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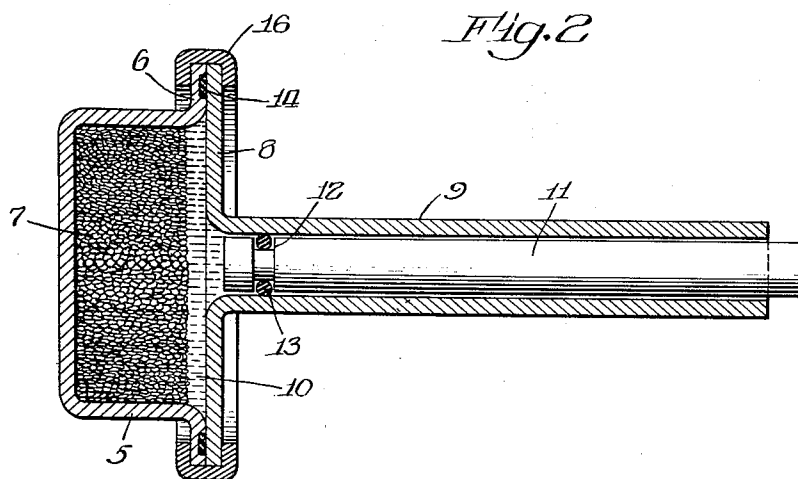
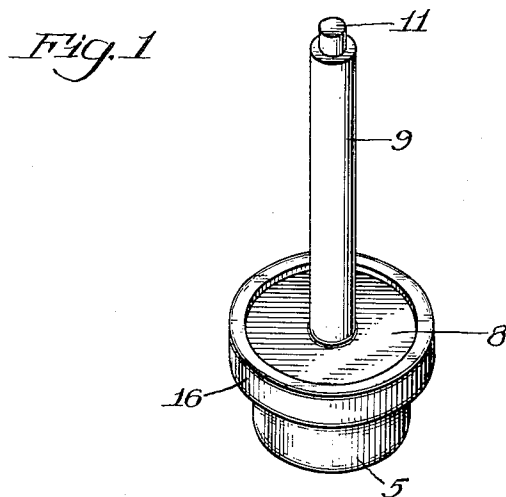
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2,938,384

TEMPERATURE-ACTUATED POWER DEVICE

Filed Nov. 16, 1954

2 Sheets-Sheet 1



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Fig. 3

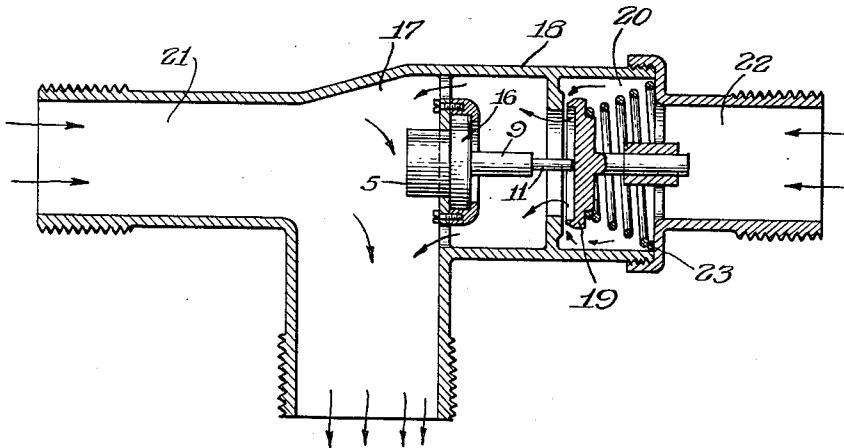
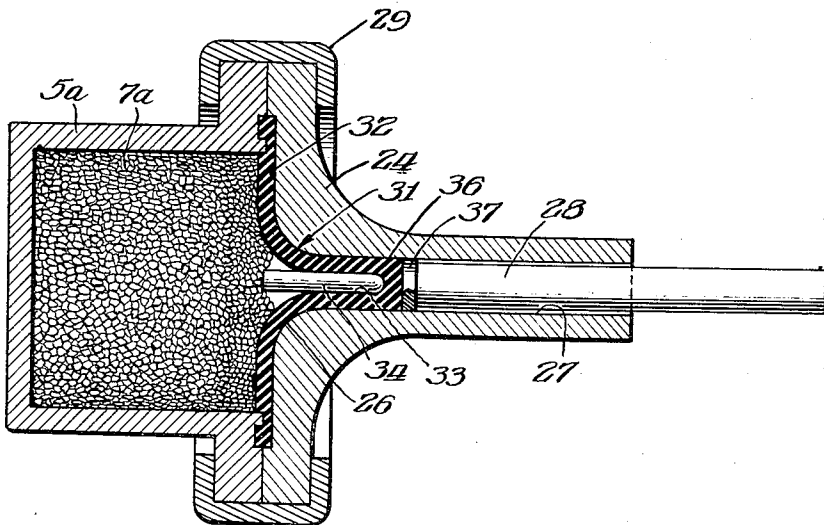


