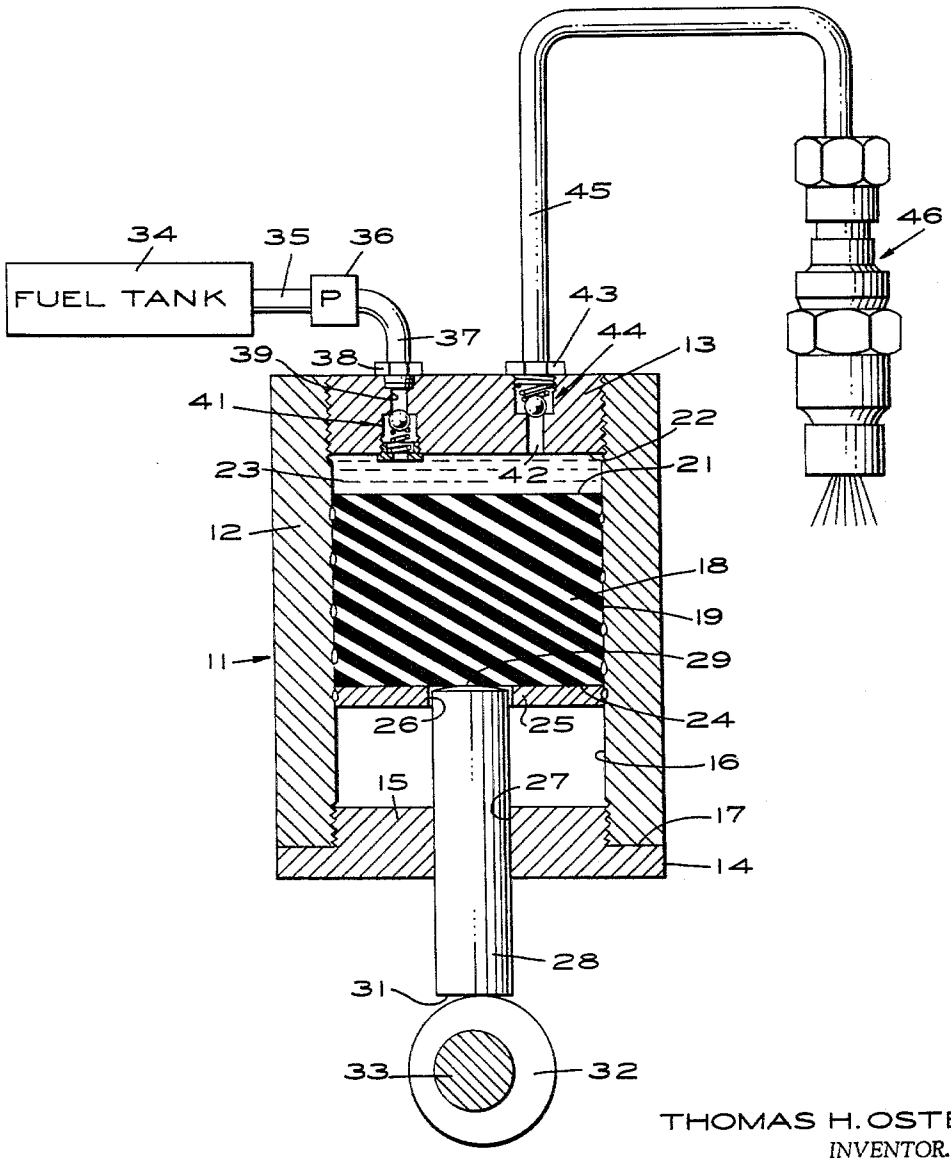
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FLUID PUMP

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FLUID PUMP

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This invention relates to a fluid pump and more particularly to an injection pump for the fuel injection system of an internal combustion engine.

It has been proposed to employ a deformable elastomeric body as a pumping member in a fuel injection system in place of a more conventional reciprocating plunger. The elastomeric body defines one side of a pumping cavity and is deformed by a driving member to vary the volume within the pumping chamber and impelled fuel to the fuel injection nozzle. By employing an elastomeric body, the sealing problems attendant with the conventional plunger are substantially reduced. The cost of the injection pump also may be reduced since close tolerances are not required between the plunger and the bore in which it reciprocates.

Injection pumps employing elastomeric bodies are shown in the patents to Pierce 2,929,332 issued March 22, 1960 and Dolza et al. 2,913,991, issued November 24, 1959, both entitled "Pump". In the devices shown in these patents, the driving member that contacts the elastomeric body has substantially the same cross-sectional area as the body at its contact with the body. Since the amount of fuel injected during each cycle is very small, particularly at partial loads, a small degree of driving member movement is required to produce the necessary volume change within the pumping cavity. The small movements require close tolerances in the design of the pump driving member to avoid high magnitude errors in displaced volume.

