

Feb. 20, 1962

E. A. JOHNSON ET AL

3,021,792

FUEL PUMP DIAPHRAGM MOUNTING

Original Filed March 31, 1958

6 Sheets-Sheet 1

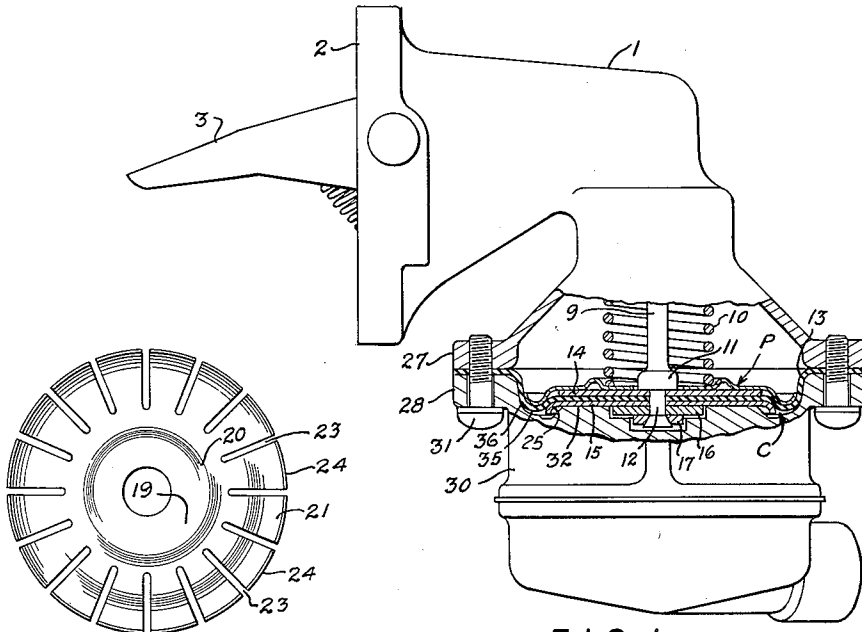


FIG. 3.

FIG. 1.

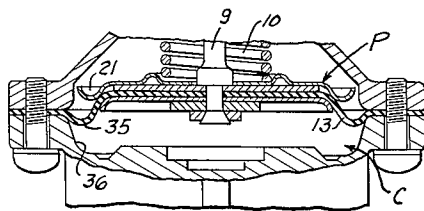


FIG. 4.

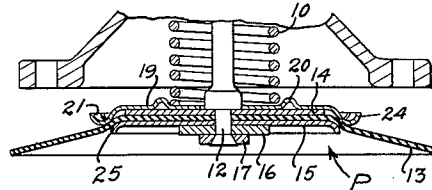


FIG. 2.

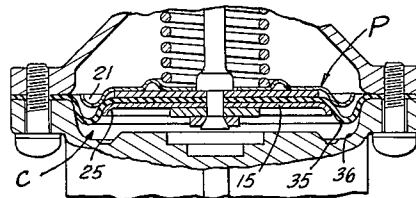


FIG. 5.

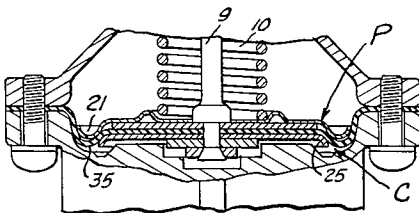


FIG. 6.

INVENTORS
ELDON A. JOHNSON
BY JACK M. WHITE

Bertram H. Mann

ATTORNEY

Feb. 20, 1962

E. A. JOHNSON ET AL

3,021,792

FUEL PUMP DIAPHRAGM MOUNTING

Original Filed March 31, 1958

6 Sheets-Sheet 2

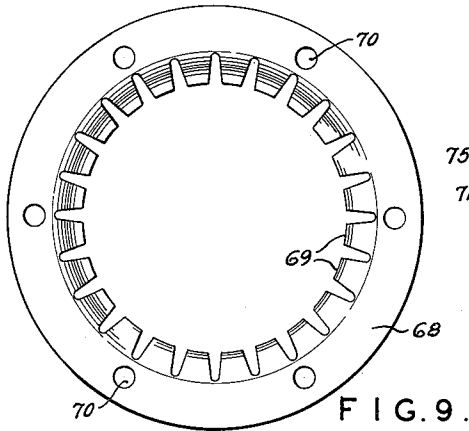


FIG. 9.

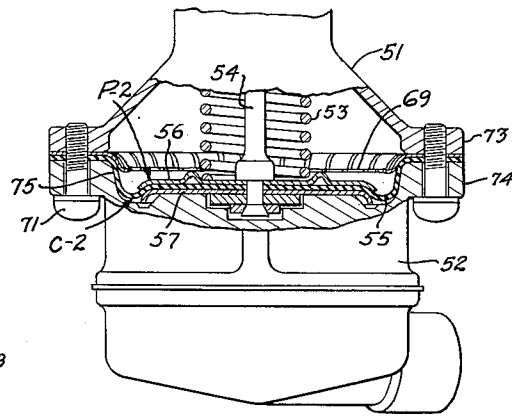


FIG. 7.

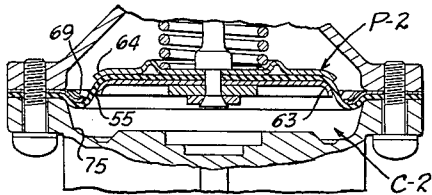


FIG. 10.

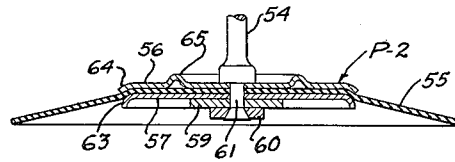


FIG. 8.

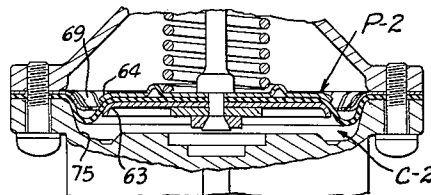


FIG. 11.

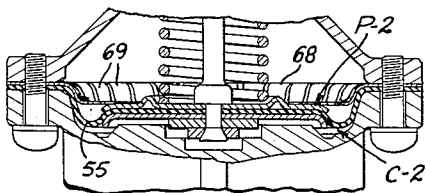


FIG. 12.

INVENTORS
ELDON A. JOHNSON
BY JACK M. WHITE
Bertram H. Mann
ATTORNEY

Feb. 20, 1962

E. A. JOHNSON ET AL

3,021,792

FUEL PUMP DIAPHRAGM MOUNTING

Original Filed March 31, 1958

6 Sheets-Sheet 3

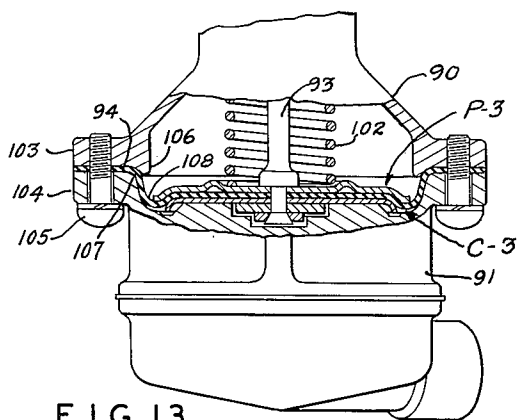


FIG. 13.

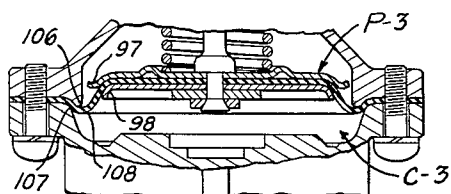


FIG. 15.

