

A. W. BROWNE & R. P. NICHOLS.
HEAT RESPONSIVE DEVICE.
APPLICATION FILED APR. 23, 1914.

1,159,893.

Patented Nov. 9, 1915.
2 SHEETS—SHEET 1.

FIG. 1.

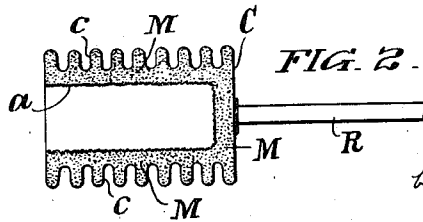
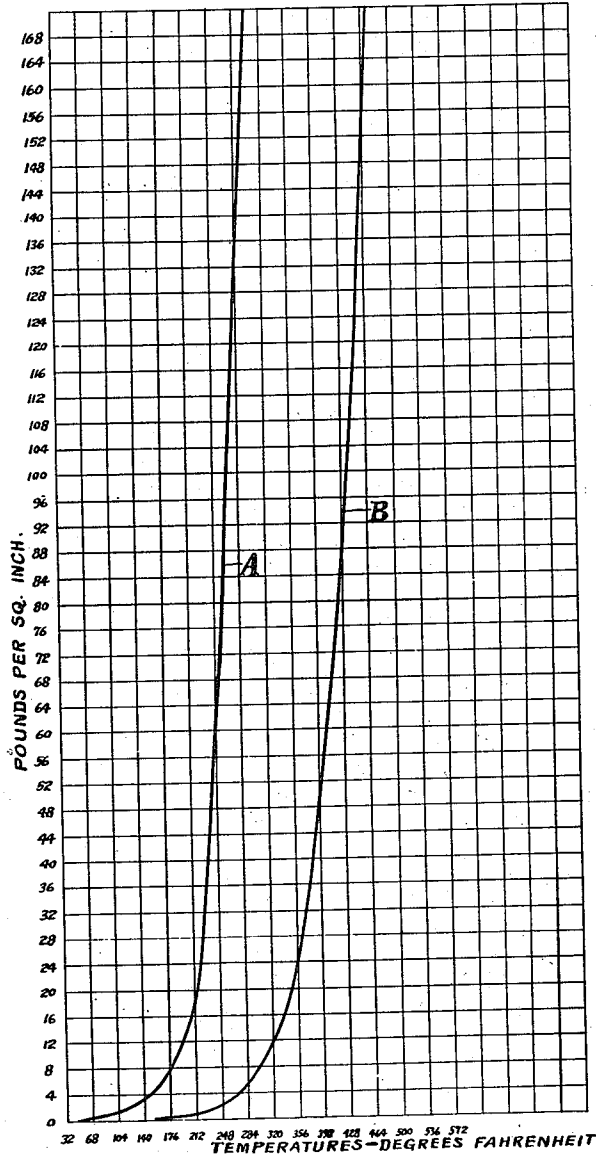


FIG. 2.

