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THERMAAL MOTOR WITH DIAPHRAGM MOLDED TO PISTON AND CHAMBER

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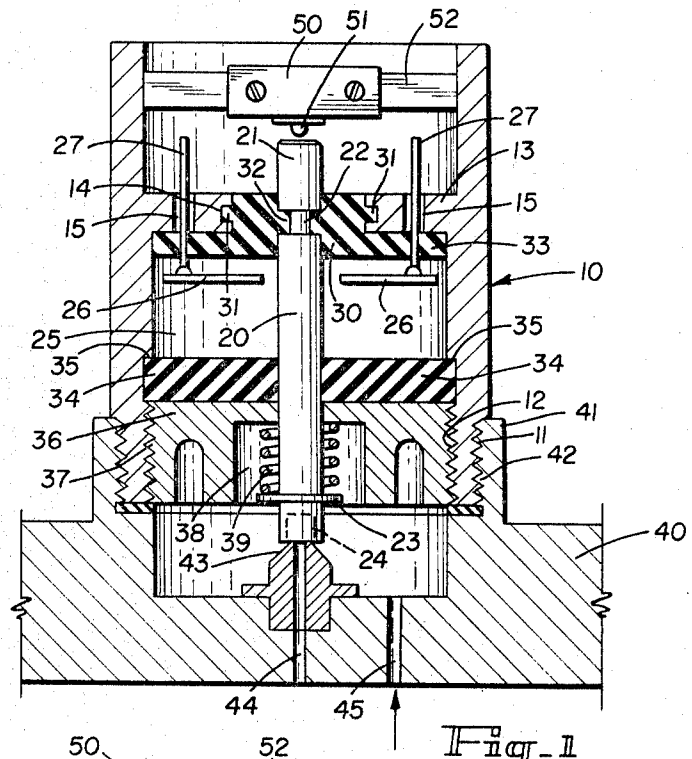


Fig. 1

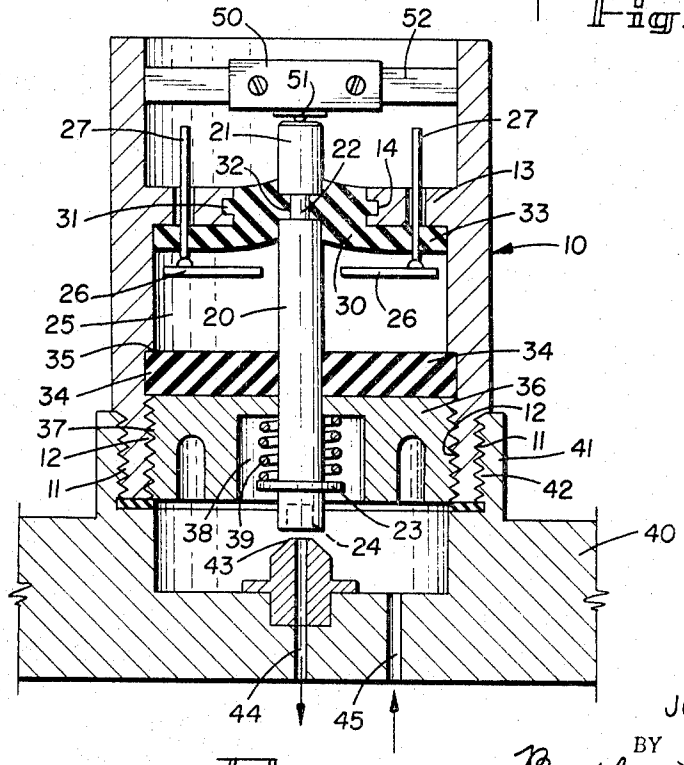


Fig. 2

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THERMAL MOTOR WITH DIAPHRAGM MOLDED TO PISTON AND CHAMBER

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U.S. Cl. 251—11 10 Claims

ABSTRACT OF THE DISCLOSURE

A thermal motor which comprises a high pressure casing in which a chamber for expansible and contractible material is efficiently and insulatingly sealed at one end by a flexible diaphragm molded to the casing and to a reciprocable piston in the casing. The opposite end of the chamber is provided with a seal through which the piston is freely movable. The diaphragm serves several purposes, including actuation of the piston, sealing one end of the high pressure chamber, sealing electrodes which supply current to heating elements in the chamber, supporting the heating elements, and insulating the chamber electrically and for heat conservation.

The thermal motor piston has opposite accessible ends which may be used for various purposes. A valve closing plug may be mounted in one end of the piston for seating on a valve seat. The opposite end of the piston may actuate a switch or other mechanism. The reciprocating movement of the piston shaft constitutes both a push and pull type action in the motor.

