July 11, 1967 H. B. DRAPEAU ETAL 3,330,480

THERMAL RESPONSIVE ACTUATOR

Filed Nov. 9, 1964 2 Sheets-Sheet 1

Fig_1

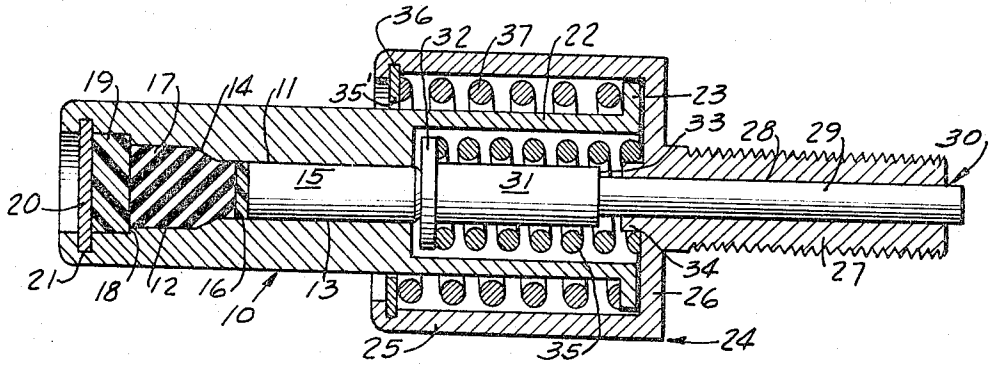
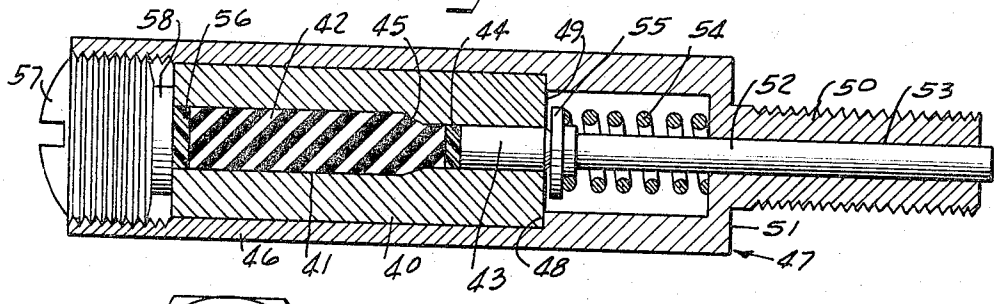