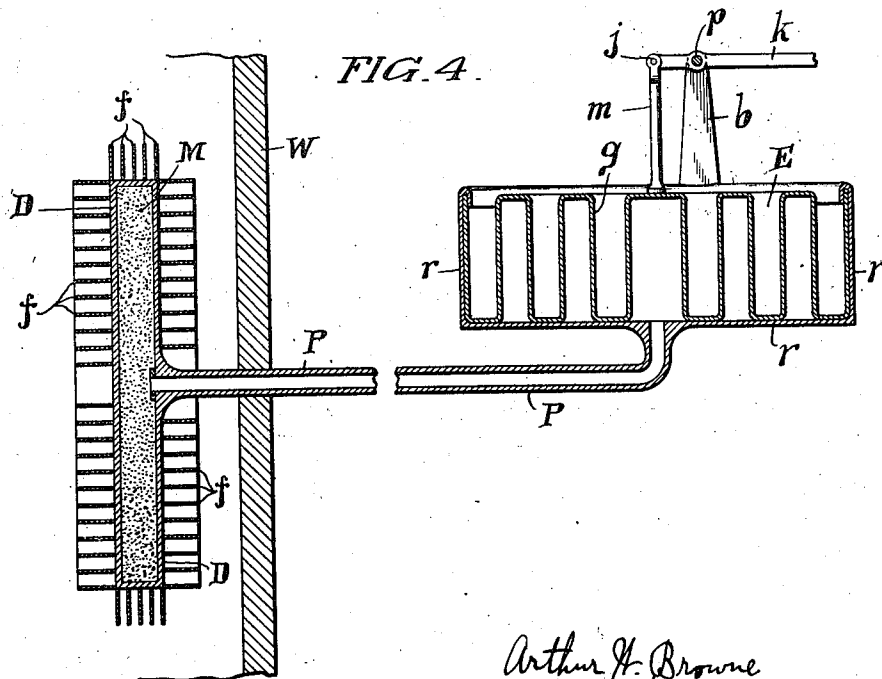
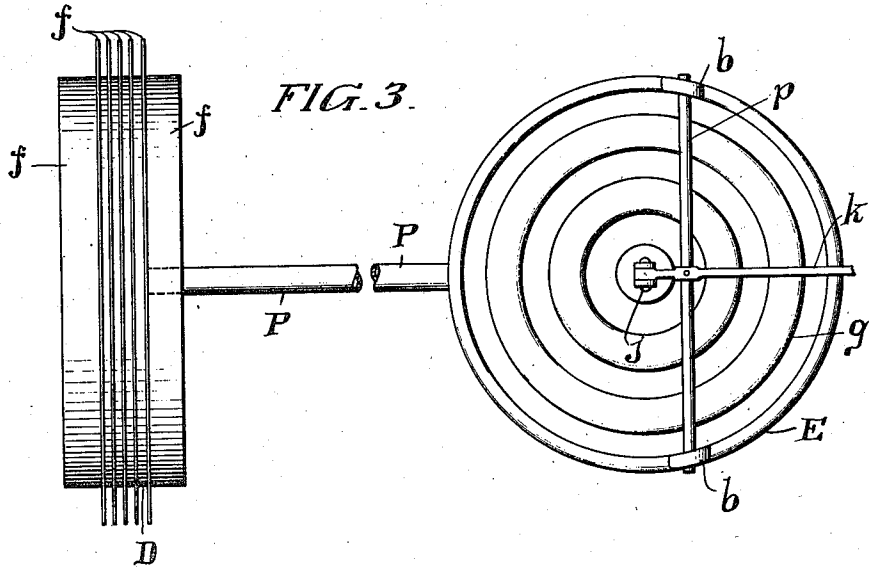
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William Conway

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UNITED STATES PATENT OFFICE.

ARTHUR W. BROWNE, OF ITHACA, AND ROBERT P. NICHOLS, OF NEW YORK, N. Y.

HEAT-RESPONSIVE DEVICE.

1,159,893.

Specification of Letters Patent.

Patented Nov. 9, 1915.

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To all whom it may concern:

Be it known that we, ARTHUR W. BROWNE and ROBERT P. NICHOLS, citizens of the United States, residing at Ithaca and New York city, State of New York, respectively, have invented a new and useful Heat-Responsive Device, of which the following is a specification.

Our invention relates to the employment of variations in temperature for the purposes of actuating any suitable or desired device, as for regulation purposes.

By our invention, a suitable material is confined either in a rigid or expansible container or chamber subjected to the variations in temperature in response to which a device is to be actuated or regulation obtained, such material, either solid or liquid, evolving a gas, and re-absorbing the same upon change in the applied temperature in opposite direction.

From the employment of such materials, there flow, *inter alia*, the following advantages:

The motive fluid is a gas, as distinguished from a vapor, and, accordingly, the desired motion is obtainable either through a rigid member attached to an expansible chamber containing the gas evolving material and subjected to the temperature changes; or the gas evolving container subjected to temperature changes, and this in our preferred arrangement, may be rigid and the evolved gas transmitted to any suitable distance through a pipe with whose more or less distant end a chamber having a movable wall communicates, such movable wall then transmitting the movement through any suitable mechanical connections to any desired device. Particularly in this latter case is there an advantage in our invention in that the gas being transmitted to a distance is nevertheless re-absorbed by the gas-evolving material upon a drop in temperature, whereas, in the case of employment of a vaporizable volatile material condensation of the vapor would occur in the pipe or parts remote from the heat absorbing chamber, the action being, in effect, a distillation of the volatilizable material from the heat absorbing chamber to the distant parts of the system where the vapor would re-condense into liquid, and the apparatus would be inoperative or of little practical value

because there would soon be no material remaining in the heat absorbing chamber to produce vapor.

Furthermore we may employ for the gas evolving material substances which at ordinary temperatures may be solids, easily confined in the heat absorbing receptacle and therefore not likely to displacement in the system during shipment or other handling, as is the case where volatile liquids or other vapor producing substances are employed.

Furthermore by our invention substances may be employed which rapidly evolve large volumes of gas, as by chemical decomposition, and in response to a temperature change in opposite directions re-absorb the gas, as in re-forming a chemical compound, with great avidity and with substantial completeness.