This invention relates to a thermal motor provided with a casing, a piston shaft reciprocable in the casing, and a flexible piston actuating diaphragm molded to the piston shaft and the casing. Expansible material in the high pressure chamber of the casing actuates the diaphragm and thereby moves the piston in one direction when the material expands in response to heat.

The main object of the invention is to provide a diaphragm which serves several purposes, including actuation of the piston, sealing one end of the high pressure chamber, sealing electrodes which supply current to heating elements in the chamber, supporting the heating elements, and insulating the expansion chamber electrically and for heat conservation so that less current input is required. The end of the high pressure chamber opposite the diaphragm is sealed by a resilient seal through which the piston shaft reciprocates. The diaphragm and seal are made of suitable rubber or rubber compounds.

Another object of the invention is to provide a piston having opposite ends available for contacting or imparting motion to various kinds of mechanisms. For example, in the embodiment shown herein, one end of the piston carries a valve plug for seating on a valve seat to close a valve, and the opposite end of the piston actuates a switch button. Thus the mechanism serves as a pull motor for opening the valve and as a push motor for actuating the switch. Mechanisms other than a valve or a switch may be actuated by one or both ends of the piston.

Another object of the invention is to construct the thermal motor casing in such manner that the motor is easily connected to a valve housing and easily detached therefrom, one end of the motor casing being threaded for this purpose, whereby the use of bolts and the like for connecting the casing to the work is avoided.

Another object of the invention is to shape the piston shaft and diaphragm complementally to provide a secure seal between the piston and diaphragm and to so mount

the diaphragm in the casing that the shaft is supported by the diaphragm and motor casing.

Other objects and advantages will be apparent from the drawings and following description.

In the drawings:

FIG. 1 is a vertical sectional view showing the thermal motor mounted on a valve housing, with the piston in valve closing position.

FIG. 2 is a view similar to FIG. 1 showing the piston in valve opening position and its upper end in switch closing position.

In that embodiment of the invention shown in the drawing, **10** indicates the thermal motor casing as a whole. The casing has external threads **11** and internal threads **12** on its lower end. An inwardly projecting flange **13** on the casing **10** is provided with an annular groove **14** on its inner edge surface and with vertical openings **15** located inwardly of the casing side walls.

A piston **20** has an upper exposed end **21** above the groove of smaller diameter portion **22**. A spring retainer **23** is fixed on the piston **20** near its lower end, in which is mounted a valve plug **24**. Expansible and contractible material occupies the high pressure chamber **25**. Electrical heater elements **26** are located in the chamber **25**; current is supplied to the heaters by electrodes **27** which extend through the openings **15** in the casing flange **13**.

A diaphraim **30** made of flexible resilient moldable material is molded to the casing **10** and piston shaft **20**. It has a radially extending flange **31** which fits into the groove **14** of the casing flange **13**, and an inwardly directed flange **32** which fits into the groove formed by the reduced diameter portion **22** in the piston **20**. The larger diameter portion **33** of the diaphragm **30** fits snugly against the inner surface of the casing beneath the casing flange **13** and is molded to the casing. The diaphragm **30** securely seals one end of the high pressure chamber **25** and cooperates with the casing flange **13** to support the piston **20**.

A resilient seal **34** has a central opening for reception of the piston shaft **20**, its peripheral surface snugly engaging the casing **10** in the annular groove formed below the shoulder **35**. The seal **34** closes the end of the high pressure chamber **25** opposite the diaphragm **30**. The seal **34** is supported and retained by the retainer **36** threaded externally at **37** to engage the threads **12** on the casing **10**. A central downwardly opening recess **38** in the seal retainer **36** provides space for a coiled spring **39** between the spring retainer ring **23** and the upper wall of the seal retainer **36**.

The thermal motor may be used to open and close a valve or to actuate other work located externally of the motor casing **10**. In this embodiment of the invention, the thermal motor is mounted on a valve housing **40** provided with a collar **41** internally threaded at **42** to engage the threads **11** on casing **10**. The valve has a valve seat **43** surrounding the valve outlet **44** adapted to be closed by the valve plug **24**. The valve inlet is designated **45**.

The end of the piston shaft **20** opposite the valve plug **24** may be utilized to impart motion to various mechanism, such for example as the switch shown herein comprising a casing **50**, switch button **51** and mounting means **52**. It will be understood that the thermal motor shown herein does not require a switch actuated by piston **20**. The switch **50** has been shown as an example of work located outside of the motor which may be actuated by one end of the piston **20**. It will also be understood that the opposite end of the piston may be utilized to actuate work other than the valve mechanism described herein.