Fig_2



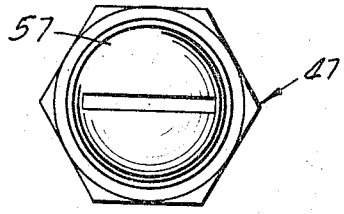




Fig_3

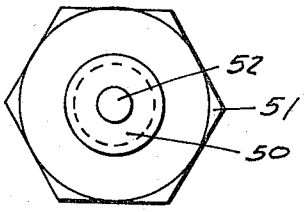



Fig_4

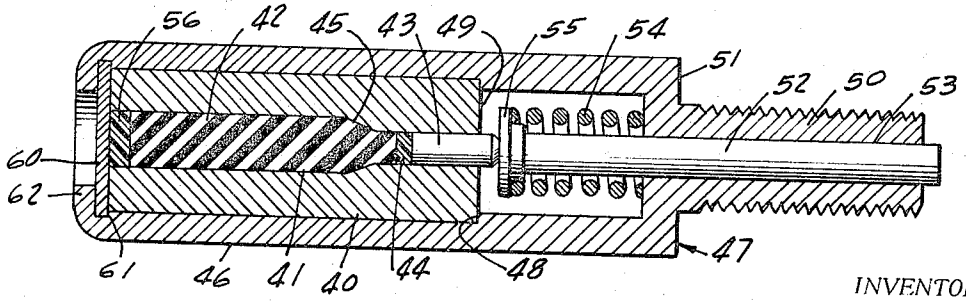



Fig_5

INVENTOR.
HAROLD B. DRAPEAU
DONALD F. JANOUS

BY Dill, Sherman, Meroni, Gross & Simpson ATTORNEYS

July 11, 1967 H. B. DRAPEAU ET AL 3,330,480

THERMAL RESPONSIVE ACTUATOR

Filed Nov. 9, 1964 2 Sheets-Sheet 2

Fig. 6

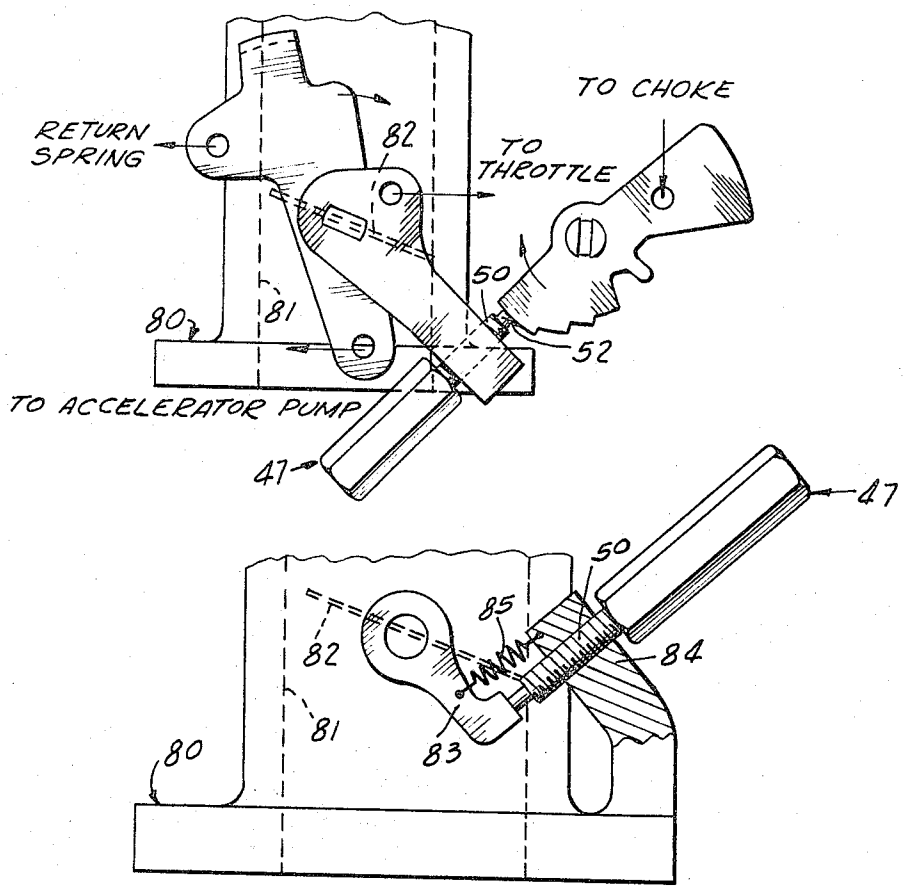



Fig. 7

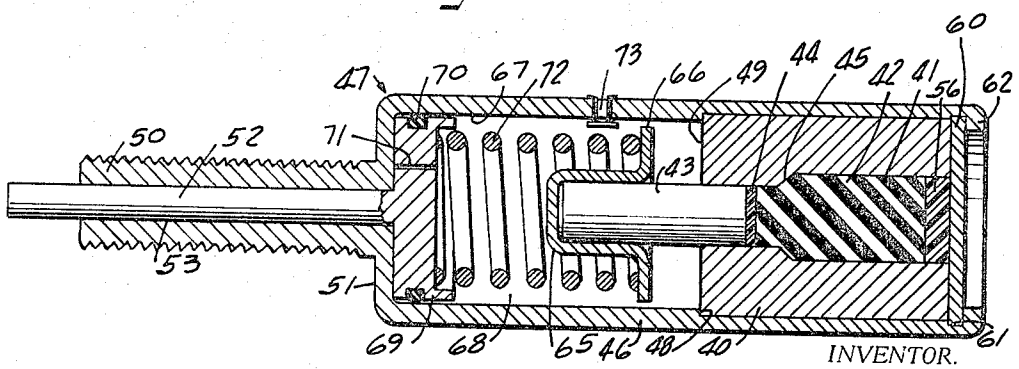



Fig. 8

INVENTOR.
HAROLD B. DRAPEAU
DONALD F. JANOUS

BY Hill, Sherman, Meroni, Gross & Simpson ATTORNEYS

United States Patent Office 3,330,480 Patented July 11, 1967



3,330,480

# THERMAL RESPONSIVE ACTUATOR

Harold B. Drapeau, Oak Park, and Donald F. Janous, Chicago, Ill., assignors to The Dole Valve Company, Morton Grove, Ill., a corporation of Illinois

Filed Nov. 9, 1964, Ser. No. 409,770
10 Claims. (Cl. 236—100)

The present invention relates to temperature responsive force transmitting devices and to a novel temperature responsive carburetor control assembly.

It will be understood by those skilled in the art that the idling speed of an automotive engine drops off as the under-the-hood temperature rises above 100° F. This temperature response characteristic results from the fact that warm air is less dense than cold air and hence carries less oxygen per unit volume resulting in reduced combustion and consequent energy output which, in turn, results in reduced engine speed. Tests have indicated that such a decrease in engine idling speed may be in the realm of 100 r.p.m. for each 50° F. rise in the temperature of air beneath the hood. It has also been determined that the under-the-hood temperature may vary from ambient up to somewhere in the realm of 240° F. following a long high speed run on a hot day. Thus, engine idling speed may be decreased 300 r.p.m. or more purely as a result of variances in the temperature of air beneath the hood. Such a decrease in engine idling speed creates troublesome engine stall problems in hot weather. In some cases, such a reduction in idling speed may result in a stalled engine. Still further, automobiles which are equipped with air conditioning require a maximum idling torque to carry the air conditioning load when the weather is hot.

Still further, inasmuch as engine idle speeds are responsive to ambient temperature to some degree, seasonal adjustment of the carburetor has been required in the past.