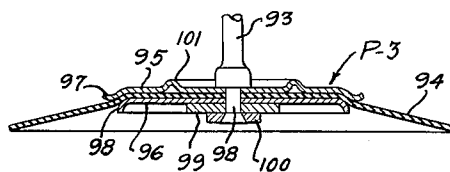


FIG. 14.

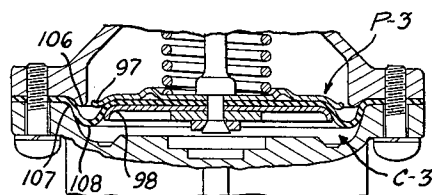


FIG. 16.

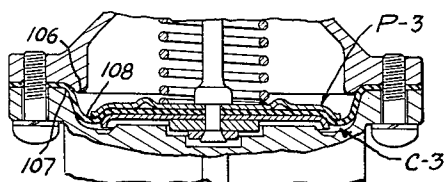


FIG. 17.

INVENTORS
ELDON A. JOHNSON
JACK M. WHITE

BY *Bertram H. Mann*

ATTORNEY

Feb. 20, 1962

E. A. JOHNSON ET AL

3,021,792

FUEL PUMP DIAPHRAGM MOUNTING

Original Filed March 31, 1958

6 Sheets-Sheet 4

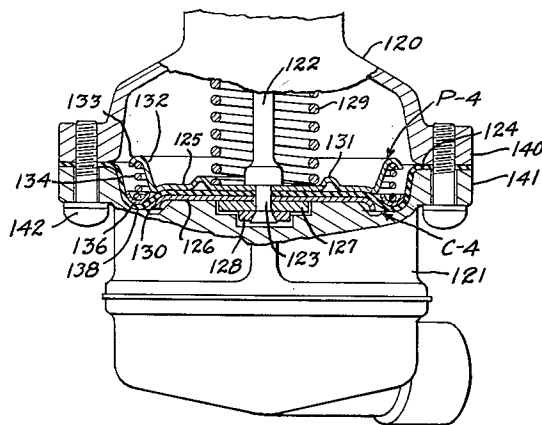


FIG. 18.

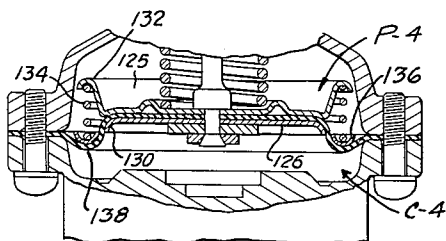


FIG. 19.

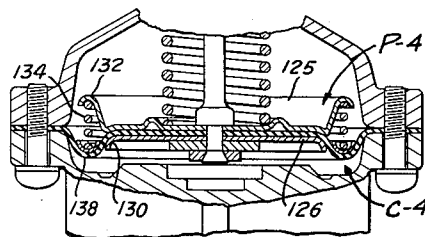


FIG. 20.

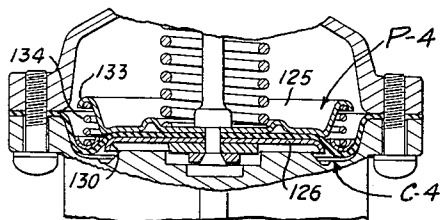


FIG. 21.

INVENTORS
ELDON A. JOHNSON
JACK M. WHITE

BY

Bertram H. Mann

ATTORNEY

Feb. 20, 1962

E. A. JOHNSON ETAL

3,021,792

FUEL PUMP DIAPHRAGM MOUNTING

Original Filed March 31, 1958

6 Sheets-Sheet 5

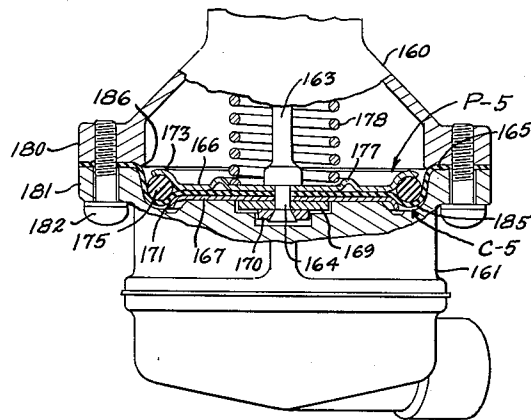


FIG. 22.

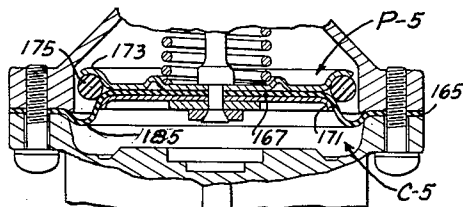


FIG. 24.

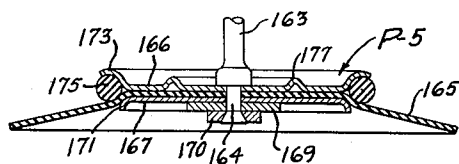


FIG. 23.

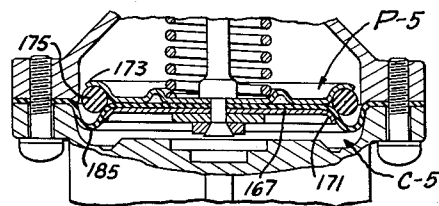


FIG. 25.

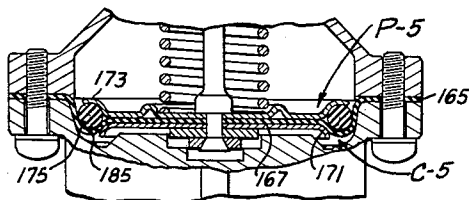


FIG. 26.

INVENTORS
ELDON A. JOHNSON
BY JACK M. WHITE
Bertram H. Mann
ATTORNEY

Feb. 20, 1962

E. A. JOHNSON ET AL

3,021,792

FUEL PUMP DIAPHRAGM MOUNTING

Original Filed March 31, 1958

6 Sheets-Sheet 6

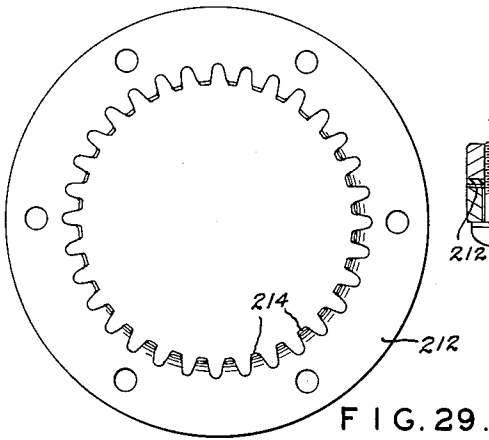


FIG. 29.

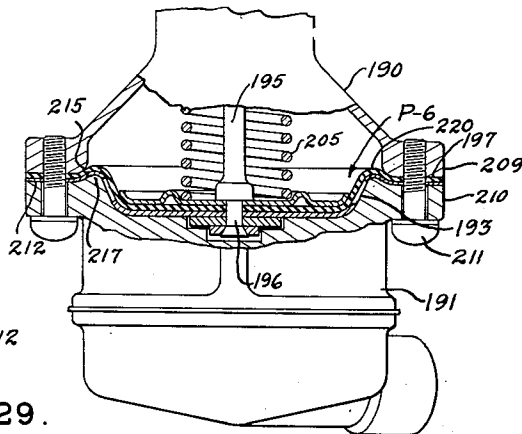


FIG. 27.