Furthermore in the case where a rigid receptacle for the gas-evolving material is employed and subjected to the temperature changes there is the advantage over the case where an expansible chamber is used for subjection to the temperature changes, that there is no shifting of the "zero" or starting point of the motion for a given temperature as in the case of the use of an expansible chamber where, after subjection for some time to varying temperatures an annealing effect or other molecular change takes place in the walls of the expansible chamber resulting in different degree of resistance to a given pressure within it.

Furthermore by employing a material such as evolves gas rapidly, that gas when transmitted to a distance shrinks in volume and is reduced in pressure very slightly per degree fall in temperature as compared to the case where a vapor is used which will condense and be greatly reduced in pressure for ordinary falls of temperature. And where the gas is evolved, as in our system, at very greatly increasing rates for relatively small changes in temperature, whatever slight shrinkage in volume or fall in pressure there may be, due to transmission to distant points, is substantially inconsequential.

For illustration of our invention reference may be had to the accompanying drawings, in which:

Figure 1 shows pressure-temperature curves illustrating characteristics of mate-

rial we may employ. Fig. 2 is a longitudinal sectional view, partly in elevation, illustrating an expansible chamber containing gas-evolving material. Fig. 3 is a top plan view of apparatus which may be employed for practicing our invention when a rigid container for the gas-evolving material is used. Fig. 4 is a vertical sectional view, some parts in elevation, of the apparatus shown in Fig. 3.

Referring to Fig. 1, the curve A shows in pounds per square inch the pressures of evolved gas, ammonia, NH_3 , resulting from the application of various temperatures to copper sulfate pentammonate, $\text{CuSO}_4 \cdot 5\text{NH}_3$. And the curve B shows the pressure in pounds per square inch of the gas evolved at various temperatures from copper sulfate tetrammonate, $\text{CuSO}_4 \cdot 4\text{NH}_3$, into which the copper sulfate pentammonate degenerates upon losing ammonia gas. Both of the curves, A and B, show that the pressure rises slowly through a relatively small temperature range then very rapidly for further small rise in temperature. These copper sulfate ammonates are solids and give off rapidly amounts of ammonia gas with rise in temperature, and with falling temperature re-absorb the gas with avidity, with rapidity and substantial completeness.

Other ammonates may be employed such for example as the ammonates of ammonium sulfo-cyanate, ammonium nitrate, ammonium chlorid, ammonium bromid, ammonium iodid, calcium chlorid, etc.

For the purposes of our invention the above-named materials may be used as well as any other suitable anhydrous salt or other solid material charged with ammonia gas, or with any other gas, giving up such gas readily upon change of temperature and re-absorbing it upon change of temperature in opposite direction, both evolution and reabsorption of gas resulting from chemical change.

Another class of substance which may be used comprises compounds of sulfur dioxide combined with suitable salts for example compounds of potassium iodid with sulfur dioxide.

In Fig. 2, M represents the material which evolves and re-absorbs gas as hereinbefore described. This material is disposed within the expansible chamber C having the corrugated walls *c*. Within the chamber C there may be provided the member *a* for confining the material M in contact with the walls subjected to heat changes. And where the material M is a solid the member *a* may consist of wire gauze or the like, but where the material M is liquid the member *a* is obviously made liquid tight. It is to be understood, however, that the member *a* may be omitted and that the material M may be disposed throughout the interior of the

chamber C, or in any portion of it. Assuming the left hand wall of the chamber C as fixed, and the right hand wall as movable, a rod R is attached to the movable wall. Accordingly upon changes in temperature in the medium surrounding the chamber C gas will be evolved or absorbed by the material M with resultant expansion or collapse of the chamber C with resultant movement of the rod R to the right or to the left, such movement being availed of for any suitable purpose to move any suitable device such as a damper, an electric switch, etc..

In Figs. 3 and 4, the material M is contained within a rigid chamber or container D which may be provided with the ribs or fins *f* of material of high heat conductivity for more effectually communicating heat to or removing it from the walls of the chamber D. Communicating with chamber D is the tube or pipe P which extends to any suitable or desired distance from the place where the temperature variations have occurred and to the point where movement in response to such temperature changes is to be availed of. At the distant end of the pipe P is a chamber E having the rigid walls *r* and the expansible corrugated walls *g*, it being understood that the interior of the pipe P communicates with the interior of the chamber E. Upon the fixed wall of the chamber E may be disposed the brackets *b* in which may be mounted the pivot pin *p* to which is secured the rocking lever *k* pivoted at its one end at *j* to the member *m* attached to the expansible chamber wall *g*.

It will be understood that as gas is evolved from material M the gas pressure throughout pipe P and within the chamber E rises, with resultant rise of the movable wall *g*, and attached member *m* tilting the lever *k* upon its pivot *p*, such movement of the lever *k* being used for any desired or suitable purposes, as actuating a damper, an electric switch, etc., and as temperature of the medium surrounding the receptacle D falls material M will re-absorb the gas, reducing the pressure in the chamber E with consequent reverse movement of the member *k*.