In any event, the idling characteristics of automobile engines have never been very satisfactory inasmuch as the engine runs too fast when the car is cold and may be too low when it is hot as where the operator is driving through slowing moving traffic.

Inasmuch as the drop in engine speed appears to be linear as the temperature of air entering the carburetor increases, any device which is designed to regulate engine idle speed as a function of temperature to compensate for this characteristic must also have a temperature responsive linear output.

We have devised an anti-stall device which operates the carburetor butterfly valve as a function of variances in the temperature of air ambient the carburetor and thereby as a function of the temperature of air entering the carburetor throat.

In the embodiments of our invention illustrated in the drawings we have disclosed a temperature responsive force transmitting device which employs a temperature sensitive thermally expansible material having a linear coefficient of expansion.

This device is employed in several forms and may replace the mixture adjustment screw or its equivalent on the carburetor.

It is therefore a principal object of the present invention to provide an improved thermal responsive force transmitting device.

Another object of the invention resides in provision of a thermal responsive force transmitting device employing a thermally expansible substance having a linear coefficient of expansion.

Yet another object of the invention resides in the provision of a thermal responsive force transmitting device of the type above described which is completely self-contained and which has its own power member return spring and means for accommodating element over-travel.



A further object of the invention is directed to the provision of an automobile carburetor engine anti-stall device.

A still further and more specific object of the invention is directed to an anti-stalled device of the type generally referred to above which is effective to vary the adjustment of the carburetor butterfly valve in accordance with ambient air temperatures.

Another object of the invention is directed to the provision of a thermal responsive force transmitting device of this general character which is designed to be mounted on an engine carburetor in place of the usual mixture adjustment screw and which can itself be adjustably positioned to vary engine idle speed.