Fig. 4



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## TEMPERATURE-ACTUATED POWER DEVICE

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4 Claims. (Cl. 73-358)

Our invention relates to temperature-actuated power devices.

The present invention is concerned with the type of devices operating under the action of expansion or contraction of a thermally responsive medium which is confined within a sealed chamber, the said medium acting on a plunger of relatively small cross-sectional area to produce axial movement of the plunger. This axial movement of the plunger may be used to open or close valves or switches or to actuate any suitable mechanism.

One of the objects of our invention is the provision of a device of the foregoing character which has a high degree of sensitivity to temperature changes.

Another object of our invention is the provision of a thermally responsive element having a high degree of expansion and contraction.

Another object of our invention is the provision in a thermally responsive element of a solid heat-exchanging porous mass and an expansible fusible medium having a high coefficient of expansion impregnated in said mass.

A further object of our invention is the provision of a device of the foregoing character which is highly consistent in its response to temperature changes.

Other and further objects and advantages of our invention will become apparent from the following description when considered in connection with the accompanying drawings, in which

Fig. 1 is a perspective view of a temperature-actuated power device in accordance with our invention;

Fig. 2 is a longitudinal cross-sectional view on an enlarged scale of the device shown in Fig. 1;

Fig. 3 is a longitudinal cross-sectional view of a thermostatically controlled water-mixing valve incorporating our invention;

Fig. 4 is a longitudinal cross-sectional view of a modified embodiment of our invention.

According to one form of our invention, as illustrated in Fig. 2, we provide a cup-shaped casing 5 having an integral annular flange 6, the said casing being formed preferably of metal having high heat-exchanging characteristics. Contained within and substantially filling said casing is a pellet or mass of porous metal 7. The said pellet may be formed, for example, from powdered copper compressed and sintered so as to form a coherent solid mass having a desired porosity. The pellet 7 of course may be pre-formed and sintered and then inserted within the casing 5, or a mass of powdered metal may be compressed within the casing and both subjected to a sintering procedure. In the latter case, the mass of copper particles is bonded to the casing walls. In any event, it is essential that the pellet or sintered mass be

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in very intimate contact with the inner wall surfaces of the casing to provide a direct heat exchange between the external surfaces of the casing and the pellet. We have found that a pellet having a porosity of about 40% is satisfactory for conditions involved in the use of our device in connection with thermostatically controlled water-mixing valves. It is of course to be understood that the porosity of the pellet may be varied to suit the desired conditions of application.

While copper is highly desirable for use in applications where high heat-exchanging characteristics are desired, it is to be understood, however, that other materials such as stainless steel, aluminum, or brass may be used where different degrees of heat conductivity are desired. For example, in applications where a delayed heat transfer is desired, stainless steel, because of its lower heat conductivity characteristics would be employed.

To serve as the motive or power medium we employ fusible crystalline materials, taken preferably from the general class of crystalline waxes which includes paraffins and soaps. Combinations of such materials give desired fusion points. These materials have a high coefficient of expansion in their transition phases or changes of state in desired temperature ranges during which they undergo substantial volumetric changes. Following are some examples of proportions of combined materials and the resulting fusion points of each combination:

### Example 1

90% paraffin wax  
10% micro-crystalline wax  
Fusion point 120° F.