While it has been assumed that it is the member D which is heated, as being for example, disposed within a heated space surrounded by the wall W, it is to be understood that our invention is applicable to any state of affairs, as where the temperature of the medium surrounding the chamber E is higher than that of the medium surrounding the chamber D. In fact, because of the nature of material and motive medium employed it is immaterial what the relative temperatures of the chambers D and E may be. The same is true in connection with the structure of Fig. 2.

The material M herein described does not volatilize or give off a vapor, but gives off

a gas which remains such, and therefore can be employed for transmitting movement to a distance without the effect attendant upon the use of vapor, namely, its condensation and remaining in a distant part of the system.

Furthermore, in the arrangement shown in Figs. 3 and 4 the container D may be rigid, as distinguished from expansible, thereby maintaining the zero or starting point of movement for a given temperature fixed, as distinguished from the case where an expansible chamber is used and subjected to considerable temperatures, in which latter case due to alternate heatings and coolings through wide temperature ranges the yield of the expansible chamber varies, under given conditions, with age or length of use.

What we claim is:

1. Motion producing apparatus comprising a permanently closed system all parts of which are permanently in communication with each other, a chamber included in said system, a material contained in said chamber and having the property of evolving and reabsorbing gas in response to temperature changes, a distortable chamber remote from said chamber and forming part of said system and responding to evolution and absorption of said gas, and a rigid gas connection between said chambers, said gas constituting the sole motive medium.

2. Motion producing apparatus comprising a permanently closed system all parts of which are permanently in communication with each other, a rigid chamber included in said system, a material contained in said chamber and having the property of evolving and reabsorbing gas by chemical change in response to temperature changes, a distortable chamber forming part of said system and responding to evolution and absorption of said gas, and a rigid gas connection between said chambers, said gas constituting the sole motive medium.

3. Motion producing apparatus comprising a permanently closed system all parts of which are permanently in communication with each other, a solid material confined in one part of said system and evolving and absorbing gas by chemical change in response to temperature variations, said system having a distortable part responsive to evolution and absorption of said gas.

4. Motion producing apparatus comprising a permanently closed system all parts of which are permanently in communication with each other, a chamber included in said system, a solid material contained in said chamber and having the property of evolving and reabsorbing gas by chemical change in response to temperature changes, a distortable chamber forming part of said system and responding to evolution and absorp-

tion of said gas, and a rigid gas connection between said chambers, said gas constituting the sole motive medium.

5. Motion producing apparatus comprising a permanently closed system all parts of which are permanently in communication with each other, a rigid chamber included in said system, a solid material contained in said chamber and having the property of evolving and reabsorbing gas by chemical change in response to temperature changes, a distortable chamber remote from said chamber and forming part of said system and responding to evolution and absorption of said gas, and a rigid gas connection between said chambers, said gas constituting the sole motive medium.

6. Motion producing apparatus comprising a permanently closed system all parts of which are permanently in communication with each other, a solid ammonate confined in one part of said system and evolving and absorbing gas in response to temperature variations, said system having a distortable part responsive to evolution and absorption of said gas.

7. Motion producing apparatus comprising a permanently closed system all parts of which are permanently in communication with each other, a copper sulfate ammonate confined in one part of said system and evolving and absorbing gas in response to temperature variations, said system having a distortable part responsive to evolution and absorption of said gas.

8. In motion producing apparatus, the combination with a permanently closed system all parts of which are in permanent communication with each other, of a material permanently held in one part of said system and having the property of rapidly evolving and re-absorbing gas by chemical change in response to temperature changes, the pressure in said system changing through a greater range per unit of temperature change at high temperatures than at low temperatures, said system having a wall movable in response to evolution of gas from said material, said gas being reabsorbed directly from said system into said material upon change of temperature in opposite direction.

9. In motion producing apparatus, the combination with a permanently closed system, of a solid ammonate permanently held in one part of said system and subjected to temperature changes, said system having a wall movable in response to evolution of gas from said ammonate, said gas being reabsorbed directly from said system by said ammonate upon change in temperature in opposite direction.

10. The combination with a permanently closed system, of copper sulfate ammonate permanently held in one part of said system

and subjected to variations in temperature,
said system having a wall movable in re-
sponse to evolution of gas from said copper
sulfate ammonate, said gas being directly
5 reabsorbed from said system upon change in
temperature in opposite direction.
In testimony whereof, we have hereunto

affixed our signatures in the presence of the
two subscribing witnesses.

ARTHUR W. BROWNE.
ROBERT P. NICHOLS.

Witnesses:

CHARLES A. BROWNE,
G. D. NICHOLS.