United States Patent

O'Connor

[15] **3,703,342**

[45] **Nov. 21, 1972**

[54] **FUEL PUMP BELLOWS CONSTRUCTION**

[72] Inventor: **Alton J. O'Connor,** Cass City, Mich.

[73] Assignee: **Walbro Corporation,** Cass City, Mich.

[22] Filed: **July 30, 1971**

[21] Appl. No.: **167,651**

[52] **U.S. Cl.** **417/326,** 92/93, 222/212, 417/412

[51] **Int. Cl.**.....**F04b 35/00,** F01b 19/00, B65d 37/00

[58] **Field of Search** 92/34, 48, 93, 132; 222/183, 222/215, 386.5, 389, 212, 490, 494; 417/472, 473, 383, 389, 326, 412, 413; 74/18.2; 264/296

[56] **References Cited**

UNITED STATES PATENTS

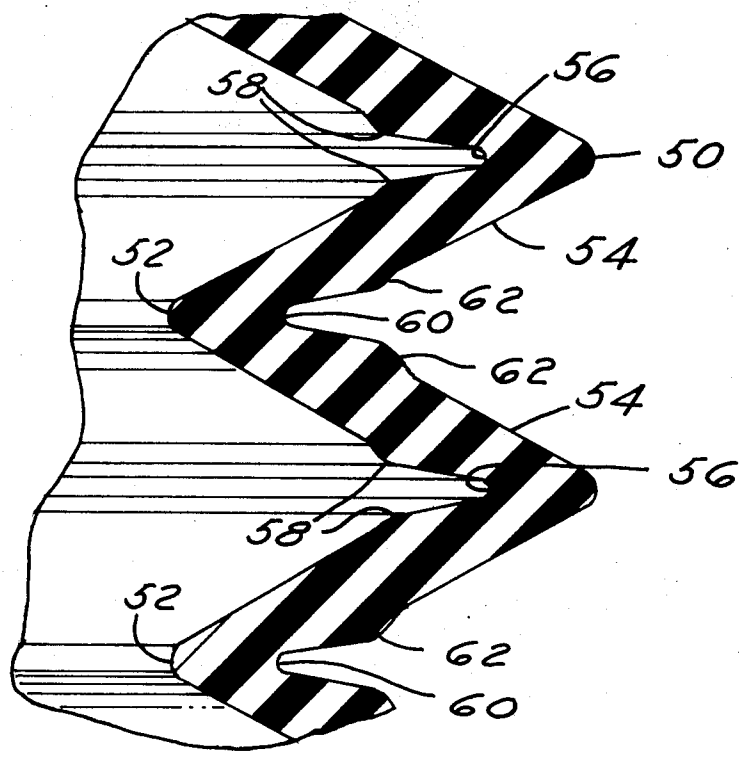
3,130,333	4/1964	Freye	417/412
3,235,135	2/1966	Robert et al.	222/386.5
3,506,163	4/1970	Rauh et al.	264/296
3,201,111	8/1965	Afton	92/93
3,319,532	5/1967	Pridham	92/34

Primary Examiner—William L. Freeh
Assistant Examiner—G. P. La Pointe
Attorney—Barnes, Kisselle, Raisch & Choate

[57] **ABSTRACT**

A one-piece pump bellows of a flexible, resilient material with a corrugated generally cylindrical sidewall having a plurality of interleaved outer and inner bends with interconnecting wall portions. The corrugated wall is not of uniform thickness and the thickness at the bends of the wall is greater than the maximum thickness of the interconnecting wall portions. The thickness of the interconnecting wall portions immediately adjacent the bends is less than the maximum thickness of the interconnecting wall portions. The outer bends have associated pairs of opposed circumferential ribs on the inside surface of the interconnecting walls and the inner bends have associated pairs of opposed circumferential ribs on the outside surface of the interconnecting walls. The pairs of opposed ribs are adapted to abut when the bellows is foreshortened by overstroking which decreases the maximum stress to which the bends are subjected and substantially increases the service life of the bellows.

