn and delivery by the pump. There is no inconvenience in allowing the mechanical strength of the rubber component to be reduced to a very moderate value by swelling in the liquid medium.

However, diaphragms of this type are not suitable for equipping pumps intended for directly injecting an accurately metered quantity of fuel into the different cylinders of an engine. In this case, the diaphragms are subjected to relatively high pressures and to severe alternate stresses due to the action of metal push members disposed very close to one another and to which relative movements of translation are impressed. One example of this pump construction is shown and described in the French Patent No. 1,112,569 filed on October 4, 1954, by same applicant, and entitled: “Improvements in Fuel Injection Pumps of the Diaphragm Volumetric Type.” In devices of this character the use of rubberized fabric discs is not convenient for the rubber will rapidly separate from the fabric and disintegrate.

Therefore, homogeneous elastic diaphragms are used, but with the materials acknowledged up to now as the best after many tests, the useful life remains limited by the fluctuation of the diaphragms and is still insufficient— in spite of the minor cost and higher precision of diaphragm pumps in comparison with piston pumps—to permit their diffusion on a commercial scale.

The important technical improvement consisting in the commercial manufacture of diaphragm pumps for injecting liquid hydrocarbons is now possible due to the present invention which has for its object the use of composite diaphragm material consisting of a novel composition and on the other hand a specific method of preparation yielding properties that are particularly suitable for use in the manufacture of elastic diaphragms of pumps for circulating liquid hydrocarbons, especially of direct-injection pumps for internal combustion engines.

Whereas it was generally admitted up to now that among the materials capable of withstanding very considerable elongation without exceeding the elastic limit the ones offering the greater resistance to the decomposing action of liquid hydrocarbons were the vulcanized mixtures of butadiene and acrylic nitrile copolymers containing only carbon blacks, inorganic fillers and vulcanizing ingredients in addition to the elastomer, the applicant discovered a specific mixture composition that cannot be obtained unless the means forming the subject matter of this invention are resorted to, whereby the resistance of the end product to a relatively long time of contact with liquid hydrocarbons and to simultaneous mechanical stresses including very considerable elongation is much higher than the values attained heretofore.

The improved material thus obtained is characterized in that its organic base is a mixture of butadiene-acrylic nitrile copolymer with gelatin, the proportion of any one of these two component elements in the mixture being at least 30%. The composition incorporates in addition the sulfur required for carrying out the vulcanization, the latter being facilitated by the addition of accelerators such as zinc oxide and stearic acid.

The preparation consists in incorporating the gelatin in powder form or in the form of minute fragments in a butadiene-acrylyc nitrile latex copolymer, and subsequently allowing the mixture component elements to contact each other at room temperature during a time sufficient to cause the gelatin to become swollen by the water content of the elastomer suspension, so as to constitute a homogeneous paste.

On the other hand, the two cylinders of a rubber mixer which are adjusted initially with a sufficient relative gap and heated at about 30° C. are rotated and the paste is poured upon one of the cylinders while progressively reducing their gap, so that the water is eliminated by evaporation and the paste becomes progressively harder. When the mixture is completely dry the ingredients are incorporated therein according to the conventional technique; finally, the composition is vulcanized optionally after a calendaring step.

It is advantageous to use butadiene-acrylic nitrile copolymers having an acrylic nitrile content ranging from about 25% to about 45%. Pure gelatin is used which is capable of yielding high-viscosity solutions for a given water content, for example a viscosity above 6° Engler measured at 60° C. on a broth containing 17.75% of gelatin and 82.28% of water, is desirable.

Diaphragms of fuel injection pumps for automotive engines may be prepared under the conditions set forth hereafter by way of example:

Example

2,250 kilograms of pure gelatin as specified hereinabove are added to 7,500 litres of a homogeneous aqueous suspension containing 33% or 2,440 kilograms of butadiene-acrylic nitrile copolymer with 38% of acrylic nitrile. The gelatin is allowed to swell during 24 hours, the suspension being stirred continuously or intermittently.

