June 24, 1958 E. A. JOHNSON ET AL 2,840,003

FUEL PUMP DIAPHRAGM ASSEMBLY

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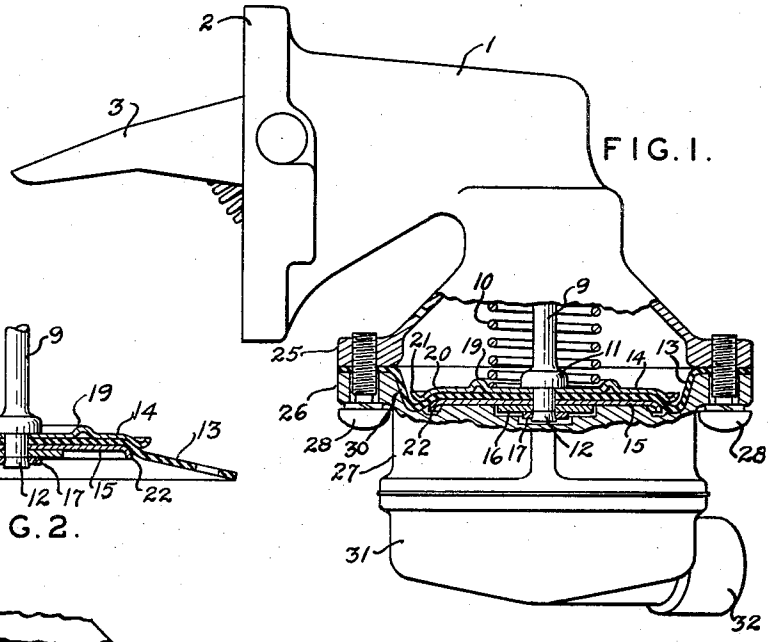


FIG. 1.

FIG. 2.

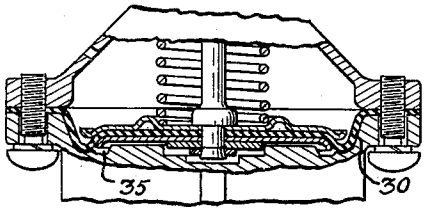


FIG. 3.

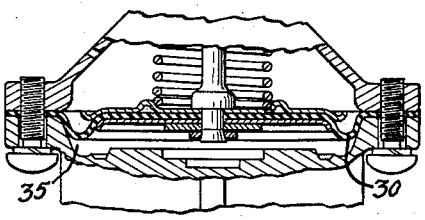


FIG. 5.

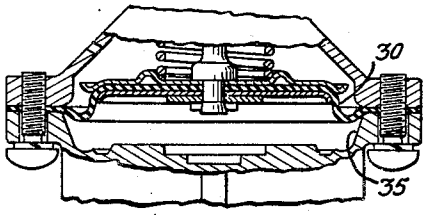


FIG. 4.

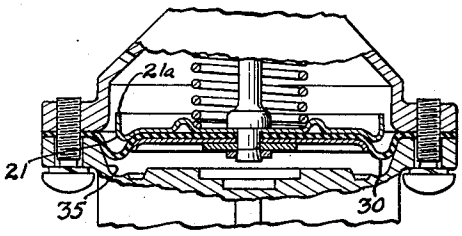


FIG. 6.

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FUEL PUMP DIAPHRAGM ASSEMBLY

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Application September 16, 1954, Serial No. 456,360

3 Claims. (Cl. 103—150)

This invention relates to engine driven fuel pumps of the diaphragm type and, more specifically, to means for increasing the durability and volumetric efficiency of this type of pump.

In present pulsating fuel pump design, a circular, flexible diaphragm is clamped at its periphery between the circular flanges of the rocker arm casing and the valve casing of the pump. The diaphragm is flexed to produce the pumping action by a stem connected to the diaphragm and reciprocated from a cam driven rocker arm. This connection with the stem is secured centrally to the diaphram by a pair of backing plates locked to the free end of the stem in clamping relation to the diaphragm. During pump assembly, it is usual to provide sufficient slack in the diaphragm outside of the backing plates to accommodate the reciprocating action of the backing plates during their movement from one extreme end of the stroke to the other. Although the diaphragm is of flexible material, it cannot be repeatedly stretched or crimped without fracture. Because there will always be slack in the diaphragm in the midstroke position of the backing plates, a circumferential wrinkle or loop is formed between the backing plates and the pump chamber. On the suction stroke, this wrinkle will form a loop on one side of the backing plates, but, on the pressure stroke, this wrinkle will form a loop in the opposite direction. This inherent back and forth switching of the flexing loop of the diaphragm substantially reduces the life of the diaphragm as well as the capacity of the pump, since adequate space must be provided between the backing washers and the clamped periphery of the diaphragm to accommodate the loop. This, of course, results in a larger loop structure, in order to avoid frictional scraping together of the walls of the loop and excessive crimping of the loop.