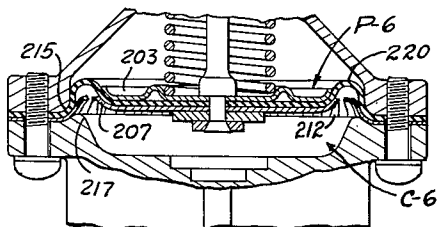


FIG. 30.

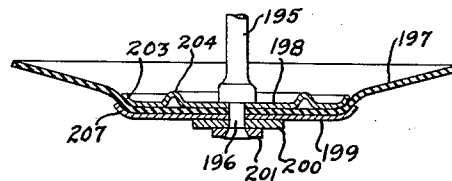


FIG. 28.

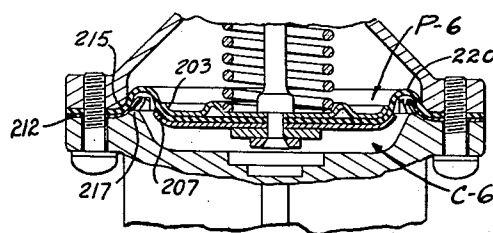


FIG. 31.

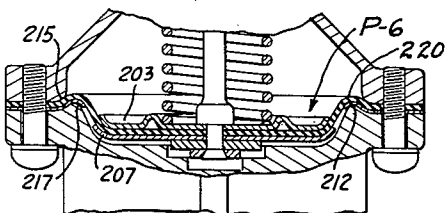


FIG. 32.

INVENTORS
ELDON A. JOHNSON
JACK M. WHITE
BY

Bertram H. Mann

ATTORNEY

1

3,021,792

FUEL PUMP DIAPHRAGM MOUNTING

Eldon A. Johnson, St. Louis, and Jack M. White, Florissant, Mo., assignors to ACF Industries, Incorporated, New York, N.Y., a corporation of New Jersey
Continuation of application Ser. No. 725,193, Mar. 31, 1958. This application Oct. 30, 1959, Ser. No. 849,984
15 Claims. (Cl. 103—150)

This application is a continuation of our copending application S.N. 725,193, filed March 31, 1958, now abandoned.

This invention relates to a fuel pump for an internal combustion engine of the type having a pump diaphragm reciprocated by a drive from the engine to produce the pumping action, and more specifically to a means for increasing the volumetric efficiency of this type of pump.

In present fuel pump design, a circular disk of flexible diaphragm material is clamped at its periphery between the circular flanges of a pump casing, which is generally formed in two parts and termed here a rocker arm casing and a valve casing. The central portion of the diaphragm is held between a pair of backing plates which are secured in clamping engagement with the central portion of the diaphragm. Reciprocating motion is imparted to a stem on the backing plates through a suitable mechanism so as to flex the diaphragm within the casing to produce the pumping action.

The backing plates are necessarily somewhat smaller in diameter than the internal dimensions of the pumping chamber formed between the diaphragm and the valve casing, and the flexing of the diaphragm occurs in that portion which is free and extends between the outside of the backing plates and the wall of the pump casing. It is usual to provide sufficient slack in the free flexing portion of the diaphragm outside of the backing plates and within the casing to accommodate the reciprocating action of the backing plates during their movement from one extreme end of the stroke to the other, for, although the diaphragm is of flexible material, it cannot be repeatedly stretched, or, for that matter, folded sharply upon itself, without eventually producing fracture in the diaphragm. For this reason, the pumps are always assembled with some amount of slack in the free portion of the diaphragm between the backing plates and the casing when the backing plates are in the midstroke position. This slack forms a circumferentially extending loop or bight.

On the suction stroke of the pump, this bight or loop will form on one side of the backing plates toward the pumping chamber, but on the exhaust stroke the bight or loop will be reversed to the opposite side of the backing plates away from the pumping chamber. The movement of the bight or loop, as it reverses, is in the opposite direction from the direction of movement of the backing plates. This tends to reduce the displacement of the pump by an amount corresponding to the space within the bight or loop adversely affecting the volumetric efficiency of the pump.

With highly volatile fuels, it is desirable to reduce the clearance in the pumping chamber at the end of the exhaust stroke to the minimum practical; or, in other words, poor volumetric efficiency in the pump contributes to the occurrence of vapor lock.

It is an object of this invention, therefore, to design a diaphragm type of reciprocating pump with the maximum possible volumetric efficiency.

It is another object of this invention to produce a pump in which the clearance between the pump assembly and the pumping chamber is reduced to the absolute minimum

2

when the parts reach the position at the end of the exhaust pumping stroke.

To obtain these objects, the internal contour of the pumping chamber is constructed in a shape complementary to the contour of the pump assembly, which includes the backing plate and the diaphragm, so as to reduce the pump working clearance to a minimum.

In addition, the outside diameter of the backing plates is preferably chosen so that only a working clearance will exist with the inside of the pump chamber. Preferably this clearance is such as to prevent loop reversal, and is insufficient to accommodate the passage of the bight from one side of the backing plates to the other during the pumping strokes, although this is not necessary in some forms of the invention described hereinafter.

Preferably the bight formed in the diaphragm is retained on one side or the other of the backing plate by a support which may be fixed or movably mounted on the casing or backing plates and engages the concave side of the loop, for example, to maintain the bight in a predetermined relation to the backing plates.

Also, in the preferred constructions the contour of the pumping chamber circumferentially thereof is so designed that during the pumping stroke the bight will move toward contact with the pumping chamber in a progressively radially inward manner so as to displace the fuel toward the center of the pumping chamber and the exhaust valve in the pump.

In some of the forms hereinafter described, the backing plates have only a minimum working clearance with the internal walls of the pumping chamber of the pump valve casing in order to reduce the area of the flexing part of the diaphragm to the minimum. It will be recognized that the larger this area becomes, the greater is the resultant hydraulic pressure exerted or imposed thereon. In other forms of the invention hereinafter described, the size of the backing plates with respect to the walls of the casing is relatively unimportant because of the type of support provided for the bight in the diaphragm.

According to this invention, a reciprocating pump of the diaphragm type has a casing with an internal end wall portion. Inlet and outlet openings are preferably located in this wall. The reciprocating pumping element, including the diaphragm, forms the opposite wall of the pumping chamber. The diaphragm has its outer peripheral portion secured between the valve casing, which includes the pumping chamber and the rocker arm casing of the fuel pump. The pumping element has backing plates on opposite sides of the diaphragm clamped thereto and disposed within and without the pumping chamber. A stem attached centrally of the backing plates is positively operated in one direction during the intake stroke. A spring surrounding the stem powers the opposite or discharge stroke. The backing plate within the pumping chamber is spaced a sufficient distance from the wall of the chamber to provide an annular clearance between the wall and the plate to accommodate the slack of the diaphragm, and a fixed or movable support engages the slack to form the bight in the diaphragm and maintain the bight displaced in one direction with respect to the backing plates. Thus the contour of the opposite walls of the pumping chamber formed by the pump casing, and the direction in which the bight of the diaphragm is maintained, contribute to the attainment of a minimum working clearance between the pumping element and the wall of the pumping chamber, especially at the end of the exhaust stroke of the pump, to achieve the maximum volumetric efficiency.

The accompanying drawings illustrate several forms 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 side elevation, partly in section, illustrating the relationship between some of the parts during assembly of the pump of FIG. 1.

FIG. 3 is a plan view of a spring fingered flexible backing disk used in the modification of the pump of FIG. 1.

FIGS. 4, 5 and 6 are operational views, partly in section, illustrating the relative positions between the movable parts and fixed parts of the pump of FIG. 1 during the working stroke.

FIG. 7 is a fragmentary side elevation of a pump, partly in section, illustrating another form of the invention.

FIG. 8 is a detail view, in section, illustrating the pumping element of the pump shown in FIG. 7.