These and other objects, advantages and features of the present invention will become apparent from time to time as the following specification proceeds and with reference to the accompanying drawings, wherein:

FIGURE 1 is a vertical sectional view of a device constructed in accordance with the present invention and which carries its own power member return spring and over-travel accommodating mechanism;

FIGURE 2 is a vertical sectional view through another embodiment of our invention;

FIGURE 3 is an end view of the device illustrated in FIGURE 2 and showing the left end of said device;

FIGURE 4 is another end view of the device illustrated in FIGURE 2 but showing the opposite end of that device from FIGURE 3;

FIGURE 5 is a vertical sectional view through yet another embodiment of our invention;

FIGURE 6 is a side elevational view of the throat section of an automobile engine carburetor and showing a thermal responsive force transmitting device constructed in accordance with our invention mounted in its proper position in relation thereto;

FIGURE 7 is a fragmentary side elevational view which is similar in nature to FIGURE 6 but which shows a slightly different version of our device and in a different mounted relationship and which shows some parts in vertical section for the purpose of clarity; and

FIGURE 8 is a vertical sectional view through still another embodiment of our invention and showing several of the operating components thereof in side elevation for the purpose of clarity.

In the embodiment of the invention illustrated in FIGURE 1 a solid cylinder **10** is preferably formed of a metallic thermally conductive material and has a bore **11** formed therein along the central axis thereof. The bore **11** has portions of relatively greater and lesser diameter **12** and **13**, respectively, at the left and right hand ends thereof and these portions are joined by a conical section **14** which converges from the portion of greater diameter to the portion of lesser diameter as at **14**. A power member **15** is formed of solid cylindrical stock and is slidably guided within the portion **13** of the bore **11** and is engaged by an anti-chafing disc **16** at its innermost end. In the illustrated embodiment of our invention a rubber plug **17** constitutes the thermal expansion material and extends upwardly into the smaller diameter section of the bore **11** and engages the anti-chafing disc **16**. The left hand most end of the bore **11** is stepped as at **18** and a closure seal is positioned within that end of the bore on the step **18** and serves as a seat for the plug **17** and as a means for sealing the left hand end of the bore **11**. This seal is itself retained within the bore by a retainer **20** which is fitted within an annular groove in the casing **10** during the assembly process to close that end of the casing.

An annular wall **22** is formed integrally with the remainder of the casing heretofore discussed and comprises

a part thereof and extends outwardly to the right and terminates in an outturned annular flange 23.

A cup-shaped shell 24 has a side wall 25 which extends over and around the right hand most end of the cylinder 10 and has an end wall 26 which is engageable with the flanged end section of the cylinder 10. An externally threaded boss 27 extends from and is formed integrally with the end wall 26 of the shell 24 and has a bore 28 formed therein which is coaxial with the bore 11 and which slidably receives the radially reduced end 29 of a piston 30. The radially enlarged inner end 31 of the piston 30 terminates in a flat circular disc 32 which, in turn, engages the right hand most end of the power member 15. A shoulder 33 formed intermediate the radially reduced and radially enlarged ends 29 and 31, respectively, of the piston 30 is engageable with an inwardly extending spring centering boss 34 formed on the end wall 26 of the shell 24. A piston return spring 35 is disposed intermediate the end wall 26 (around the boss 34) and the disc 32 and serves to return the piston 30 and power member 15 to their illustrated positions when the temperatures ambient the cylinder 10 are rather low.

An annular retaining ring 35' is fitted with a groove 36 formed on the inner surface of the side wall 25 and this ring serves as the seat for one end of an overtravel spring 37. The opposite end of that spring is seated on the outturned flange 23. It will be understood that the overtravel spring 37 is a heavier spring than the spring 35.

The plug 17 has a relatively high and linear coefficient of expansion so as to make the output of the device 10 linear relative to increases in the temperature ambient the device. Other materials than rubber might be employed as the expansion material but when used in a carburetor control assembly and other similar applications, it is important that the plug material be workable to the degree required and have this linear coefficient of expansion. The rubber is an ideal material.

Accordingly, upon rises in temperature ambient the cylinder 10 the plug 17 will expand and move the power member 15 toward the right which, in turn, will cause the piston 30 to move extensibly from the boss 27. When the piston 30 has reached the extent of its travel (that is when the shoulder 33 moves into engagement with the boss 34), the spring 37 will then begin to compress and the cylinder 10 will then back off or move relatively from the shell 24.