9 Claims, 4 Drawing Figures

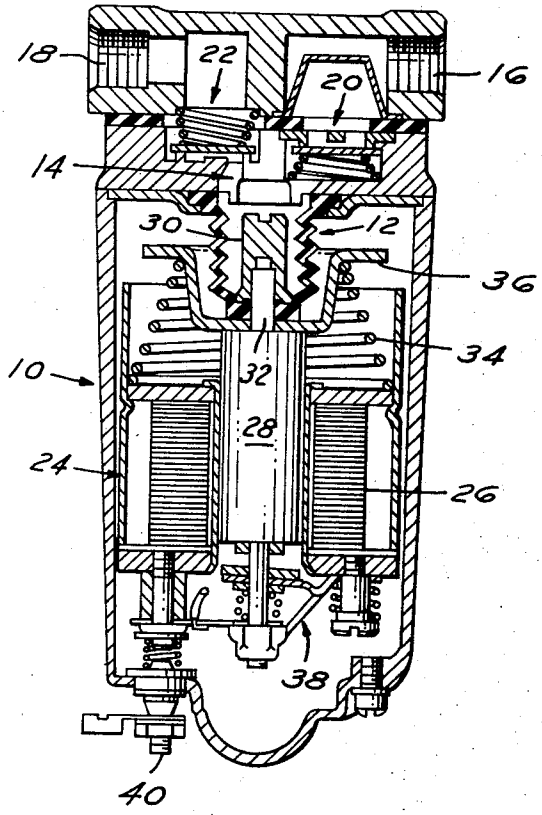


PATENTED NOV 21 1972

3,703,342

SHEET 1 OF 2

FIG. 1



INVENTOR
ALTON J. O'CONNOR
BY
Barnes, Kisselle, Raisch & Choate
ATTORNEYS

FIG. 2

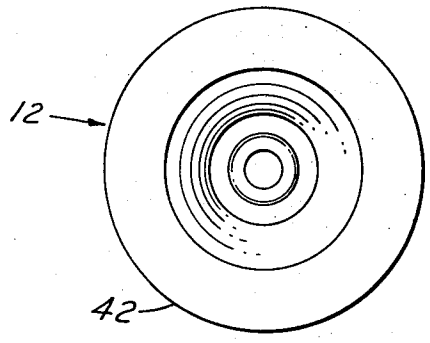


FIG. 3

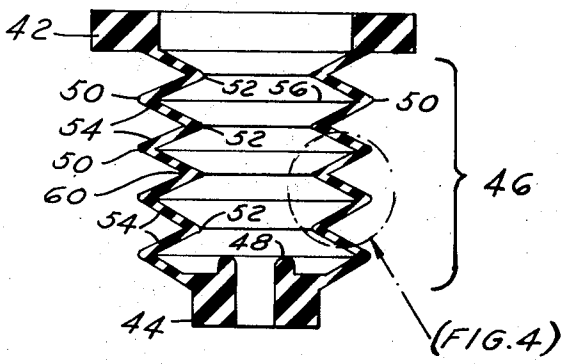
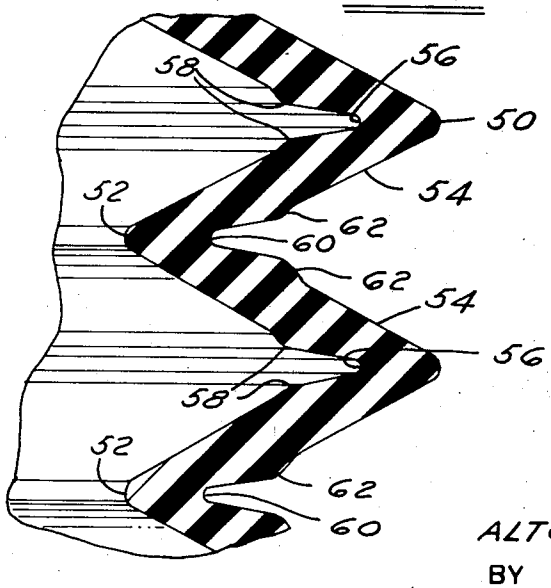


FIG. 4



INVENTOR
ALTON J. O'CONNOR
BY
Barnes, Kisselle, Raisch & Choate
ATTORNEYS

FUEL PUMP BELLOWS CONSTRUCTION

This invention relates to fuel pumps for vehicle engines and the like and more particularly to a bellows therefore.

Objects of this invention are to provide a fuel pump bellows which has a substantially longer service life, requires less actuating force, is operable at lower environmental temperatures, and is more readily moulded than prior art fuel pump bellows.

These and other objects, features, and advantages of this invention will be apparent from the following description, appended claims, and accompanying drawings in which:

FIG. 1 is a sectional view of a fuel pump with a bellows embodying this invention.

FIG. 2 is a plan view of the bellows of FIG. 1.

FIG. 3 is an enlarged sectional view of the bellows of FIG. 1.

FIG. 4 is an enlarged fragmentary sectional view of the encircled portion of the corrugated sidewall of the bellows of FIG. 3.