As shown in FIG. 1, the diaphragm **30** is in the position it assumes when the expansible material in the chamber **25** has contracted, and the piston **20** has been

urged into valve closing position by the spring **39** bearing on the spring retainer **23**. In FIG. 2, the diaphragm has been forced upwardly by the expansion of the material in the chamber **25**, thereby moving the piston **20** into valve opening position wherein the plug **24** is unseated relatively to the seat **43**. This valve opening movement of the piston **20** is "pull motor" action. By the same movement, the piston end **21** may be utilized as in a "push motor" to actuate the switch button **51** or other mechanism (not shown).

It will be apparent that the high pressure chamber **25** is completely sealed by the diaphragm **30**, casing **10** and seal **34**, and that the parts **30** and **34** are mounted in the casing **10** in such manner that they are functionally integral with the casing and provide efficient seals for the chamber **25**, as well as electrical and heat insulation to protect the electrodes and conserve heat in the chamber. The molding of the diaphragm to the casing and piston by provision of the interfitting parts described ensures not only complete sealing at one end for the chamber **25** but also a mounting and support for the piston. At the other end of the chamber **25**, the seal **34** of substantial thickness, supported on the seal retainer **36**, through which the piston moves when actuated, completes the perfect sealing of the chamber.

I claim:

1. A thermal motor comprising

(a) a high pressure casing having a chamber therein for expansible material,

(b) heat responsive expansible material in the chamber,

(c) a piston reciprocable in the chamber having an end accessible for contacting mechanism located outside of the chamber,

(d) a flexible resilient diaphragm interfittingly molded to the piston and to the casing adjacent one end of the chamber,

(e) a seal closing the opposite end of the chamber having an opening through which the piston moves when reciprocated, and

(f) means in the chamber for heating the heat responsive material to expand the material and to actuate the diaphragm and piston.

2. The motor defined by claim **1** which includes electrical heating elements in the chamber and electrodes which extend from the chamber through the flexible diaphragm and are insulated thereby.

3. The motor defined by claim **1** in which the portion of the piston to which the diaphragm is interfittingly molded consists of sections of different diameters which provide shoulder surfaces engaged by the diaphragm.

4. The motor defined by claim **1** in which the casing has an inwardly extending flange having a major surface bearing on the diaphragm in the area adjacent the diaphragm periphery and an edge which has an annular groove therein for reception of part of the diaphragm located inwardly of said peripheral area.

5. The motor defined by claim **1**, which includes a valve plug in one end of the piston and a valve housing having a valve seat therein, said valve housing being

attached to the motor casing for contact between the valve plug on the piston and said valve seat.

6. The motor defined by claim **1**, in which the diaphragm insulates one end of the chamber and yieldingly cooperates with the casing to support the piston for reciprocatory movement in the chamber.

7. The motor defined by claim **1** which includes electrical heating elements in the chamber and electrodes which extend from the chamber through the diaphragm, and in which the diaphragm insulates one end of the chamber and said electrical heating elements and electrodes, and actuates the piston when the material in the chamber expands by heat.

8. The motor defined by claim **1**, which includes a valve housing having a valve seat therein connected to the motor casing at one end, a valve plug in one end of the piston for contacting the valve seat and closing the valve, said valve being opened by pull action of the piston.

9. The motor defined by claim **8** in which the piston has an accessible end opposite the valve plug end for actuating other mechanism by push action of the piston.

10. A thermal motor comprising

(a) a high pressure cylindrical casing having a chamber therein for expansible material and provided with internal and external threads adjacent one end of the casing,

(b) a piston reciprocable in the casing having an end accessible for contacting mechanism located outside of the casing,

(c) a flexible diaphragm molded to the piston and to the casing adjacent one end of the chamber,

(d) members integral with each of said diaphragm and said casing interfittingly engaging each other whereby the casing and diaphragm support the piston in the chamber,

(e) a seal closing the opposite end of the chamber having an opening through which the piston moves when reciprocated,

(f) a support for the seal connected to the internal threads of the casing, said support having a recess therein,

(g) a spring in the recess surrounding the piston,

(h) a spring retainer on the piston against which the spring bears,

(i) a valve plug in one end of the piston, and

(j) a valve including a valve seat secured to the threaded end of the casing in valve plug seating relationship to the piston.

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U.S. Cl. X.R.

60—23; 236—68