The operation of the embodiment of the invention illustrated in FIGURE 2 is substantially the same as that heretofore described with respect to FIGURE 1 but for the fact that no over-travel spring mechanism is provided. In this embodiment of the invention the cylinder 40 has a long bore 41 formed therein which has a long thermal expansion plug 42 seated in the left hand end thereof and a power member 43 fitted in the right hand end thereof with an anti-chafing disc 44 therebetween. A taper section 45 of the bore 41 converges from the larger diameter left hand end of the bore to the smaller diameter right hand end thereof and serves as a motion amplifier as is well known in the art to amplify the expansive forces of the plug 42 as such forces are transmitted to the power member 43. The particular requirements of any given installation will, of course, dictate whether or not such a motion amplifying section is required and the characteristics that it should have to provide the desired results.

In this embodiment of the invention the inner surface of the side wall 46 of shell 47 is shouldered as at 48 and the right hand end wall 49 of the cylinder 40 is seated on this shoulder. A boss 50 is formed integrally with and extends outwardly toward the right from the end wall 51 of the shell 47 and is externally threaded for reasons which will hereinafter become apparent. Piston 52 is guided for slidable movement within a bore 53 formed in the boss 50 and is biased to the illustrated position by a return spring 54 which has one end seated on the end wall 51 and its



opposite end seated on disc 55 at the inner end of the piston 53.

A sealing disc 56 is fitted within the left hand most end of the bore 41 to confine the plug 42 and is maintained in its illustrated position by a threaded end cap 57. The end cap 57 is threadly mounted within the left hand end of the cylindrical shell 47 and has a boss 58 which engages the left hand end of the cylinder 40 and the sealing disc 56. It will be observed that in this embodiment of the invention the side wall 46 of the shell 47 embraces the cylinder 40 completely and that the resultant structure is pencil-like in configuration.

The end views 3 and 4 of the embodiment of the invention shown in FIGURE 2 clearly show that the outer surface of the side wall 46 of the shell 47 is hexagonal in configuration whereby to provide a gripping surface for a wrench or the like for purposes which will hereinafter become apparent.

The embodiment of the invention illustrated in FIGURE 5 is quite similar in nature to that illustrated in FIGURE 2 and like numerals have been used to indicate like parts in the figure. The only principal difference between this embodiment of the invention and that shown in FIGURE 2 lies in the manner in which the left hand end of the shell and cylinder are closed. In this version of our device a closure plate 60 covers the left hand end of the cylinder 40 and is positioned on an annular seating shoulder 61. The end of the shell 47 has been peened over as at 62 to maintain the closure plate 60 firmly in its illustrated position.

Turning now to FIGURE 8, there is shown a modified version of our device wherein the temperature responsive force transmitting device is provided with a dashpot between the power member and the piston. By employing such a device in an engine anti-stall capacity closing of the throttle can be slowed down as ambient temperature increases to compensate for possible "too rich" mixture which might result. The time delay feature permits air to flow through the carburetor throat to lean the mixture and keep the air-fuel ratio within the acceptable firing range and thereby prevent engine stall during throttle closing.

The shell and cylinder arrangement are much like that shown in FIGURE 5 and like parts are identified by like numerals. In this embodiment of the invention, however, the power member 43 extends a considerable distance out of the cylinder 40 and has a stirrup 65 mounted over the outer end thereof which, in turn, has an outturned annular flange 66. The cylindrical inner side wall 67 of the shell 47 intermediate the end 51 and the end wall 49 of cylinder 40 serves to define an air chamber 68. Piston head 69 is slidable along the chamber and has an O-ring 70 received within an annular peripheral groove formed therein and this O-ring engages the side wall 67. The piston head 69 is formed integrally with the piston 52 and has a restricted air passage 71 formed therethrough which serves to slowly bleed air from one side to the other of the head 69. Return spring 72 is interposed between the head 69 and the outturned flange 66 and serves to return the power member 43 to its illustrated position upon cooling of the plug 42 and to store energy for moving the piston 52 upon expansion of the plug 42. A vent valve passage 73 is provided to permit air to enter the chamber 68 as the head 69 moves to the left therein. The utility of this mechanism as an anti-stall device will be explained shortly hereafter.