REFERRING TO THE DRAWINGS

FIG. 1 shows a fuel pump **10** with a bellows **12** embodying this invention, communicating with a pump chamber **14**. Fuel pump **10** has inlet and outlet passageways **16** and **18** communicating with chamber **14** through one-way intake and discharge valve assemblies **20** and **22**. Bellows **12** is actuated by a solenoid assembly **24** with a wound wire energizing coil **26** and cylindrical armature slug **28**. Bellows **12** is connected to armature **28** by a nut **30** threadily engaging one end of a rod **32** extending axially through and fixed to armature **28**. Bellows **12** and armature **28** are yieldably biased in one direction by a coil spring **34** bearing on a cup **36** which is also connected to the armature by nut **30**. The energizing and de-energizing of coil **26** to reciprocate armature **28** and hence bellows **12** is controlled by an assembly of electrical contacts **38** mounted on the lower end of coil **26** with one of the contacts connected to the lower end of shaft **32** for opening and closing the contacts by the reciprocating movement of armature **28**. Electrical energy is supplied to coil **26** through a binding post **40** and electrical contacts **38**. The structure and operation of fuel pump **10** is explained in greater detail in U.S. Pat. No. 3,130,333, issued to J. R. Freye on Apr. 21, 1964, and incorporated herein by reference.

As shown in FIGS. **2** and **3**, bellows **12** has axially spaced concentric upper and lower mounting rings **42** and **44** with a homogeneously integral corrugated cylindrical sidewall **46** therebetween. Lower mounting ring **44** has an annular rib **48** on its inner face adapted for sealing engagement with rod **32** of armature **28**. Corrugated sidewall **46** has a plurality of interleaved outer and inner bends **50** and **52** with interconnecting generally frusto-conical wall portions **54**. The entire bellows **12** is a one-piece homogeneously integral device of a resilient flexible nonmetallic synthetic rubber-like material such as the polyurethane material sold under the trademark Genthane by General Tire and Rubber Company, 1 General Street, Akron, Ohio. As shown in FIG. **4**, the thickness of corrugated sidewall **50** is not uniform and the thickness of the wall at outer and inner bends **50** and **52** is greater than the maximum thickness of interconnecting portions **54** of the corrugated wall. Each outer bend **50** has an associated inwardly opening circumferential groove **56** with a pair of opposed circumferential ribs **58** on the inner surface of the interconnecting wall portions **54** adjacent the bend **50**. Similarly, each inner bend **52** has an associated outwardly opening groove **60** with a pair of opposed circumferential ribs **62** on the outer surface of the wall portions **54** adjacent the bend **52**. The minimum thickness of wall portions **54** immediately adjacent the apex of grooves **56** and **60** is less than the maximum thickness of the wall portions **54**.

In use, bellows **12** is installed in fuel pump **10** which is connected to a source of direct current through terminal post **40** to energize solenoid **24** and reciprocate bellows **12**. The bias of spring **34** of pump **10** foreshortens bellows **12** from its free length and shifts armature **28** generally axially upwardly (as shown in FIG. 1) to close the contacts of switch **38**. Closure of the contacts of switch **38** energizes coil **26** to move armature **28** axially downward against the bias of spring **34** which then extends bellows **12** beyond its free length and opens the contacts of switch assembly **38**. Opening of the contacts de-energizes coil **26** allowing spring **34** to move armature **28** axially upward which foreshortens bellows **12** from its free length and again closes the contacts of switch assembly **38**, to thus repetively reciprocate bellows **12**. This reciprocation of bellows **12** provides the pumping action which moves the fluid from inlet **16** through chamber **14** and discharges the fluid through outlet **18**. The length of the reciprocal motion imparted to bellows **12** and switch assembly **24** is dependent on the pressure of the fluid in chamber **14** and whether it is in liquid or gaseous form. When the fluid in chamber **14** is in gaseous form, solenoid assembly **24** imparts a longer stroke or length of reciprocating motion to bellows **12** than when a liquid is in chamber **14** due to the incompressability of the liquid and the greater energy required to move the liquid through chamber **14**. Normally the fluid in chamber **14** is in the form of liquid fuel, but it can become gaseous due to such abnormal conditions as partial vaporization of the fuel, priming of the pump, or air in the line connected to inlet **16**. These abnormal conditions are usually associated with motor-driven vehicles such as automobiles, trucks, and motorcycles. When this longer stroke or overstroking of bellows **12** occurs, the bellows is foreshortened from its free length sufficiently so that the pairs of ribs **58** and **60** associated with bends **50** and **52** are urged into abutment. The abutment of pairs of ribs **58** and **60** transmits a portion of the compression force acting on bellows **12** directly to interconnecting wall portions **54** which decreases the maximum stress to which bends **50** and **52** would otherwise be subjected. This is believed to result in a substantially longer useful service life of bellows **12** compared to prior art pump bellows. Regardless of the theoretical explanation, it has been found that pump bellows **12** does have a substantially longer life than prior art pump bellows of a similar size.

