June 17, 1947. I. E. COFFEY 2,422,529

METHOD OF MAKING DIAPHRAGMS

Original Filed June 15, 1944 2 Sheets-Sheet 1

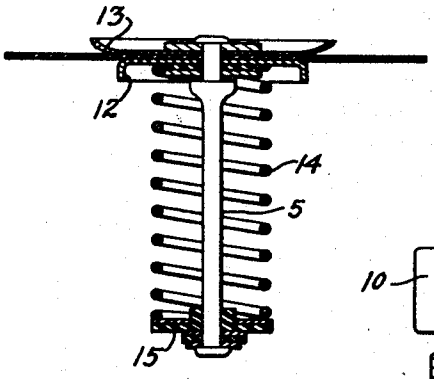


FIG. 2.

FIG. 1.

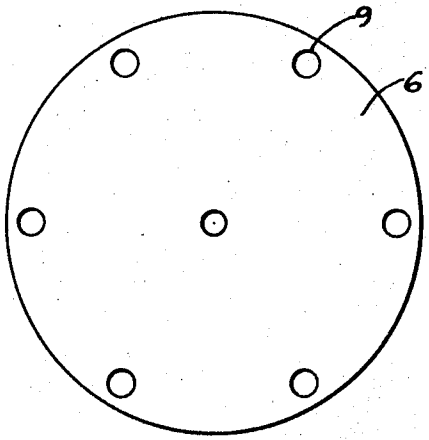


FIG. 3.

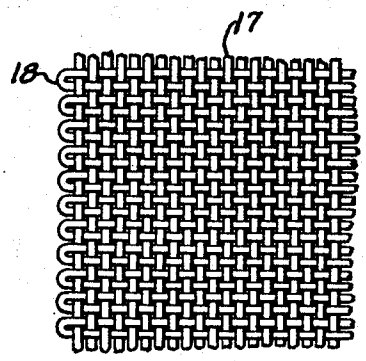


FIG. 4.

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METHOD OF MAKING DIAPHRAGMS

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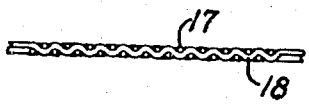


FIG. 5.

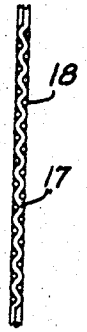


FIG. 6.

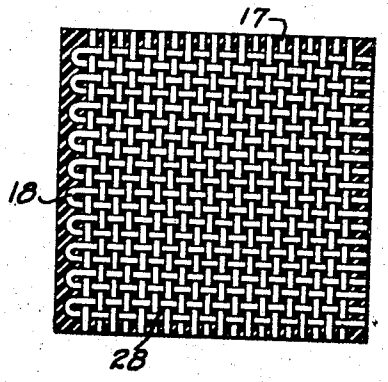


FIG. 7.

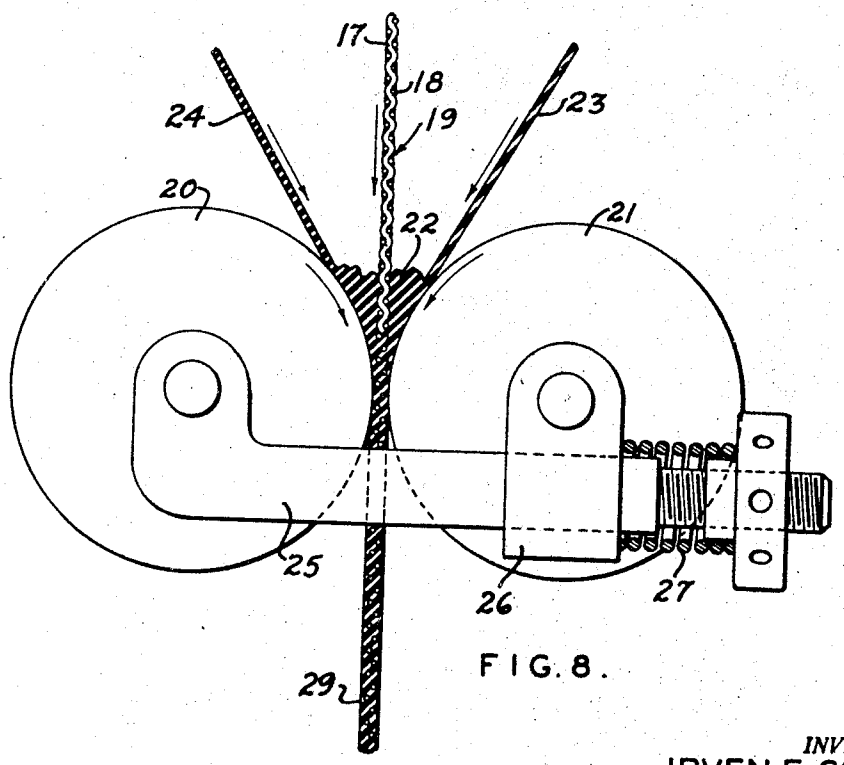


FIG. 8.