FIG. 9 is a plan view of the spring fingered backing support for the diaphragm in the pump shown in FIG. 7.

FIGS. 10, 11 and 12 are operational views of the pump shown in FIG. 7, partly in section, illustrating the action of the parts and their relative positions during the pumping stroke.

FIG. 13 is a fragmentary side elevational view, in section, of a pump assembly according to still another form of the invention.

FIG. 14 is a sectional view of the pumping element used in the pump illustrated in FIG. 13.

FIGS. 15, 16 and 17 are operational views, partly in section, illustrating the action of the pumping element and the position between the movable parts in the pump of FIG. 13.

FIG. 18 is a fragmentary side elevation, partly in section, illustrating an assembled pump according to another form of this invention.

FIGS. 19, 20 and 21 are operational views, partly in section, illustrating the position of the movable parts during the pumping stroke in pump of FIG. 18.

FIG. 22 is a fragmentary side elevational view, with parts in section, illustrating a pump assembly according to another form of the invention.

FIG. 23 is a detail view, in section, illustrating the pumping element used in the pump of FIG. 22.

FIGS. 24, 25 and 26 are operational views illustrating in front elevation and section the action of the movable parts within the pump of FIG. 22 during the pumping stroke.

FIG. 27 is a fragmentary side elevational view, with parts in section, illustrating a pump assembly according to another form of the invention.

FIG. 28 is a detail view in section, illustrating the pumping element used in the pump of FIG. 27.

FIG. 29 is a top plan view of the spring fingered ring element used in the pump of FIG. 27.

FIGS. 30 through 32, inclusive, are operational views illustrating in fragmentary front elevation and section the action of the movable parts within the pump shown in FIG. 27.

This application discloses several forms of an invention related to that shown and described in our co-pending application Serial No. 456,360 filed September 16, 1954, for "Fuel Pump Diaphragm Assembly," now Patent 2,840,003 of June 24, 1958.

The fuel pump shown and described hereinafter is of the same type, and of similar construction, to that shown in detail by FIG. 1 of the patent to Coffey 2,803,265 of August 20, 1957. Insofar as the mechanism for reciprocating the diaphragm is concerned, the structures are identical, and this description will be confined to the structure arrangement and operation of those parts of the pump which constitute the improvement according to this invention. Reference may be made to this Coffey patent for details of construction not shown or described 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) for securing the fuel pump to the appropriate part of the engine designed to accommodate it. Within the rocker casing 1 is an arm 3 which is normally driven by contact with an engine driven push rod or an engine driven cam or eccentric. When secured to the engine by suitable bolts through the flange 2, the arm 3 will be maintained in the contact with the engine driven device for producing oscillation of the arm 3, which in turn reciprocates the stem 9. Surrounding the stem 9 is a compression spring 10 which urges the stem 9 in a direction to exhaust the fluid from the pumping chamber hereinafter described. The intake stroke is affected by action of the engine driven device on the arm 3 which compresses the spring 10. Stem 9 has a shoulder 11 and a reduced extension 12 forming a continuation of the stem 9.

The diaphragm 13 is part of pumping element P and is held between a backing plate 14 located outside the pumping chamber C, and a backing plate 15 within the pumping chamber. The plates and diaphragm are mounted on the reduced extension 12 by a pair of washers 16 and 17. Washer 17 locks with the reversely tapered end shown on the extension 12, all as illustrated and described in detail in an application of James L. Edelen, Serial No. 429,343 filed May 12, 1954, now Patent No. 2,904,876, for "Shaft and Mounting for Sealing and Loop Forming a Pump Diaphragm."

According to this invention, the pumping element P which comprises the diaphragm 13, backing plates 14 and 15, and stem 9, is provided with an auxiliary plate 19 between the compression spring 10 and backing plate 14. As shown in FIGS. 2 and 3, the auxiliary plate 19 has an annular corrugation 20 forming a seat for confining the end of compression spring 10. At the periphery of plate 19 is a reversely turned edge 21 which surrounds both backing plates 14 and 15 and forms an annular shaped supporting means for the diaphragm. Auxiliary plate 19 is preferably constructed with radially extending slots 23 to form individual spring fingers 24. The backing plate 15 is preferably formed with a rounded edge 25 at its periphery.

When the pump shown in FIG. 1 is assembled, backing plates 14 and 15 securely clamp the central portion of the diaphragm 13 to the operating stem 9. The auxiliary plate 19, shown in FIG. 2, is held in position by the spring 10 seated therein. The stem is inserted within the rocker casing 21 and connected in a suitable manner with the rocker arm 3, so that the spring 10 is compressed between its seat in the rocker arm casing (not shown) and the auxiliary plate 19 on the pumping element P, as shown in FIG. 2. The pressure of the spring 10 resiliently urges the auxiliary plate 19 toward the backing plate 14 so that spring fingers 24 forming the annular lip 21 clamp the diaphragm 13 between the inner side of this annular lip 21 and the outside of the rounded edge 25 on the backing plate 15 to form an annular support. The pressure exerted between the fingers 24 on the annular lip 21 and the rounded edge 25 on the backing plate 15 cause the diaphragm 13 to assume a shape which is generally frusto-conical, as illustrated in FIG. 2. The peripheral edge of the diaphragm 13 as shown in FIG. 2 is secured between flange 27 on the rocker arm casing 1 and flange 28 on the valve casing of the pump 30. Flanges 27 and 28 are clamped together by securing screws 31. Suitable holes are spaced about the periphery of the diaphragm 13 to accommodate the securing screws.

FIG. 1 illustrates the fully assembled pump substantially as it would appear before mounting on the engine. Since there is no resistance against the arm 3, spring 10 expands until the backing plate 15 contacts with the wall of the pumping chamber 32 in the valve casing 30. The annular lip 21 formed at the ends of the fingers 24 on the auxiliary plate 19 urges the diaphragm 13 in a direction forcing the loop or bight portion 35 thereof

5

into contact with the annular surface 36 of the pump chamber C formed in the valve casing 30. The diameter of the auxiliary plate 19 is such that it clears the inside of the pumping chamber C by approximately the thickness of the diaphragm 13, and the fingers 24 forming lip 21 are contoured to contact the inner surface of the bight of the diaphragm 13 causing it to conform as nearly as possible with the annular surface 36 of the pumping chamber C.

This construction is such that, as illustrated in FIG. 1, there is substantially no clearance remaining between the pumping element P and the contour of the chamber C in the position shown in FIG. 1. In other words, the amount of clearance remaining between the pumping element P and the contour of the pumping chamber C is only such as is required by manufacturing tolerances. The bight projects between the plates and the inside casing wall.

OPERATION

FIGS. 4, 5 and 6 illustrate the pumping action of the parts. As will be seen from these figures, the pumping element P forms one wall of the pumping chamber C which contains suitable inlet and outlet valve controlled ports and external inlet and outlet connections thereto in the manner shown in the above cited Patent 2,803,265 to Coffey. In FIG. 4 the pumping element P is shown at the end of the intake stroke, wherein the engine driven device has moved the rocker arm 3 to withdraw the pumping element P and fill the chamber C with fuel through the suitable intake valve.

Of course, during the intake stroke there is usually little tendency for the bight in the diaphragm 13 to reverse. As the pumping element P moves into the chamber C, however, there is a tendency for the pressure in chamber C to increase and reverse the position of the bight with respect to the plates, but the clamping fingers 24 are always in contact with a portion of the concave surface of the bight in the diaphragm 13, holding it against rounded lip 25 of plate 15 and thus supporting it against reversal during the exhaust stroke of the pump. This is quite clearly shown in FIG. 5, wherein the parts are shown in a midstroke relationship.