This space within the wrinkle contributes to the occurrence of vapor lock. Space must be minimized in order to attain the maximum possible volumetric efficiency to handle modern fuels which contain highly volatile ends. Experiments with larger backing plates to obtain this objective have not been successful, since such plates cause kinking and frictional interference in the flexing portions of the diaphragm. Moreover, when the backing plates exceed a certain size in relation to the pump, the diaphragm acts as an over-center type of spring on each stroke. This is not too important on the suction stroke, because the pump is being actuated by the engine driven eccentric. The discharge stroke of the pump is spring powered, however, and the opposing spring action of the diaphragm can prevent the pump from developing its designed discharge pressure at low speeds and stall the pump at high engine speeds.

This invention has as its object to increase the volumetric efficiency in this type of pump without the disadvantage above mentioned. According to this invention, the clearance between the backing plates and the pump chamber is decreased, and the plates themselves are so proportioned and contoured as to prevent the reversal of

the wrinkle formed in the diaphragm on each opposite stroke. This arrangement of the backing plates requires that the wrinkle in the diaphragm will form a loop in one direction only in such a manner that its displacement is also utilized to reduce clearance and improve the volumetric efficiency.

The accompanying drawings illustrate one manner in which the invention may be carried out.

In the drawings, Fig. 1 is a side elevation, partly in section, of a pump constructed according to the present invention.

Fig. 2 is a detail of the diaphragm and backing plate assembly for that pump shown in section.

Fig. 3 is a fragmentary view, partly in section, of a pump according to this invention showing the position of the parts at the discharge end of the stroke.

Fig. 4 is a similar view to Fig. 3 showing the relation of the parts at the extreme opposite end of the stroke.

Fig. 5 is a view similar to Figs. 3 and 4 showing the position of the parts at midstroke.

Fig. 6 is a view similar to Fig. 5 of a modified form of the invention.

The pump shown in Fig. 1 of the drawings is the same type as that shown in a patent of Irven E. Coffey, No. 2,625,114 and reference may be made to this patent for the detailed construction not shown in the present application.

The pump shown in Fig. 1 has a rocker arm casing **1** with a flange **2** having bolt holes (not shown) to secure the pump to the engine of the motor vehicle. Within the rocker casing **1** is an arm **3** which is normally driven from an engine driven cam to reciprocate the stem **9** in the pump. Surrounding the stem **9** is a compression spring **10** for urging the stem **9** downwardly on the discharge stroke. The intake stroke is effected by the action of the rocker arm **3** against the resistance of spring **10**. Stem **9** has a shoulder **11** and a reduced extension **12** extending beyond the shoulder, upon which the backing plates and diaphragm are mounted. Diaphragm **13** is held between an outer or upper backing plate **14** outside the pump chamber and a lower or inner backing plate **15** on the inside of the pump chamber. These plates are mounted on reduced extension **12** by a pair of washers **16** and **17**. The diaphragm **13** includes a central portion clamped between the backing plates **14** and **15**, and outer annular portion of bight form which projects towards the pump chamber, and a peripheral portion which is clamped between the flanges **25** and **26** of the housing. Washer **17** locks with the reversely tapered end of the reduced extension **12**, all as illustrated and described in detail in the application of James L. Edelen, Serial Number 429,343, filed May 12, 1954, for Shaft End Mounting for Sealing and Loop Forming a Pump Diaphragm. Outer backing plate **14** may be provided with an intermediate rib **19** forming a seat for spring **10**.

According to this invention, outer backing plate **14** is larger than inner backing plate **15**, and is provided adjacent its periphery with a downturned lip **20** which terminates in a reversely rolled edge or curved lip **21**. Inner backing plate **15** is substantially flat when secured in position on the stem **9**, and has a similarly turned, complementary lip **22** disposed in parallel relation and radially inwardly of or underlying the overhanging lip **20** of outer backing plate **14**.

As can be seen from Fig. 2, the complementary lips on the backing plates grip and stress the diaphragm **13** to effect a distinct frusto-conical deformation or bight **30** in the diaphragm from a normally flat condition. This distortion is clearly illustrated in Fig. 2. Referring again to Fig. 1, the periphery of the diaphragm **13** is clamped between the circular peripheral flange **25** of the rocker arm casing **1** and the corresponding flange **26** of the

valve chamber casing 27 by a series of cap screws 28. Sufficient slack is provided in the flexing portion or bight 30 of the diaphragm between the backing plates and the casing so as to permit the full stroke of the pump without stretching this part of the diaphragm.