In FIGURE 7 we have shown a simplified view of the base 80 of a carburetor with its main throat 81 shown in broken lines. Suffice it to say that a butterfly valve 82 is disposed within the throat 81 and that it is connected to a lever 83 which is pivoted on the outside of the carburetor and is pivoted about the same axis as that lever. It will therefore be observed that clockwise movement of the lever 83 will effect clockwise movement of the valve 82 and will thereby open the throat to permit a larger quantity of air to flow through the throat. It will be observed that the outer threading on the bosses of each of the as-

semblies heretofore described permits mounting the temperature responsive force transmitting device within a suitable support such as the support **84** in place of a mixture adjustment screw and with the piston **52** (or in the case of the embodiment of the invention illustrated in FIGURE 1, the piston **30**) in engagement with the distal end of the member **83**. The hexagonal configuration of the shell **47** permits the operator to grip the shell with a tool and thereby axially adjust the position of the unit within the support **84** to provide the desired operating characteristics. Then as the temperature of air ambient the shell **47** increases the thermal expansion plug will expand and effect extensible movement of the piston **52** in a manner already described and thereby cause the member **83** to pivot in a clockwise direction to further open the valve **82** and thereby permit a greater quantity of air to flow through the throat **81** as the air becomes hotter. This action will effectively precent the engine from losing r.p.m. as the temperature of the air increases and will thereby effectively prevent the engine from stalling.

A spring **85** is illustrated as interconnecting the support **84** and the lever **83** and is intended to represent the fact that spring means with a fixed bias are provided to return the butterfly valve and its interconnected lever **83** to the illustrated position. It will be understood that when the operator steps down on the accelerator, the valve **82** and its interconnected lever arm **83** will be rotated in a clockwise direction to open the throat **81** and the arm **83** will move out of engagement with the piston **52**.

The structure illustrated in FIGURE 8 has been shown in a circumstance where such action has just taken place.

If the structure illustrated in FIGURE 8 were mounted as is shown in FIGURE 7, its operation would be substantially as follows:

When the engine is running at idle and the air underneath the hood is still cool (as when the engine is first started) the accelerator return spring or its counterpart (as is represented by the spring **85** in FIGURE 7) will serve to maintain the arm **83** in engagement with the outer end of piston **52**. The spring **85** has a fixed bias which is greater than that of the spring **72** in the relatively uncompressed state of the spring **72** and will therefore be effective to hold the piston **52** in a position somewhat to the right of that shown in FIGURE 8 with the head **69** in an intermediate position within the chamber **68**. As the engine continues to run the temperature of air under the hood increases and such increased temperature causes the plug **42** to expand and extensively move the power member **43** from the cylinder **40**. Such extensible movement of the power member **43** acts to compress the spring **72** and thereby increase its bias. As the bias of return spring **72** increases the piston **52** is urged to move toward the left against the bias of the spring **85** and such movement causes the butterfly valve **82** to move to a further open position to permit a larger volume of air to flow through the throat. The rate of air flow through the carburetor can thereby be adjusted in accordance with the temperature of air beneath the hood and thereby in accordance with the temperature of the air entering the carburetor to maintain the engine at a relatively constant r.p.m.

When the operator accelerates, the butterfly valve is pivoted in a clockwise direction to pull the arm **83** out of engagement with the piston **52**. Without the bias of spring **85** tending to hold the piston **52** in a relatively retracted position, the spring **72** is effective to force the piston **52** all the way to the left hand end as is shown in FIGURE 8. When the operator lets up on the accelerator abruptly the arm **83** will strike the outer end of the piston **52** and urge it to move to the right. Such movement will, however, be resisted not only by the spring **72** but also by the differential in air pressure created across the head **69** of the piston **52** as air slowly seeps through the restricted passage **71**. This dashpot arrangement thus retards movement of the piston **52** under such circumstances and this retarding or hysteresis effect will permit the valve **82** to remain in a further open position than would otherwise be possible to insure that enough air will flow to the cylinders to insure burning of the vaporized fuel in the cylinders and to prevent the stalling that might otherwise occur because of a "too rich" mixture at the moment of deceleration.