The suspension will finally assume the consistency of a paste. The latter is then poured progressively onto the heated spaced cylinders of a rubber mixer, these cylinders being progressively moved towards each other as the water contained initially in the paste evaporates. Upon completion of the evaporation step the following ingredients are incorporated in the mixture according to the conventional technique:

<table>
<thead>
<tr>
<th>Kilograms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stearic acid</td>
<td>0.0225</td>
</tr>
<tr>
<td>Zinc oxide</td>
<td>0.115</td>
</tr>
<tr>
<td>Mercaptobenzothiose</td>
<td>0.0270</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.0450</td>
</tr>
</tbody>
</table>

Then the resulting composition is calendared to form
sheets of regular thickness, and discs are cut therein which are subsequently disposed in adequate moulds to effect the final shaping and vulcanization of the disc.

The vulcanization takes place at a temperature of about 150° C. during 60 minutes. Of course, it is also possible to calender the mixture in the form of sheets of uniform thickness which are vulcanized in this form and subsequently cut or punched out to the desired diaphragm configuration, as shown by way of example in the accompanying drawing.

Although a typical embodiment of the invention has been described in the single example hereinabove, it will be readily understood by anybody conversant with the art that many modifications may be brought to the practical embodiment of the invention without departing from the scope set forth in the appended claims.

1. A method of preparing a hydrocarbon-resistant flexible composition adapted to be shaped to form elastic sheets and the like which comprises the steps of incorporating gelatin in dry form directly into an aqueous suspension of a butadiene-acrylonitrile copolymer having a content of about 25% to about 45% of acrylonitrile, said gelatin being effective to form a solution having a viscosity above 6" Engler measured at 60° C. on a broth containing 17.75% of gelatin and 82.28% of water allowing said gelatin to swell in said suspension, pouring the resulting pasty mixture onto heated rotating cylindrical surfaces to effect progressive evaporation of moisture from the mixture until the mixture is substantially dry, incorporating in said substantially dry mixture of gelatin and copolymer .0225 part by weight of stearic acid, .115 part by weight of zinc oxide, .0270 part by weight of mercaptobenzothiazole, and .0450 part by weight of sulfur, and calendering the resulting composition to form sheets having predetermined thickness.

2. A method of preparing a hydrocarbon-resistant flexible composition adapted to be shaped to form elastic sheets and the like which comprises the steps of incorporating pure gelatin having a viscosity higher than 6" Engler measured at 60° C. on a broth containing 17.75% of gelatin and 82.28% of water directly into an aqueous suspension of butadiene-acrylonitrile copolymer having an acrylonitrile content ranging from 25% to 45%, allowing said gelatin to swell in said suspension, pouring the resulting pasty mixture onto rotating cylindrical surfaces which are heated to about 50° C. to effect progressive evaporation of moisture from the mixture until the mixture is substantially dry, incorporating in said substantially dry mixture of said gelatin and said copolymer .0225 part by weight of stearic acid, 115 part by weight of zinc oxide, .0270 part by weight of mercaptobenzothiazole, and .0450 part by weight of sulfur, and calendering the resulting composition to form sheets having predetermined thickness.

3. A method of preparing a hydrocarbon-resistant flexible composition adapted to be shaped to form elastic sheets and the like which comprises the steps of incorporating gelatin in dry form directly into an aqueous suspension of a butadiene-acrylonitrile copolymer having a content of about 25% to about 45% of acrylonitrile, said gelatin being effective to form a solution having a viscosity above 6" Engler measured at 60° C. on a broth containing 17.75% of gelatin and 82.28% of water, allowing said gelatin to swell in said suspension, pouring the resulting pasty mixture onto heated rotating cylindrical surfaces to effect progressive evaporation of moisture from the mixture until the mixture is substantially dry, incorporating in said substantially dry mixture of gelatin and copolymer stearic acid, zinc oxide, mercaptobenzothiazole, and sulfur, and calendering the resulting composition to form sheets having predetermined thickness.

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