FIG. 6 shows the position of the parts near the end, or at the end, of the discharge stroke of the pump. The end of the stroke is determined primarily by the action of the engine driven device on the rocker arm 3. Depending upon the action of this engine driven device, the parts may appear as in FIG. 6, where there is some notable clearance between the wall of the pumping chamber C and the pumping element P, or, as in FIG. 1, where there is no clearance at all remaining between the element and the chamber wall. In the former position as shown in FIG. 6, it will be apparent that the surface of the fingers forming lip 21 conforms to the bight inner surface and presses the diaphragm 13 against some portion of the outer annular surface 36 of the wall of the pumping chamber C. The tightly clamped relation between the rounded outer lip 25 and the inner surface of the fingers 24 is maintained by the spring 10.

If the parts go into the position shown in FIG. 1, the lip 21 engages the full inner surface of the bight of the diaphragm, holding it definitely in contact with the annular surface 36 of the pumping chamber C, and the flexible curved shape of the fingers 24 forming lip 21 determines the curved shape of the diaphragm bight portion, which in turn corresponds to the curved shape of the annular surface 36 of the pumping chamber C.

First modification

A modified form of the invention is shown in FIGS. 7 through 12, inclusive.

The pump shown in FIG. 7 has a rocker arm casing 51 and a valve casing 52 containing a pumping chamber C-2 and a pumping element P-2, both constructed as heretofore set forth. In order to condense the disclosure,

6

a detailed description of other pump elements has been omitted.

The valve casing 52 contains the usual valve controlled inlet and outlet ports, together with a supply and discharge connection connected therewith, all disclosed by the above cited Coffey patent. The discharge stroke of the pump is powered by the usual coil spring indicated as 53, which surrounds a stem 54 operated as heretofore described to reciprocate the pumping element P-2.

In this modification, the diaphragm 55 as shown in FIGS. 7 and 8 is secured between two backing plates 56 and 57 retained on the stem 54 by a pair of washers 59 and 60, the latter of which is wedgingly engaged with the tapered portion on the reduced end 61 of the stem 54, all in the manner heretofore described by the above cited Edelen patent.

Backing plate 57, which is disposed on the pumping chamber side, has a rounded outer lip 63 against which the diaphragm 55 is pressed by a curved lip 64 on the backing plate 56. An annular bead 65 forms a seat for the spring 53. As in the prior modification, the clamping action exerted on the diaphragm 55 by the curved annular peripheral lips on the backing plates 56 and 57 between which the diaphragm is squeezed causes a distortion in the diaphragm from a flat condition into the more or less frusto-conical shape shown in FIG. 8, so that when the diaphragm is assembled in the pump, the lips 63 and 64 are an annular-shaped supporting means for the bight formed in the diaphragm to hold it in a direction toward the pumping chamber C-2, the lip 64 engaging the concave surface of the bight for this purpose, all as shown in FIG. 7.

FIG. 9 illustrates an annular supporting ring 68 with inwardly projecting, reversely curved spring fingers forming a lip 69. Ring 68 is suitably apertured at 70 for the retaining screws 71 which secure the casings together.

In assembly, ring 68 and the periphery of diaphragm 55 are clamped between the flanges 73 and 74 of the rocker arm casing and valve casing, respectively. Preferably, in assembly the ring 68 is positioned on the side of the diaphragm away from the pumping chamber C-2, so that when the screws 71 are tightened, spring fingers forming lip 69 compress the diaphragm against the rounded lip 75 at the periphery of the pumping chamber C-2. Lips 69 and 75 form an annular supporting means for the diaphragm. The spring ring 68 and the lip 69 produce an effect similar to the cooperating lips 63 and 64 on the backing plates. Not only do the fingers 69 compress the diaphragm 55 against the surface 75, but also engage the concave surface of the annular bight in the flexing part of the diaphragm between the backing plates and the casing flanges during part of the pump stroke.

Operation

FIGS. 10, 11 and 12 illustrate the action of the pumping element during the exhaust stroke of the pump under the influence of spring pressure. At the end of the suction stroke and the beginning of the exhaust stroke, the parts will be in the position indicated in FIG. 10 with the bight in the diaphragm 55 held in the direction of the pumping chamber C-2 by both the action of the lips 63 and 64 and spring pressure of the lip 69 of the ring 68. The diaphragm 55 bends the lip 69 away from chamber C-2 and lip 75 thereof. The diameter of the backing plates is such as to have a sufficient working clearance with the internal periphery of the lip 69 about equal to the thickness of the diaphragm.

During the exhaust stroke of the pump, the parts assume a position such as illustrated in FIG. 11, in which, regardless of positive pressure within the pumping chamber C-2, the rounded lips 63 and 64 cooperating with the action produced by the rounded lips 69 and 75 direct and form an annular support for the loop or bight in the diaphragm into the pumping chamber and prevent any possible reversal.

FIG. 12 illustrates the position of the parts near the end of the exhaust stroke. The clearance illustrated between the pumping element P-2 and the wall of the chamber C-2 will depend upon the action of the engine driven device on the rocker arm. In other words, the stroke will be limited by contact between the rocker arm and the engine driven device whether that is an eccentric or a push rod. Preferably, there will be substantially no clearance between the parts such as illustrated in FIG. 7, and what clearance exists is due to manufacturing tolerance. During the movement of the pumping element from one extreme to the other, as illustrated in FIGS. 10 to 12, diaphragm 55 moves into engagement progressively with the periphery of the pumping chamber C-2, and this movement is progressive from the outer periphery of the chamber inwardly. This action is aided by the unflexing of the fingers 69.

Although the relation between the diameter of the backing plates and the casing wall or internal diameter of ring 68 is not critical, it is desirable to minimize the working clearance so that the total hydraulic force on the flexible part of the diaphragm forming the bight is insufficient to collapse the diaphragm at this point and form a sharp fold. This, of course, is true of all of the embodiments except that illustrated in FIGS. 27, etc.

Second modification

The construction shown in FIGS. 13 through 17, inclusive, illustrates a modification of the invention which is in some respects substantially identical with that shown in FIGS. 7 through 12, inclusive, and which operates in the same or a similar manner.

According to these figures, this modification comprises a rocker arm casing 90 and a valve casing 91, which are identical in most respects with those heretofore described in the above cited Coffey patent. The valve casing contains the usual valve controlled inlet and outlets, together with connections for the supply and discharge lines. This structure has not been shown because it forms no part of the present invention.

The casing 91 has a cavity therein forming one side of a pumping chamber C-3, the other of which is formed by the reciprocating pumping element P-3. As shown in FIGS. 13 and 14, the pumping element P-3 comprises a stem 93 mounting a diaphragm 94 between two backing plates 95 and 96 which are retained on the reduced end portion 98 of the stem 93 by a pair of washers 99 and 100. The washer 100 is wedgingly engaged with the tapered part of the reduced portion 98 of the stem 93 so as to firmly clamp the diaphragm 94 between the backing plates. Backing plate 95 has an annular rib 101 formed therein which in turn acts as a seat for the spring 102 which furnishes the power on the discharge stroke of the pump. Backing plates 95 and 96, in turn, have curved lips 97 and 98, respectively, which form an annular supporting means to grip and compress the diaphragm 94 into a substantially frusto-conical shape as illustrated in FIG. 14.

With reference to FIG. 13, the diaphragm 94 is secured between the flanges 103 and 104, respectively, which flanges are secured by screws 105. The rocker arm casing 90 has an internal curved lip on an annular supporting rib 106 extending at the inner edge of flange 103. The lip on rib 106 cooperates with a curved edge 107 on the internal circumference of the flange 104. The diaphragm 94 is tightly compressed between the lip on rib 106 and the curved edge 107, and the rib 106 extends far enough so as to engage a substantial portion of the concave surface of the bight 108 formed in the diaphragm 94.