### Example 2

50% paraffin wax  
50% mineral oil  
Fusion point 104° F.

### Example 3

25% paraffin wax  
75% petrolatum  
Fusion point 115° F.

### Example 4

75% paraffin wax  
25% petrolatum  
Fusion point 121° F.

In carrying out our invention, we impregnate or saturate the porous pellet with a composition of crystalline material having a desired fusion point while said material is in a liquid or molten state. The same is accomplished by first evacuating air from the interstices or pores of the pellet as by heating the pellet or subjecting it to a vacuum. The material is then forced under pressure into the pores or interstices of the pellet until the pellet is completely saturated with the material. When the charged pellet thereafter is subjected to heat within a prescribed temperature range, the crystalline material undergoes a change of state from solid to liquid accompanied with a correspondingly large increase in volume of such liquid material. Upon cooling of the material below its fusion point, the material undergoes corresponding contraction when reverting to its crystalline state. It is believed that upon cooling and contraction of the material within the pores of the pellet a capillary action is induced which ensures return of the material back into the pores and

interstices of the pellet over and above the externally applied return forces.

To utilize the expansive characteristics of these materials and to convert the same into useful mechanical motion, we provide a bonnet 8 having a reduced neck portion 9 which is axially bored to receive a plunger 11, the plunger being provided with an annular recess 12 to receive an O-ring seal 13 which effectively seals the plunger within the bore. A suitable gasket 14 is interposed between the flange 6 of the casing 5 and the bonnet 8, and the two parts are secured in sealing engagement as with a coupling collar 16 which is spun over the marginal edges of the flange and the bonnet. It will be understood, however, that other suitable means may be provided for securing the two parts together.

The space within the casing between the saturated pellet 7 and the inner end of the plunger 11 is charged with a suitable force-transferring medium 10 capable of flow, which material also acts as a lubricant. It will be understood, however, that under certain conditions of operation or application, the force-transferring medium may be omitted, in which event the pressure-responsive material will act directly on the plunger.

It is required in our invention that the plunger 11 be spring-biased to effect a return of the same when contraction of the motive medium is effected, as when the device is cooled below the fusion point of the motive medium. This may be accomplished, as is illustrated in Fig. 3 of the drawings, which illustrates a practical application of our device in combination with a water-mixing valve. Here the temperature-responsive device of our invention is suitably secured within the hot water inlet chamber 17 of the valve housing 18, with the plunger 11 acting on a spring-loaded valve 19 in the cold water inlet chamber 20. In the operation of the thermostatically controlled water-mixing valve illustrated in Fig. 3, hot water enters through port 21 and circulates around the casing 5. If the temperature of the water is higher than the fusion point of the motive medium, it is caused to expand to move the plunger 11 to the right, as viewed in Fig. 3, to unseat the valve 19 to admit cold water entering through the port opening 22 into the chamber 17. As the temperature of the water chamber 17 is lowered contraction of the motive medium within the casing is effected, permitting the plunger 11 to be moved to the left by the spring 23, thereby effecting closure or partial closure of the valve 19. The operation of water-mixing valves of the type described is well known, and the construction and operation of such valves form no part of our invention.

The embodiment illustrated in Fig. 4 includes a casing 5a and impregnated pellet 7a identical with those hereinbefore described. A bonnet 24 shaped substantially as illustrated in Fig. 4 includes a curvilinearly tapered throat portion 26 and a cylindrical bore 27 in which is received the plunger 28. The bonnet is secured to the casing by a coupling collar 29 which is spun over the marginal edges of the casing flange and bonnet. A motion-transmitting boot 31 shaped substantially like that illustrated in Fig. 4 lies against the throat portion 26 and enters into the bore 27. The boot is provided with an annular flange 32 which is confined between the casing and the bonnet, the flange serving also as a gasket for sealing purposes. The boot 31 is provided with an axial bore 33 in which is received a rigid plug 34, the exposed end of the plug being in contact with the motive medium which fills the chamber immediately above the impregnated pellet. Disposed between the head 36 of the boot and the plunger 28 is a disk 37 of elastic material of such character that it will flow under pressure of the plunger 28 and contract to its original shape when the pressure is removed, thereby providing a sealing means with a minimum of friction on the side walls of the bore 27. Thus, when the pressure is high and the elastic boot 31 has a greater tendency for extrusion,

the disk 37 reduces the clearance between the plunger 28 and the bore 27 by making actual contact with the wall of the bore.