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METHOD OF MAKING DIAPHRAGMS

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Original application June 15, 1944, Serial No. 540,464. Divided and this application September 13, 1945, Serial No. 616,137

5 Claims. (Cl. 28—74)

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This invention relates to diaphragms and particularly to diaphragms for fuel pumps and the like and is a division of my application Serial No. 540,464, filed June 15, 1944.

An important use of the diaphragm is in connection with the fuel pump such as disclosed in my copending application, Serial No. 536,162, filed May 18, 1944. Diaphragms of this character are made on a cloth base and are coated or impregnated with a material such as synthetic rubber, which is resistant to the action of the gasoline or other liquid which is to be pumped. One of the inherent characteristics of the diaphragm is that it must be flexible enough to permit distortion into a substantially frustoconical shape by the diaphragm operating means while the edges of the diaphragm are rigidly held. Since the synthetic rubber with which the diaphragm is coated has comparatively little tensile strength, the cords of the fabric forming the base of the diaphragm must be relied on to supply the necessary tensile strength. The service required of diaphragms in fuel pumps for automotive engines is severe, as they have to operate at high speed under considerable tension for thousands of hours during the life of the car. For this reason, considerable diaphragm trouble has been experienced by fuel pump manufacturers in spite of such expedients as multiple thickness and multiple layer diaphragms. Up to the time of this invention, it has been impossible to obtain a satisfactory diaphragm, particularly of the single layer, rubber coated type which is most desirable for fuel pump use.

It is an object of my invention to produce a new and improved diaphragm of the synthetic rubber coated type which will be capable of lasting the full life of the automobile when used in automotive fuel pump service.

It is a further object of my invention to produce a new and improved diaphragm in which strains applied in distorting the diaphragm will be evenly resisted by the threads of the cloth in both directions.

It is a further object of my invention to produce new and improved diaphragm material which can easily be made in large quantities while maintaining the high standards of durability and strength.

It is a further object of my invention to produce a new and improved method of making diaphragms of the above described character.

The invention will be better understood upon reference to the following specification and accompanying drawings:

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Fig. 1 shows a diaphragm, according to my invention, mounted in a fuel pump of the type shown in my copending application Serial No. 536,162, filed May 18, 1944.

Fig. 2 shows a sectional elevation of a diaphragm assembly separate from the pump.

Fig. 3 is a plan view of a single diaphragm as shown in Figs. 1 and 2.

Fig. 4 is a plan view showing the weave of the fabric upon which my diaphragm is based.

Fig. 5 shows a longitudinal sectional view of the fabric shown in Fig. 4.

Fig. 6 shows a transverse sectional view of the fabric.

Fig. 7 is a sectional plan view showing the material after the application of the synthetic rubber, the top layer of rubber being removed for inspection of the fabric.

Fig. 8 shows the method of applying the synthetic rubber to the fabric.

The reference numeral 1 indicates the main body member of the fuel pump having a flange 2 by means of which it is adapted to be mounted on an engine, or machine, to which it is to be attached. Operating lever 3, normally yieldingly held in the position shown by the spring 4, is connected to the diaphragm shaft 5 by a one way connection which has no bearing on the present invention and is not shown herein. The full structural details of the pump are shown in my above mentioned copending application. The flexible diaphragm 6 is mounted between flanges 7 and 8 and may be provided with perforations 9 to receive the flange bolts or rivets. The pump is provided with an inlet 10 and an outlet 11, together with suitable valves for controlling the inlet and outlet. The central part of the diaphragm 6 is rigidly clamped between the washers 12 and 13, which are especially shaped as shown herein and as claimed in my copending application. An operating spring 14, held in place between the washers 12 and 15 serves to maintain a constant discharge pressure for the pump.

In the operation of a pump, it is obvious that the diaphragm must be shifted from the position shown in Fig. 1, first, to the flat position corresponding to Fig. 2 and, finally, to a position corresponding to the dotted lines 16 shown in Fig. 1. This requires the diaphragm to be not only flexible, but resilient, and since the reciprocating action of the diaphragm must be very rapid under certain conditions, heavy strains are imposed due to the inertia of the liquid which must be accelerated and decelerated in the up and down

movement of the diaphragm. As stated above, the object of this invention is to provide a means and method for producing a diaphragm having the strength and resilience required to function in the above described manner.