It will be readily recognized that the rib 106 performs substantially the same function as the spring fingers 69 in the previous modification, gripping the diaphragm and directing the bight 108 therein into the pumping chamber C-3. The clearance between the pumping element P-3 and the wall of the chamber C-3 at the end of the pump-

ing stroke is only such as required by manufacturing tolerances.

Operation

The operation of this embodiment is illustrated in FIGS. 15 through 17, inclusive.

At the beginning of the exhaust stroke and end of the suction stroke, the bight 108 in the diaphragm 94 is held directed toward the pumping chamber C-3 by the lip on rib 106 and the lips 97 and 98 on the backing plates. The diameter between the internal surface of the rib 106 and the backing plate 97 is only such as required by manufacturing working tolerance.

As the exhaust stroke of the pump continues, the diaphragm 94 progressively contacts the curved surface 107 of pumping chamber C-3, thereby decreasing the flexible area of the diaphragm exposed to pump pressure. At the end of the stroke, as shown in FIG. 17, some clearance may exist between the pumping element P-3 and the wall of the pump chamber C-3. This clearance, of course, depends upon the amount of stroke permitted by the engine driven device. At the present time it seems preferable that there be no clearance at the end of the exhaust stroke. However, this may be unattainable practically.

Third modification

This modification is similar in operation, at least, to the first modification described, and FIGS. 18 through 21, inclusive, illustrate the construction and operation thereof. According to these figures, the pump has a rocker casing 120 and a valve casing 121. The valve casing has the usual valve controlled inlet and outlet ports and suitable supply and discharge connections communicating therewith, as in the above cited Coffey patent, but not shown in this figure because they form no part of the present invention.

The valve casing 121 has a cavity therein with walls forming one side of a pumping chamber C-4, the other wall of which is a movable pumping element P-4. The pumping element P-4 comprises a stem 122 with a reduced end portion 123 upon which is secured a diaphragm 124 between a pair of backing plates 125 and 126. The backing plates are held in place against the shoulder on the stem 122 by a pair of washers 127 and 128, the latter of which wedgingly engages with a tapered surface on the end of the reduced portion 123, all as described in the aforesaid Edelen patent.

Backing plate 125 has an annular rib 131 formed therein which acts as a seat for spring 129, which, in turn, powers the exhaust stroke of the pump. Backing plate 126 on the chamber side of the diaphragm 124 has a rounded lip 130 at its outer periphery. Backing plate 125 on the opposite side has a flange 132 formed thereon which carries an integral turned lip 133 forming an annular concave seat for a coil spring 134. The opposite end of this coil spring 134 forms a part of and resiliently urges an annular-shaped supporting means including ring 136 which in turn forms the annular bight 138 in the diaphragm 124 and holds the diaphragm against rounded lip 130.

The outer periphery of the diaphragm 124 is clamped between the flanges 140 and 141 on the rocker arm casing 120 and the valve casing 121, respectively. Screws 142 clamp the edge of the diaphragm between the flanges.

Operation

In this modification, the spring 134 is always under compression, although the amount of compression may vary depending upon the variation in slack in the bight portion of the diaphragm during the stroke. As shown in FIG. 19, for example, the pumping element P-4 is at the beginning of the exhaust stroke or end of the intake stroke of the pump. In this position, the bight 138 in the diaphragm is held toward the pumping chamber C-4 by the action of the spring 134 and ring 136. In the

9

position in FIG. 19, the slack in the bight of the loop is greatest. Consequently, the spring 135 will be expanded to its maximum extent. As the exhaust stroke progresses to the position in FIG. 20, the amount of slack has decreased, and the tension of the spring 134 has increased. This action progresses to the final end of the exhaust stroke, such as illustrated in FIG. 21 or in FIG. 18. In this position of the pumping element P-4, spring 134 will be compressed to the greatest extent and supply the most resistance to deformation of the loop or the bight 138.

As the stroke progresses, the diaphragm is progressively forced into engagement with the wall of the pumping chamber C-4 starting with the position shown in FIG. 19 and progressing inwardly of the pumping chamber, as shown by FIGS. 20 and 21, so as to force the fuel inwardly.

Fourth modification

FIGS. 22 through 26, inclusive, illustrate a modified form of the invention very similar in arrangement of parts and operation to the first modification heretofore described.

According to these figures, the pump has a rocker arm casing 160 and a valve casing 161. The valve casing 161 contains inlet and outlet valve controlled passages from the pumping chamber communicating with supply and discharge connections, all as well known in the aforesaid Coffey patent.

One wall of the valve casing forms, with the pumping element P-5, a pumping chamber C-5.

The pumping element as shown in FIGS. 22 and 23 comprises a stem 163 having a reduced portion 164 upon which is mounted the diaphragm 165. The diaphragm is secured between a pair of backing plates 166 and 167 held on the stem 163 by a pair of washers 169 and 170. The washer 170 wedgingly engages with the tapered portion on the reduced end 164 of the stem 163, and is secured under pressure so that the backing plates 166 and 167 clamp the diaphragm 165 therebetween, all as disclosed in the aforesaid Edelen patent.

The backing plate 167 has a rounded lip 171 at its outer periphery. Backing plate 166 has a flange 173 forming a seat for a rubber O-ring 175. Flange 173 holds the rubber O-ring 175 tightly against an annular portion of the diaphragm 165 adjacent the curved lip 171 on the backing plate 167. The flange 173 and ring 175 form an annular supporting means resiliently holding the bight 185 against reversal with respect to the backing plates. Annular rib 177 forms a seat for the actuating spring 178, and when the spring expands as shown in FIG. 22, the diaphragm 165 is forced against the wall of the pumping chamber formed in the valve casing 161 by the rubber O-ring 175. This action is somewhat similar to the spring fingers on the backing plate heretofore described.

The outer periphery of the diaphragm 165 is apertured so that it can be clamped between the flanges 180 and 181 of the rocker casing 160 and the valve casing 161, respectively, by securing screws 182. In this particular view of the device, the spring 178 is fully expanded, forcing the backing plates and diaphragm against one wall of the pumping chamber formed in the valve casing. The clearances illustrated, if any, are only those necessary or required by manufacturing tolerance. Obviously, the closer the clearance, the better the volumetric efficiency of the pump will be.

Operation

FIGS. 24 through 26, inclusive, illustrate the operation of this modification. In FIG. 24 the pumping element P-5 is at the end of the suction stroke and the beginning of the exhaust stroke for the pump. In this position, the rubber O-ring 175 engages a portion of the concave surface of the bight 185 opposite lip 171 formed by the

10

slack in the diaphragm between the backing plates and the casing. If desired, the rocker casing 160 (FIG. 22) may be provided with a curved lip 186 around the internal periphery of the flange 180 so as to direct the diaphragm 165 toward the pumping chamber C-5. Also, in the actual device, the flange 173 or tension in the ring 175 may cause considerable compression of the O-ring 175, causing it to be distorted over the zone of engagement with the portion of the diaphragm 165 on the lip 171, so that the amount of contact between the O-ring and the diaphragm is more than that illustrated. It is contemplated, however, that there will be substantial contact between the O-ring 175 and the concave side of the bight 185 in the diaphragm, and, as the stroke progresses, as shown in FIGS. 25 and 26, the amount of contact increases, causing the diaphragm to be forced onto the wall of the pumping chamber C-5 in a progressive manner radially inward thereof, so that the fluid pumped will be forced inwardly.