Such bellows **12** were made of polyurethane with an upper mounting ring outside diameter of 1.125 inches, a lower mounting ring outside diameter of 0.437 inch, and a free length of 1.09 inches. Corrugated wall **46** has a free length of 0.82 inch with the outer bends having an outside diameter of 0.81 inch and the inner bends having an inside diameter of 0.37 inch. Each pair of ad-

jacent interconnecting wall portions forms an included angle of approximately 58° and the grooves associated with the bends have an included angle of approximately 20°. The apex of the grooves has a radius of approximately 0.006 inch and the pairs of ribs begin approximately 0.037 inch from the apex of their grooves and have a radius of approximately 0.032 inch. The thickness of the outer and inner bends of the corrugated wall is approximately 0.056 inch and the minimum thickness of the interconnecting wall portions immediately adjacent the apex of the grooves associated with the bends is 0.030 inch. The maximum thickness of the interconnecting wall portions is approximately 0.045 inch. This bellows is shown in section one and one half times its actual size in FIG. 2 except for the thickness and detailed shape of the corrugated wall which is shown in section seven and one half times its actual size in FIG. 4.

The configuration of corrugated side wall **46** with a greater thickness at bends **50** and **52** than the maximum thickness of interconnecting portions **54** and with a lesser wall thickness immediately adjacent the bends than the maximum thickness of the interconnecting wall portions provides a bellows which requires substantially less force to foreshorten and extend than prior art pump bellows. This configuration reduces the actuating force while still preventing the bellows from ballooning or substantially expanding radially when foreshortened to pressurize liquid therein. This substantial reduction in the amount of the force required to actuate bellows **12** increases the efficiency of pump **10** and the service life of bellows **12**. This configuration of the corrugated sidewall of bellows **12** also allows the bellows to function satisfactorily in an environment having a substantially lower atmospheric temperature without impairing the service life of the bellows. Compared to prior art pump bellows, this sidewall configuration provides thicker wall portions particularly at the bends **50** and **52** and the maximum thickness of interconnecting wall portions **54**, while still requiring less actuating force, which facilitates moulding the bellows without voids, thin spots, and other defects in the corrugated wall which decreases the cost of manufacture of the bellows.

I claim:

1. A one-piece homogeneously integral bellows of a resilient nonmetallic rubber-like synthetic material for use in a pump having a flexible corrugated generally circular wall with a plurality of interleaved radially and axially spaced outer and inner circumferential bends with interconnecting wall portions, said bends having a greater thickness in cross section than the maximum thickness in cross section of said interconnecting wall portions with said interconnecting wall portions having a lesser thickness in cross section immediately adjacent said bends than said maximum thickness in cross section of said interconnecting wall portions.

2. The one-piece bellows of claim **1** in which said inner bends have an associated pair of circumferential ribs in opposed relation on the outer surface of the interconnecting wall portions.

3. The one-piece bellows of claim **1** in which said outer bends have an associated pair of circumferential ribs in opposed relation on the inner surface of the interconnecting wall portions.

4. The one-piece bellows of claim **3** in which said inner bends have an associated pair of circumferential ribs in opposed relation on the outer surface of the interconnecting wall portions.

5. The one-piece bellows of claim **4** in which said pairs of ribs are adapted to abut when said bellows is foreshortened by overstroking of said bellows by the fuel pump.

6. In a fuel pump of the type having a pumping chamber with an inlet and an outlet, a solenoid actuator with a stroke of variable length for reciprocating one end of a bellows, and a switch means for effecting reciprocation of one end of the bellows by the solenoid actuator, a one-piece bellows fixed at one end, coupled to said pumping chamber, and operably connected at the other end to said solenoid actuator for reciprocation comprising a one-piece homogeneously integral corrugated wall of a flexible resilient nonmetallic rubber-like synthetic material with a plurality of interleaved radially and axially spaced outer and inner circumferential bends with interconnecting wall portions, said bends having a greater thickness in cross section than the maximum thickness in cross section of said interconnecting wall portions with said interconnecting wall portions having a lesser thickness in cross section immediately adjacent said bends than said maximum thickness in cross section of said interconnecting wall portions.

7. The one-piece bellows of claim **6** in which said outer bends have an associated pair of circumferential ribs in opposed relation on the inner surface of the interconnecting wall portions.

8. The one-piece bellows of claim **7** in which said inner bends have an associated pair of circumferential ribs in opposed relation on the outer surface of the interconnecting wall portions.

9. The one-piece bellows of claim **8** in which said pairs of ribs are adapted to abut when said bellows is foreshortened by overstroking of said bellows by the fuel pump.

* * * * *