I have shown in Fig. 4 a plain, woven cloth which serves as the base on which my diaphragm is formed. The warp 17 is more widely spaced than the weft 18, and the tension of the weft is initially greater than that of the warp, so that the additional tension or stretching applied during the rolling operation will equalize the spacing and also the tension. The cloth is made of the best yarn obtainable which may be cotton, rayon, or nylon.

The fabric 19 is impregnated by passing between rolls 20 and 21 which are supplied with Buna-N or other synthetic rubber in a plastic and uncured condition. As indicated at 22, the rubber builds up a gob on each side of the cloth at the entering side of the rolls. This gob is continuously supplied by means of the uncured Buna-N rubber strips 23 and 24 which are fed into the gob as required. Suitable spacing in tension of the rolls is provided by a mounting which is diagrammatically indicated at 25 and 26 with adjustable spring means 27 for controlling the pressure and spacing. The pressure is sufficient to press the uncured rubber into the interstices between the threads, so that they join in the middle as indicated at 28.

During the rolling operation, the resistance of the gobs 22 to passing through the rollers sets up a very substantial tension tending to stretch the warp away from the rollers. By feeding the cloth in the direction of the warp, I am thus able to equalize both the weave and the tension as it passes through the rolls. It will be understood that the impregnated diaphragm material 29 is treated to cure the rubber after it leaves the rolls 20 and 21. However, the details of this operation are well known in the art and need not be further shown or described.

While I prefer to use the above described method in the performance of my invention, it sometimes happens that the amount of diaphragm material to be made does not justify setting up a loom with the desired spacing and tension of the weft with respect to the warp. In such cases, the weft is usually made with substantially the same initial spacing in the cloth as the warp, but with less tension. When only this type of fabric is available, I prefer to cut the fabric into squares, turning each square sidewise, and sewing it to the side of the adjacent square so as to form a strip of cloth which may be the same width as the cloth which originally came from the loom or any other desired width. This strip of cloth is then placed on a roller and fed into the impregnating rolls 20 and 21 so as to increase the tension on the weft, which, in that case, passes longitudinally through the rolls. This method results in an impregnated and coated fabric in which the tension on the warp and weft is equalized, although the spacing may not be identical.

In this connection, it may be noted that it is the length of the rolls 20 and 21 which controls the width of the cloth which may be impregnated, and, where small quantities of material are required, the alternative method above described may be used to advantage by cutting the original cloth into short sections which are sewn together edgewise to form a narrow strip with the weft running longitudinally.

While the material produced by the herein described method has been described chiefly in connection with its use for pump diaphragms, it will be obvious that it has many uses, not only for diaphragms of all kinds, but wherever a heavy and strong rubber impregnated cloth is desired.

I claim:

1. The method of making diaphragms which comprises weaving a cloth with unequal tension on the warp and weft, impregnating and coating the cloth with a plastic material by passing the cloth between rolls to which the plastic material is supplied, and adjusting the position of the cloth so that it passes through the rolls in the direction of the looser threads so as to equalize the tension of the warp and weft.

2. The method of making diaphragms which comprises weaving a cloth with the threads in one direction at greater tension than the threads extending crosswise thereof, applying plastic coating material to the surface of the cloth, and passing the cloth between pressure elements in the direction of said looser threads whereby the plastic material is pressed into the interstices of the cloth and the cloth is simultaneously stretched so as to substantially equalize the tension of the crossed threads.

3. The method of making flexible diaphragms which comprises weaving a cloth with unequal tension on the warp and weft, applying a mass of normally flexible material in a plastic condition to the surface of the cloth, and passing the cloth and plastic material in the direction of the looser threads between pressure rolls so as to simultaneously force said plastic material into the interstices of the cloth and equalize the tension of the crossed threads.

4. The method of making a pump diaphragm which comprises weaving a cloth with threads of equal size and strength but unequal tension with respect to the warp and weft, applying a mass of uncured, synthetic rubber to each surface of the cloth, and rolling the synthetic material into the interstices of the cloth in the direction of the looser threads, the roller pressure being adjusted so as to stretch the looser threads just sufficiently to equalize the tension of the warp and weft.

5. The method of making a flexible pump diaphragm which comprises weaving a cloth with threads of substantially equal strength and size but at unequal tension and unequally spaced, the threads at greater tension being closer together than the crossed threads, applying a mass of uncured, synthetic rubber to each surface of the cloth, passing the synthetic rubber and cloth between pressure elements in the direction of the looser threads, and adjusting the pressure of the pressure elements so as to stretch the threads and separate the more closely spaced threads sufficiently to equalize the tension and spacing of the threads in both directions.

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