A dome forming cover 31 with an outlet 32 is secured to the valve body 27 in any suitable manner.

Turning now to Figs. 3 to 5, Fig. 3 illustrates the operation of the diaphragm within the pump chamber 35 at the extreme end of the discharge stroke of the pump. The action of the backing plates causes the bight 30 in the diaphragm to be pressed closely against the internal contour of the pump chamber 35. This figure illustrates that clearance between the flexing loop portion or bight 30 of the diaphragm 13 and opposing wall of the pump chamber 35 may be completely eliminated, with the use of this invention, and that the stresses in the diaphragm cause it to conform to the contour of the chamber 35 to provide full volumetric efficiency. This is important since it enables the pump to better handle gases to prevent vapor lock.

Fig. 4 illustrates the pump elements at the extreme end of the suction stroke. In this position, the bight 30 in the diaphragm 13 is in the same relation to the backing plates as in Fig. 3, due to the stresses produced on the diaphragm by the backing plates.

Fig. 5 illustrates the position of the pumping elements at midstroke, and here again the position of the bight 30 in the diaphragm 13 is shown maintained in the same looped relation to the backing plates as in the previous views. It will be noted that the action of the diaphragm with respect to the walls of the pump chamber is a rolling rather than an over center action, as experienced in prior constructions. This increases the life of the diaphragm and permits use of larger backing washers without undue kinking or scraping of the diaphragm during operation.

In Fig. 6 is shown a modification of the invention wherein lip 21 of the outer backing plate has a cylindrical outward extension 21A disposed closely adjacent to the walls of the pumping chamber. This flange will further assist in precluding reversal in the position of the bight 30, should there be any tendency for this effect.

A structure has been shown which will fulfill all the objects of the present invention as defined by the appended claims, but it is contemplated that other embodiments of the same invention will occur to those skilled in the art.

We claim:

1. A fuel pump comprising a casing forming a pumping chamber, said pumping chamber having its end wall portion provided with inlet and outlet openings, a diaphragm forming a pumping element and one wall of said chamber, said diaphragm having its outer peripheral portion secured to the casing, said diaphragm being provided with an inwardly projecting bight at its outer portion, backing plates disposed upon the inner and outer sides of a central portion of the diaphragm, a centrally positioned operating stem connected thereto, spring means on the stem normally urging said diaphragm into said pumping chamber, the peripheral edge of said inner plate being spaced a sufficient distance from the wall of said chamber to provide an annular area between said wall and said plate to permit said bight in said diaphragm to project therebetween in the direction of the pumping chamber, and said outer backing plate having a peripheral portion normally projecting into the concave portion of said bight and engaging the adjacent face of the diaphragm defining the bight for retaining said bight against substantial deflection regardless of pressure in said pumping chamber.

2. A fuel pump comprising a casing forming a pumping chamber, said pumping chamber having its end wall portion provided with inlet and outlet openings, a diaphragm forming a pumping element and one wall of said chamber, said diaphragm having its outer peripheral portion secured to the casing, said diaphragm being provided with an inwardly projecting bight at its outer portion, backing plates disposed upon inner and outer sides of a central portion of the diaphragm, a centrally positioned operating stem connected thereto, spring means on the stem normally urging said diaphragm into said pumping chamber, the peripheral edge of said inner plate being spaced a sufficient distance from the wall of said chamber to provide an annular area between said wall and said plate to permit said bight in said diaphragm to project therebetween in the direction of the pumping chamber, the outer backing plate having a peripheral portion terminating in a reversely curved lip, and said peripheral portion normally projecting into the concave portion of said bight and engaging the adjacent face of the diaphragm defining the bight for retaining said bight against substantial deflection regardless of pressure in said pumping chamber.

3. A fuel pump comprising a casing forming a pumping chamber, said pumping chamber having its end wall portion provided with inlet and outlet openings, a diaphragm forming a pumping element and one wall of said chamber, said diaphragm having its outer peripheral portion secured to the casing, said diaphragm being provided with an inwardly projecting bight at its outer portion, backing plates disposed upon the inner and outer sides of a central portion of the diaphragm, a centrally positioned operating stem connected thereto, spring means on the stem normally urging said diaphragm into said pumping chamber, the peripheral edge of said inner plate being spaced a sufficient distance from the wall of said chamber to provide an annular area between said wall and said plate to permit said bight in said diaphragm to project therebetween in the direction of the pumping chamber, said peripheral portion of the inner backing plate extending along the adjacent inner face of the bight to guide and retain the same against deflection inwardly, and the peripheral portion of the outer backing plate being spaced laterally from the peripheral portion of the inner backing plate and normally projecting into the concave portion of said bight and engaging the adjacent outer concave wall of the diaphragm defining the bight for retaining the bight against outward deflection.

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