FIGURE 6 simply illustrates another arrangement wherein a thermal responsive force transmitting device of the type constructed in accordance with our invention is mounted on part of the linkage to the carburetor valve rather than on a fixed support.

It will be understood that any one of the devices illustrated in any of FIGURES 1, 2, 5 or 8 could be mounted in the manner disclosed in either of FIGURES 6 or 7 and, of course, could be used in any number of different capacities to perform a work function as a function of increases in the ambient temperature.

It will be understood that these embodiments of our invention have been used for illustrative purposes only and that various modifications and variations in our invention may be effected without departing from the spirit and scope of the novel concepts thereof.

We claim as our invention:

**1.** A temperature responsive force transmitting device comprising:

a cylinder having a bore formed therein,

said bore having end portions of relatively greater and lesser diameter and having a conical section converging from said portion of greater diameter to said portion of lesser diameter,

a power member slidably guided within said portion of said bore of lesser diameter,

means closing the end portion of said bore of greater diameter,

a thermally expansible solid plug filling said bore intermediate said last named means and said power member and having a linear coefficient of expansion,

a shell embracing said cylinder and having an end wall spaced from the power member carrying end of said cylinder,

an externally threaded boss extending outwardly from said end wall of said shell and having a bore formed therein coaxial with said cylinder bore,

a power rod slidably guided within the said bore formed within said shell,

a head formed on the inner end of said power rod engageable with said power member, and

spring means interposed between said head and said end wall and biasing said head into engagement with said power member.

**2.** A temperature responsive force transmitting device constructed in accordance with claim **1** wherein the outer surface of said shell is a multi-flat-sided configuration suitable for gripping with a tool.

**3.** A temperature responsive force transmitting device comprising:

a cylinder having a bore formed therein,

said bore having end portions of relatively greater and lesser diameter and having a conical section converging from said portion of greater diameter to said portion of lesser diameter,

a power member slidably guided within said portion of said bore of lesser diameter,

a thermally expansible solid plug filling said bore intermediate the outermost end of said portion of greater diameter and said power member and having a linear coefficient of expansion,

a shell embracing said cylinder and having an end wall spaced from the power member carrying end of said cylinder,

a boss extending outwardly from said end wall of said shell and having a bore formed therein coaxial with said cylinder bore,

a power rod slidably guided within the said bore formed within said shell,

a head formed on the inner end of said power rod engageable with said power member,

spring means interposed between the said end wall and said head and biasing said head into engagement with said power member, and

a closure cap threadedly mounted on the opposite end of said shell from the said end wall and closing both said shell and the outermost end of said portion of said cylinder of greater diameter.

**4.** A temperature responsive force transmitting device comprising:

a housing having a bore formed therein and having an outturned flange formed on one end thereof,

a power member guided for slidable movement within said bore and extensible from said one end of said housing,

means closing the other end of said bore,

a mass of thermally expansible material filling said bore intermediate said last named means and said power member and having a linear coefficient of expansion,

a shell having an end wall positioned adjacent said one end of said housing and having portion embracing said housing,

spring means biasing said end wall of said shell toward said one end of said housing,

a bore within said shell coaxially aligned with the said bore within said housing,

a power rod slidably guided within said last named bore and engageable with said power member, and

means biasing said rod toward said power member.

**5.** A temperature responsive force transmitting device comprising:

a housing having a bore formed therein and having an outturned flange formed on one end thereof,

a power member guided for slidable movement within said bore and extensible from said one end of said housing.

means closing the other end of said bore,

a thermally sensitive rubber plug filling said bore intermediate said last named means and said power member and having a linear coefficient of expansion,

a shell having a multiple flat-sided exterior and having an end wall positioned adjacent said one end of said housing and having a portion embracing said housing,

spring means biasing said end wall of said shell toward said one end of said housing,

an externally threaded boss formed integrally with and extending from said end wall of said shell,

a bore formed within said boss and through said end wall of said shell coaxially with said bore formed within said housing,

a power rod guided for slidable movement within said last named bore and engageable with said power member, and

means biasing said rod toward said power member.