When the pumping element reaches approximately the end of the stroke as shown in FIG. 26, the entire concave surface of the bite in the diaphragm is engaged by the O-ring so as to force the diaphragm into the pumping chamber. The amount of clearance at the end of the stroke of the pumping element is regarded as a matter of degree and, as shown in FIG. 22, the clearance could be practically non-existent without changing the operation of the device. In such a case, the O-ring would act as a bumper limiting the end of the stroke. The O-ring and the diaphragm could be made integral.

Fifth modification

FIGS. 27 through 32, inclusive, illustrate another form of the invention.

This modification differs from the rest in that the bight portion of the loop is directed away from the pumping chamber rather than toward it. However, the means used is similar to those heretofore described.

According to these figures, the pump has a rocker arm casing 190 and a valve casing 191. The valve casing 191 contains inlet and outlet valve controlled passages from the pumping chamber communicating with supply and discharge connections, as in the aforesaid Coffey patent. One wall 193 of the valve casing is formed to provide a pumping chamber C-6. The other wall of the pumping chamber is formed by a pumping element P-6.

The pumping element as shown in FIGS. 27 and 28 comprises a stem 195 having a reduced portion 196 upon which is mounted a diaphragm 197. Diaphragm 197 is secured between a pair of backing plates 198 and 199 and held upon the stem 195 by a pair of washers 200 and 201. The washer 201 wedgingly engages with the tapered portion on the reduced end 196 of the stem 195, and is secured under pressure so that the backing plates 198 and 199 clamp the diaphragm 197 firmly between them, all as disclosed in the aforesaid Edelen patent.

The backing plate 198 has a rounded lip 203 at its outer periphery, and an annular bead 204 acting as a seat for the pump spring 205. Backing plate 199 has a curved outer lip 207 which clamps the diaphragm 197 against the rounded lip 203 on the backing plate 198, so that the diaphragm takes up a generally frusto-conical shape as illustrated in FIG. 28.

The flanges 209, 210 on the rocker casing 190 and valve casing 191, respectively, are secured together by a plurality of screws, for example, like 211.

Diaphragm 197 is suitably provided with spaced holes to accommodate the screws 211 when secured between the flanges 209 and 210. Ring 212 is disposed between the flanges 209 and 210, and preferably between the diaphragm 197 and the valve casing flange 210. On this ring are a plurality of spring fingers 214 which are suitably curved as shown in FIG. 27 to form an annular supporting means for the bight 220.

In the assembled device, the spring fingers 214 hold

the diaphragm against the curved annular surface 215 on the rocker arm casing 190. The valve casing 191 and the outer periphery of the pumping chamber C-6 is surrounded by an annular rib 217 shaped to conform with the contour of the bight 220 in the diaphragm 197 in the position shown in FIG. 27 when the pumping element P-6 is at the end of the discharge stroke of the pump.

Operation

The operation of the pump described above is illustrated in FIGS. 30 through 32, inclusive.

In FIG. 30 the pumping element P-6 is shown at the end of the suction stroke or the beginning of the exhaust stroke. In this position the loop or bight 220 is directed away from the pumping chamber C-6 by the coaction of the lips 203, 207 on the backing plate and spring fingers 217 acting to hold the diaphragm against the curved inner surface of the rocker housing 190.

As the slack in the loop 220 is taken up during the discharge stroke as shown in FIG. 27, the diaphragm material in the bight portion thereof 220 begins to tighten against the annular lip formed by fingers 214, causing them to flex downwardly toward the annular rib 217 in the pumping chamber C-6.

At the end of the discharge stroke, resilient fingers 214 are flexed into engagement with the annular rib 217, and the diaphragm bight portion 220 is pulled down tightly therein so as to eliminate substantially all of the clearance between the pumping element P-6 and the wall of the pumping chamber C-6.

As aforesaid, the amount of clearance depends upon the engine driven device which will limit the stroke of the pumping element P-6 in this direction. FIG. 32 illustrates some clearance, whereas in FIG. 27 there is very little clearance and only as much as manufacturing tolerances require. Even though there is some clearance such as in FIG. 32, the volumetric efficiency of the pump is vastly improved, since the area within the bight portion of the loop is completely filled in by the annular rib 217 over which the diaphragm is pulled during the exhaust stroke of pumping element P-6.

Applicants have shown several modifications of the invention, but it is contemplated that still other forms will occur to those skilled in the art which would come within the scope of the appended claims.

We claim:

1. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a rounded lip around said casing at the periphery of said pumping chamber, a pumping element including a diaphragm having its outer periphery secured in said casing adjacent said rounded lip to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting in one direction with respect to said pumping chamber, the outer peripheral edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight portion to project therebetween in the direction of the pumping chamber, an annular shaped supporting means separate from said backing plates having a surface shaped to conform with the concave surface of the bight portion of the diaphragm, means in said casing for urging said annular shaped supporting means in the direction of said bight portion, said annular shaped supporting means having a portion in opposed relationship with one of said rounded lips for clamping a portion of said annular bight portion of said diaphragm

bight portion, said annular shaped supporting means having a portion in opposed relationship with one of said rounded lips for securing a portion of the bight of said diaphragm against one of said lips to hold the bight portion against reversal with respect to said backing plates.

2. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and fluid outlet, a rounded lip on said casing at the periphery of said pumping chamber, a pumping element including a diaphragm having its outer periphery secured in said casing adjacent said rounded lip to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting in one direction with respect to said pumping chamber, the outer peripheral edge of one of said backing plates having a rounded lip for engaging said diaphragm, the outer periphery of said backing plates being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said backing plates and the wall to provide working clearance therebetween, said annular space being small enough to prevent bight reversal with respect to said backing plates, an annular shaped supporting means separate from said backing plates having a surface shaped to conform with the concave surface of the bight portion of the diaphragm, means in said casing for urging said annular shaped supporting means in the direction of said bight portion, said annular shaped supporting means having a portion in opposed relationship with one of said rounded lips for clamping a portion of the bight portion of said diaphragm against one of said lips to hold the bight portion of the diaphragm against reversal with respect to said backing plates.

3. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a rounded lip on said casing at the periphery of said pumping chamber, a pumping element including a diaphragm having its outer periphery secured in said casing adjacent said rounded lip to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the peripheral outer edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip of the backing plate and the wall to permit said bight to project therebetween in the direction of the pumping chamber, an annular shaped supporting means separate from said backing plates having a surface shaped to conform with the concave surface of the bight portion of the diaphragm, said annular shaped supporting means including resilient means for urging said annular shaped supporting means in the direction of said bight, and a mounting for said annular shaped supporting means in said casing, said annular shaped supporting means having a portion in opposed relationship with one of said rounded lips for clamping a portion of said annular bight portion of said diaphragm

13

against one of said lips to hold said annular bight portion against reversal with respect to said backing plates.

4. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a pumping element including a diaphragm having its outer periphery secured in said casing to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the peripheral outer edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight portion to project therebetween in the direction of the pumping chamber, an annular shaped support means separate from said backing plates having a surface shaped to conform with the concave surface of the bight portion in said diaphragm at one portion of the pump stroke, said separate annular support means including a resilient element separate from said backing plates supported in said pump casing and outside of said pumping chamber for urging said separate annular support means into said bight portion in said one portion of said pump stroke, said resilient element operating to urge said diaphragm into contact with said rounded lip on the backing plate.

5. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a pumping element including a diaphragm having its outer periphery secured in said casing to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one of said backing plates on the pumping chamber side thereof, a centrally positioned operating stem connected to said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the peripheral outer edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight to project therebetween in the direction of the pumping chamber, an annular support means having a surface shaped to conform with the concave surface of the bight portion in said diaphragm at one portion of the pump stroke, said annular support means including a resilient element separate from said backing plates supported on said pumping element and outside of said pumping chamber for urging said annular support means into said bight portion in said one portion of said pump stroke, said resilient element operating to urge said diaphragm into contact with said rounded lip on the backing plate.

6. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a pumping element including a diaphragm having its outer periphery secured in said casing to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one of the backing plates on the chamber side there-

14

of, a centrally positioned operating stem connected to said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the peripheral outer edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber to provide an annular space between the outer periphery of said rounded lip on the backing plate and the chamber wall to permit said bight portion to project therebetween in the direction of the pumping chamber, and an annular support means separate from said backing plates and having a surface shaped to conform with the surface of said pumping chamber and engaging the concave surface of the bight portion in said diaphragm in one portion of the pumping stroke, said separate annular support means including a resilient element separate from said backing plates supported on said pump casing and outside of said pumping chamber for urging support means into said bight portion in said one portion of the pump stroke, said resilient element operating to urge said diaphragm into contact with said rounded lip on the backing plate.

7. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fuel inlet and a fuel outlet, a pumping element including a diaphragm having its outer periphery secured in said casing to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one of said backing plates on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the outer peripheral edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight portion to project therebetween in the direction of the pumping chamber, an annular shaped supporting means separate from said backing plates having a convex surface shaped to conform with the concave surface of the bight portion in said diaphragm throughout the pump stroke, said separate annular supporting means including a resilient element separate from said backing plates, and flange means at the periphery of the backing plate on the opposite side from the pumping chamber for urging said separate supporting means into said bight, said annular shaped supporting means and said flange means on said backing plate opposite from said pumping chamber operating to urge said diaphragm into contact with said rounded lip on the backing plate.

8. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a pumping element including a diaphragm having its outer periphery secured in said casing to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one of said backing plates on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the outer peripheral edge of the backing plate on the chamber side of said

diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight portion to project therebetween in the direction of the pumping chamber, an annular shaped supporting means separate from said backing plates having a surface shaped to conform with the concave surface of the bight in said diaphragm during the stroke of said pump, said separate annular shaped supporting means including a coil spring and an annular ring, and an annular seat on the backing plate opposite the chamber side of said diaphragm for holding said spring, said annular supporting means operating to urge said diaphragm into contact with said rounded lip on the backing plate.

9. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a pumping element including a diaphragm having its outer periphery secured in said casing to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one of said backing plates on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the outer peripheral edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm, said rounded lip on the backing plate being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight portion to project therebetween in the direction of the pumping chamber, an annular shaped supporting means in the form of a rubber O-ring separate from said backing plates and having a surface positioned to form the concave surface of the bight portion in said diaphragm throughout the pump stroke, means at the periphery of the backing plate opposite the chamber side of said diaphragm for urging said separate supporting means into said bight, said O-ring being tensioned to urge said diaphragm into contact with said rounded lip on the backing plate.

10. A fuel pump comprising a casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a rounded lip on said casing at the periphery of said pumping chamber, a pumping element including a diaphragm having its outer periphery secured in said casing adjacent said rounded lip to form the other wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one of said backing plates on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting in one direction with respect to said pumping chamber, the peripheral outer edge of one of said backing plates having a rounded lip for engaging said diaphragm and being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight portion to project in one direction with respect to the pumping chamber, an annular shaped supporting means separate from said backing plates including a ring with a plurality of projecting resilient fingers forming a lip shaped to conform with the concave surface of the bight portion of

the diaphragm, means in said casing for mounting said annular shaped supporting means with the resilient fingers projecting into the bight portion of said diaphragm, said annular shaped supporting means having a portion in opposed relationship with one of said rounded lips for clamping a portion of the bight of said diaphragm against one of said lips to hold the bight portion against reversal with respect to said backing plates.

11. A fuel pump comprising a sectional casing with internal walls defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a rounded lip on one of said casings at the periphery of said pumping chamber, a pumping element including a diaphragm having its outer periphery secured in between said casings adjacent said rounded lip to form the outer wall of said pumping chamber, backing plates disposed on opposite sides of the central portion of said diaphragm with one of said backing plates on the chamber side thereof, a centrally positioned operating stem connected with said pumping element, and means for clamping said backing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing projecting toward said pumping chamber, the outer peripheral edge of the backing plate on the chamber side of said diaphragm having a rounded lip for engaging said diaphragm and being spaced a sufficient distance from the wall of said pumping chamber and casing to provide an annular space between the outer periphery of said rounded lip on the backing plate and the wall to permit said bight portion to project therebetween in the direction of the pumping chamber, an annular shaped supporting means in the form of an annular ring with resilient fingers separate from the said backing plates and having a lip surface on said resilient fingers shaped to conform with the concave surface of the bight portion in said diaphragm, said separate annular shaped supporting means being mounted between the sections of said casing in a position for urging said resilient fingers into the bight portion in said diaphragm, said resilient fingers on said ring of said annular shaped supporting means operating to urge said diaphragm into contact with the rounded lip on said casing at the periphery of said pumping chamber.

12. In a fuel pump for internal combustion engines, a casing, a pumping structure comprising a flexible diaphragm having its peripheral portion secured to the casing to define therewith a pumping chamber, a pair of backing plates engaging opposite sides of the central portion of said diaphragm, an operating means for said pumping structure, said diaphragm having an annular bight portion between the outer periphery of one of said backing plates and said casing projecting in one direction with respect to said pumping chamber, and an annular resilient element within said casing and engaging said annular bight portion to bias the latter in said one direction.

13. A fuel pump for internal combustion engines comprising a casing, a pumping structure including a flexible diaphragm having its peripheral portion secured to the casing to define therewith a pumping chamber, a pair of backing plates engaging opposite sides of the central portion of said diaphragm, an operating means connected to said pumping element, said diaphragm having an annular bight portion between the outer periphery of one of said backing plates and said casing projecting in one direction with respect to said pumping chamber, and an annular resilient element within said casing and engaging said annular bight portion to bias the latter in said one direction, said one backing plate having a rounded peripheral lip, and said resilient element acting to bias said bight portion against said lip.

14. A fuel pump for internal combustion engines comprising a casing, a pumping structure including a flexible diaphragm having its peripheral portion secured to the casing to define therewith a pumping chamber, a

17

pair of backing plates engaging opposite sides of the central portion of said diaphragm, operating means connected to said backing plates, said diaphragm having an annular bight portion between the outer periphery of one of said backing plates and said casing projecting in one direction with respect to said pumping chamber, and an annular resilient element within said casing and engaging said annular bight portion to bias the latter in said one direction, said one backing plate having a rounded peripheral lip in annular engagement with said bight portion, and said resilient element acting to bias said bight portion against said lip.

15. A fuel pump comprising a casing with an internal wall defining a pumping chamber, said pumping chamber having one of said walls provided with a fluid inlet and a fluid outlet, a pumping structure including a diaphragm having its outer periphery secured in said casing to form the other wall of said pumping chamber, a pair of backing plates disposed on opposite sides of the central portion of said diaphragm, means for clamping said back-

18

ing plates to said diaphragm, said diaphragm being provided with an annular bight portion between the outer periphery of said backing plates and said pump casing, the peripheral outer edge of one of the backing plates having a rounded lip for engaging said diaphragm, said rounded lip on said one backing plate being spaced a sufficient distance from said pumping chamber wall and casing to provide an annular space to permit said bight portion to project therebetween, and an annular shaped support fixed within said casing and having a surface conforming with the concave surface of said bight portion in said diaphragm at one portion of the pump stroke, said annular support including a resilient element operatively urging said diaphragm into contact with said rounded lip on the backing plate.

References Cited in the file of this patent

UNITED STATES PATENTS

20	2,080,391	Rockwell	May 11, 1937
	2,464,196	Van Ranst	Mar. 8, 1949