It is therefore the principal object of this invention to provide a fluid pump embodying an elastomeric body and one that does not have high tolerance requirements.

A fluid pump embodying this invention comprises a casing having a cavity within. An elastomeric body received in the cavity forms a closure at one end thereof. A first surface of the elastomeric body and the enclosed portion of the cavity forms the pumping chamber. Fluid inlet and fluid outlet means communicate with the pumping chamber for fluid flow to and from the chamber. A driving member is positioned in engagement with a second surface of the elastomeric body for deforming the second surface by direct contact. The deformation of the second surface causes elastic deformation of the first surface for varying the volume of the pumping chamber and impelling fluid from the inlet to the outlet. The driving member has substantially less cross-sectional area at its contact with the second surface than the cross-sectional area of the second surface.

The pump described in the foregoing paragraph may be used as a fuel injection pump in an internal combustion engine injection system by connecting the fuel inlet with a source of fuel under pressure. The fuel outlet is connected by means of a discharge valve and conduit to a fuel injection nozzle. The driving member may be driven in timed speed with the engine crankshaft by any suitable manner.

Further objects and advantages of this invention will become more apparent when considered in conjunction with the accompanying drawing wherein the single figure illustrates schematically a fuel injection system for an internal combustion engine embodying this invention.

Referring now in detail to the drawing, a fuel injection pump is indicated generally by the reference numeral **11**. The injection pump **11** comprises a tubular casing **12** enclosed at its upper end by an upper end cap **13**. A lower end cap **14** having a pilot portion **15** that is threaded in a cylindrical cavity **16** that extends longitudinally through the tubular casing **12**. A shoulder **17** of the lower end cap **14** engages the lower end of the tubular casing **12**.

An elastomeric body **18** formed of a resilient, substantially incompressible material has an external surface **19** that is complementary to the cylindrical cavity **16** is received in the upper end of the tubular casing **12**. The external surface **19** is vulcanized or bonded in any suitable manner to the tubular casing **12** along the major portion of its length. The elastomeric body **18** may be formed from any suitable material that is impervious to fuel and is resilient and incompressible. A normally planar upper end surface **21** of the elastomeric body **18** opposes a planar lower surface **22** of the upper end cap **13**. The surfaces **21** and **22** and the confined portion of the cylindrical cavity **16** form a pumping chamber **23**.

A normally planar lower surface **24** of the elastomeric body **18** is engaged by a plate **25** that is affixed to the tubular casing **12** within the cylindrical cavity **16**. A cavity circular aperture **26** is formed at the center of plate **25**. A bore **27** in the lower end cap **14** supports a pump driving member of plunger **28** for reciprocation. The bore **27** is axially aligned with the circular aperture **26** and with the cylindrical cavity **16** but is smaller in diameter. An upper surface **29** of the plunger **28** engages the lower surface **24** of the elastomeric body **18**. The cross-sectional area of the plunger **28** is substantially less at its point of contact than the cross-sectional area of the surface **24**.

A lower end **31** of the plunger **28** is engaged by a cam **32** supported upon a camshaft **33**. The camshaft is driven in timed relation with the engine crankshaft in any suitable manner. Rotation of the cam **32** causes reciprocation of the plunger **28**. As the plunger **28** reciprocates, the lower surface **24** of the elastomeric body **18** is deformed. The deformation is transmitted through the elastomeric body **18** because of its incompressibility to the upper surface **21** with a resulting variation in volume within the pumping chamber **23**.

The variation in volume within the pumping chamber **23** is employed to impel fuel from a fuel source to a fuel injection nozzle, as will now be described. A fuel tank **34** is connected by a first inlet conduit **35** to the inlet side of a primary fuel pump **36**. The outlet side of the primary fuel pump **36** is connected by a second inlet conduit **37** to an inlet fitting **38** received in the upper end cap **13**. An inlet fuel passage **39** extends through the end cap **13** from the inlet fitting **38** to the pumping chamber **23**. A check valve, indicated generally by the reference numeral **41**, is positioned at the discharge end of the passage **39** to permit fuel to flow only into the chamber **23** through the passage **39**.

An outlet passage **42** is also formed in the upper end plate **13**. An outlet fitting **43** is threaded into the end plate **13** at the mouth of the outlet passage **42**. Any suitable type of discharge valve, as indicated generally by the reference numeral **44**, may be positioned in the discharge circuit of the injection pump **11**. A discharge conduit **45** extends from the outlet fitting **43** to a fuel injection nozzle, indicated generally by the reference numeral **46**.