The boot 31 may be formed of any suitable elastic material which will permit periodic extension of the head 36 into the bore of the bonnet without rupture under prolonged service conditions. Upon expansion of the motive medium within the casing, it will be apparent that pressure on the plug 34 will effect movement of the same axially to the right, as viewed in Fig. 4, effecting extension of the head 36 of the boot into the bore 27 and compression of the same against the end of the plunger 28 through the sealing disk 37, resulting in axial movement of the plunger 28. It is to be understood that the plug 34 is used preferably in applications where the character of the motive medium is such that space within the boot may not be effectively filled by the said medium. It will of course be understood that, under certain conditions, the use of a plug may be eliminated and the motive medium caused to flow directly into the bore of the boot. Additionally, the disk member 37 may be eliminated when the pressures are so low as to eliminate any tendency of the boot extruding into the space between the plunger and the bore.

While the inherent elasticity of the boot 31 in the embodiment illustrated in Fig. 4, upon contraction of the expansible medium, would normally tend to withdraw the head of the boot within the bore of the bonnet, it is also required that spring means, such as employed in the device illustrated in Fig. 3, be used to effect a return of the plunger 28.

It is evident in each of the embodiments hereinabove described that the bore of the bonnet and plunger are of reduced cross-section compared to that of the casing. Accordingly, any expansion occurring within the casing results in a magnification of linear motion within the bore of the bonnet, resulting in substantial axial movement of the plunger, which may be utilized for useful work.

Various changes coming within the spirit of our invention may suggest themselves to those skilled in the art. Hence we do not wish to be limited to the specific embodiments described or uses mentioned, but intend the same to be merely exemplary, the scope of our invention being limited only by the appended claims.

The term "fusible material," as used in the claims, is a generic term embodying those materials which have a high coefficient of expansion in their transition phases or changes of state in specific temperature ranges. The term includes the specific mixtures listed previously and other compositions generally known in the art such as paraffin wax (alone) which may be used for this purpose depending on the fusion point desired.

We claim:

1. A thermostatic expansible, contractible power generating element having a casing, a plunger reciprocable in the casing, a pressure chamber in the casing, a single solid heat exchanging porous metallic body substantially completely filling the chamber, a fusible material impregnated in the body, the material being expansible on fusion and being fusible in the operating range of the thermostatic element, and force transferring means between the body and plunger and operable to transmit the expansive force of the material to the plunger.

2. The combination according to claim 1 in which the force transferring means includes a liquid between the body and the plunger.

3. The combination according to claim 1 in which the force transferring means includes a pin between the body and plunger with the pin being axially aligned with the plunger.

4. A thermostatic expansible, contractible power generating element having a casing, a plunger reciprocable in the casing, a pressure chamber in the casing, a single solid heat exchanging porous metallic body substantially completely filling the chamber, a fusible material impreg-

nated in the body, the material being expansible on fusion and being fusible in the operating range of the thermostatic element, the material being operable to transmit its expansive force to the plunger.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |        |               |         |
|-----------|--------|---------------|---------|
| 2,220,641 | Davis  | Nov. 5, 1940  | 436,836 |
| 2,259,846 | Vernet | Oct. 21, 1941 | 621,261 |
| 2,265,586 | Vernet | Dec. 9, 1941  | 10      |

|                |               |
|----------------|---------------|
| Truxell et al. | Oct. 6, 1942  |
| Kunzog         | Aug. 31, 1948 |
| Jensen         | June 6, 1950  |
| Albright       | Apr. 15, 1952 |
| Scherer        | Oct. 22, 1957 |

##### FOREIGN PATENTS

|               |               |
|---------------|---------------|
| Great Britain | Oct. 18, 1935 |
| Great Britain | Apr. 6, 1949  |