It should be readily apparent that as the plunger **28** reciprocates, the pumping chamber **23** will alternately expand and contract in volume. During the expansion cycle which results from the resilience of elastomeric body **18**, fuel under pressure from the primary fuel pump **36** will enter the pumping chamber **23** through the open check valve **41**. The delivery valve **44** will be closed at this time. As the plunger **28** moves upwardly to compress the pumping chamber **23**, the inlet check valve **41** will close

and fuel will be impelled from the pumping chamber **23** past the discharge valve **43** to the injection nozzle **46**.

Since the cross-sectional area of the plunger **28** is substantially less than the cross-sectional area of the elastomeric body **18**, a fairly sizeable stroke or length of reciprocation is required to obtain the necessary change in volume in the pumping chamber **23**. This permits a wider tolerance in the finish of the cam **32**. The shape of the lower end of the plunger **28** is immaterial so long as its cross-sectional area is small at the upper end throughout a length equal to the stroke.

Only a single injection pump has been illustrated and described. It is to be understood that one injection pump may be provided for each cylinder or injection nozzle of a multi-cylinder engine. The individual pumps may be arranged in line wherein a longitudinally spaced cam or a single wide cam will be employed as a drive member. The pumps also can be arranged in a radial form so that any number may be driven from a single cam. Various other changes and modifications may be made without departing from the spirit and scope of the invention, as defined by the appended claims.

What is claimed is:

1. A fluid pump comprising a casing having a cavity therein, a resilient incompressible body received in said cavity and forming a closure at one end thereof, a first surface of said body and the enclosed portion of said cavity forming a pumping chamber, fluid inlet and fluid outlet means in communication with said pumping chamber for fluid flow to and from said pumping chamber, and a driving member in engagement with a second surface of said body, said driving member being movable for alternately deforming said second surface, the deformation of said second surface causing deformation of said first surface due to the incompressibility of said body for varying the volume of said pumping cavity and impelling fluid from said fluid inlet to said fluid outlet, said driving member having substantially less cross-sectional area at its contact with said second surface than the cross-sectional area of said second surface.

2. A fluid pump comprising a casing having a cavity therein, an elastomeric body received in said cavity and forming a closure at one end thereof, a first surface of said elastomeric body and the enclosed portion of said cavity forming a pumping chamber, fluid inlet and fluid outlet means communicating with said pumping chamber, for fluid flow to and from said pumping chamber and a driving member in engagement with a second surface of said elastomeric body, said driving member being movable for alternately deforming said second surface, said first and second surfaces being axially spaced for causing elastic deformation of said first surface upon deformation of said second surface to vary the volume of said pumping cavity and impel fluid from said fuel inlet to said fuel outlet, said driving member having substantially less cross-sectional area at its contact with said surface than the cross-sectional area of said second surface.

3. A fluid pump comprising a casing having a cavity therein, a resilient incompressible body having an external surface in engagement with and bonded to said cavity along at least a portion of the length of said external surface, a first end surface of said body forming a closure at one end of said cavity to form a pumping chamber therewith, fluid inlet and fluid outlet means communicating with said pumping chamber for fluid flow to and from said pumping chamber, and a driving member in engagement with a second end surface of said body, said driving member being movable for alternately deforming said second end surface, the deformation of said second end surface causing deformation of said first end surface due to the incompressibility of said body for varying the volume of said pumping chamber and the impelling fluid from said fluid inlet to said fluid outlet.

4. A fluid pump comprising a casing having a cavity therein, an elastomeric body received in said cavity and forming a closure at one end thereof, a first surface of said elastomeric body and the enclosed portion of said cavity forming a pumping chamber, fluid inlet and fluid outlet means communicating with said pumping chamber for fluid flow to and from said pumping chamber, and a driving member supported for reciprocation, one end of said driving member being in engagement with a second surface of said elastomeric body for deforming said second surface upon reciprocation, the deformation of said second surface causing elastic deformation of said first surface for varying the volume of said pumping cavity and impelling fluid from said fluid inlet means to said fluid outlet means, said one end of said driving member having substantially less cross-sectional area than cross-sectional area of said second surface.

5. A fluid pump comprising a casing having a cavity therein, a resilient incompressible body received in said cavity and forming a closure at one end thereof, a first surface of said body and the enclosed portion of said cavity forming a pumping chamber, fluid inlet and fluid outlet means communicating with said pumping chamber for fluid flow to and from said pumping chamber, and a driving member supported for reciprocation, one end of said driving member being in engagement with a second surface of said body for deforming said second surface upon reciprocation, the deformation of said second surface causing deformation of said first surface due to the incompressibility of said body for varying the volume of said pumping cavity and impelling fluid from said inlet means to said fluid outlet means, said one end of said driving member having a cross-sectional area throughout a length equal to the stroke of said driving member that is substantially less than the cross-sectional area of said second surface.

6. A fluid pump comprising a casing having a cavity therein, an elastomeric body having an external surface in engagement with said cavity and bonded thereto along at least a portion of its length, a first end surface of said elastomeric body closing said cavity and forming a pumping chamber therewith, fluid inlet and fluid outlet means in communication with said pumping chamber for fluid flow to and from said pumping chamber, and a driving member supported for reciprocation, said driving member having an end portion in engagement with the second end surface of said elastomeric body, said end portion of said driving member being adapted to deform said second end surface upon reciprocation of said driving member, the deformation of said second end surface causing elastic deformation of said first end surface for varying the volume of said pumping chamber and impelling fluid from said fluid inlet means to said fluid outlet means, said end portion of said driving member having a cross-sectional area throughout a length equal to the stroke of said driving member that is substantially less than the cross-sectional area of said second end surface.

7. A fuel injection system for an internal combustion engine comprising a fuel injection nozzle, an injection pump comprising a casing having a cavity therein, an elastomeric body received in said cavity and forming a closure at one end thereof, a first surface of said elastomeric body and the enclosed portion of said cavity forming a pumping chamber, a source of fuel, a fuel inlet conduit extending from said source of fuel to said pumping chamber, a fuel outlet conduit including a delivery valve extending from said pumping chamber to said injection nozzle, and a driving member in engagement with a second surface of said elastomeric body, said driving member being movable for alternately deforming said second surface, the deformation of said second surface causing elastic deformation of said first surface for varying the volume of said pumping chamber and impelling fuel from said pumping chamber to said fuel injection nozzle through said fuel outlet conduit, said driving member having substantially less cross-sectional area at its contact with said second surface than the cross-sectional area of said second surface.

8. A fuel injection system for an internal combustion engine comprising a fuel injection nozzle, an injection pump comprising a casing having a cavity therein, an elastomeric body having an external surface in engagement with said cavity and bonded thereto, a first end surface of said elastomeric body forming a closure for said cavity to form a pumping chamber therewith, a source of fuel, fuel inlet means including a primary fuel pump interconnecting said source of fuel with said pumping chamber, fuel outlet means including a delivery valve interconnecting said pumping chamber with said fuel injection nozzle, and a driving member in engagement with a second end surface of said elastomeric body, said driving member being movable for alternately deforming said second end surface, the deformation of said second end surface causing elastic deformation of said first end surface for varying the volume of said pumping chamber and impelling fuel from said pumping chamber to said fuel injection nozzle.

9. A fuel injection system for an internal combustion engine comprising a fuel injection nozzle, an injection pump comprising a casing having a cavity therein, an elastomeric body received in said cavity and forming a closure at one end thereof, a first surface of said elastomeric body and the enclosed portion of said cavity forming a pumping chamber, a source of fuel, fuel inlet means including a primary fuel pump interconnecting said source of fuel with said pumping chamber, fuel outlet means including a delivery valve interconnecting said pumping chamber with said fuel injection nozzle, and a driving member supported for reciprocation, said driving member having an end thereof in engagement with a second surface of said elastomeric body for deforming said second surface upon reciprocation of said driving member, the deformation of said second surface causing elastic deformation of said first surface for varying the volume of said pumping chamber and impelling fuel from said pumping chamber to said fuel injection nozzle, said end of said driving member having a cross-sectional area throughout a length equal to the stroke of said driving member that is substantially less than the cross-sectional area of said second surface.

10. A fuel injection system for an internal combustion engine comprising a fuel injection nozzle, an injection pump comprising a casing having a cavity therein, an elastomeric body having an external surface in engagement with and bonded to said cavity, a first end surface of said elastomeric body forming a closure for said cavity and forming a pumping chamber therein, a source of fuel, a primary fuel pump, inlet conduit means interconnecting said source of fuel with said primary fuel pump and said primary fuel pump with said pumping chamber, a fuel outlet conduit including a delivery valve interconnecting said pumping chamber with said fuel injection nozzle, a driving member supported for reciprocation, said driving member having an end surface in engagement with a second end surface of said elastomeric body for deforming said second end surface upon reciprocation of said driving member, the deformation of said second end surface causing elastic deformation of said first end surface for varying the volume of said pumping chamber and impelling fuel from said pumping chamber to said fuel injection nozzle, said end of said driving member having a cross-sectional area throughout a length equal to the stroke of said driving member that is substantially less than the cross-sectional area of said second end surface.

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