**6.** In combination with a carburetor having a valve for controlling the amount of air passing through the carburetor and having a lever connected to the valve and pivotally movable to vary the degree of closure thereof and having a spring biasing the valve in a closing direction, the improvement which comprises:

a support,

a temperature responsive force transmitting device mounted on said support,

said temperature responsive force transmitting device comprising:

a casing having a bore therein,

a power member positioned for slidable movement within one end of said bore,

means closing the other end of said bore, and

an expansion mass having a linear coefficient of expansion interposed between said means and said power member,



wherein said piston engages said lever, and wherein extensible movement of said power member effected upon expansion of the mass.

**7.** The combination set forth in claim 6 wherein said temperature responsive force transmitting device is adjustably positioned within said support to provide a means for varying the relative positions between said device and said lever.

**8.** In combination with a carburetor having a valve for controlling the amount of air passing through said carburetor and having a lever connected to the valve and pivotally movable to vary the degree of closure thereof and having a spring biasing the valve in a closing direction, the improvement which comprises:

a support,

a temperature responsive force transmitting device mounted on said support,

said device comprising:

a cylinder having a bore therein, said bore having end portions of relative greater and lesser diameter and having a conical section converging from said portion of greater diameter to said portion of lesser diameter,

a power member slidably guided within said portion of said bore of lesser diameter,

means closing the end portion of said bore of greater diameter,

a thermally expansible solid plug filling said bore intermediate said last named means and said power member and having a linear coefficient of expansion,

a shell embracing said cylinder and having an end wall spaced from the power-member-carrying end of said cylinder,

an externally threaded boss extending outwardly from said end wall of said shell and having a bore formed therein coaxial with said cylinder bore, a power rod slidably guided within the said bore formed within said shell, a head formed on the inner end of said power rod engageable with said power member, and spring means interposed between said head and said end wall and biasing said head into engagement with said power member.

**9.** In combination with a carburetor having a valve for controlling the amount of air passing through the carburetor and having a lever connected to the valve and pivotally movable to vary the degree of closure thereof and a spring biasing the valve in a closing direction, the improvement which comprises:

a support,

a temperature responsive force transmitting device mounted on said support,

said device comprising:

a casing having a bore therein,

a power member positioned for slidable movement within one end of said bore,

means closing the other end of said bore,

an expansion mass having a linear coefficient of expansion interposed between said means and said power member, and

a dashpot and piston assembly interposed between said power member and said lever,

whereby extensible movement of said power member is effected upon expansion of the mass.

**10.** In combination with a carburetor having a valve for controlling the amount of air passing through the carburetor and having a lever connected to the valve and pivotally movable to vary the degree of closure of the valve and a spring biasing the valve in a closing direction, the improvement which comprises:

a support,

a temperature responsive force transmitting device which comprises a cylinder having a bore formed therein,

said bore having end portions of relatively greater and lesser diameter and having a conical section converging from said portion of greater diameter to said portion of lesser diameter,

a power member slidably guided within said portion of said bore of lesser diameter,

means closing the end portion of said bore of greater diameter,

a thermally expansible solid plug filling said bore intermediate said last named means and said power member and having a linear coefficient of expansion,

a shell embracing said cylinder and having an end wall spaced from the power member-carrying end of said cylinder,

an externally threaded boss extending outwardly from said end wall of said shell and having a bore formed therein coaxial with said cylinder bore,

said threaded boss being threadedly and adjustably mounted within said support,

a power rod slidably guided within the said bore formed within said shell,

a head formed on the inner end of said power rod and slidable along said shell,



a restricted air passage formed through said head and spring means interposed between said power member and said head and biasing said power rod extensibly from the said end wall.


**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,371,277 | 3/1921 | Udale. | |
| 2,368,181 | 1/1945 | Vernet | 73—363 |
| 2,774,343 | 12/1956 | Schaffer et al. | 261—39.1 X |
| 2,990,716 | 7/1961 | Butts | 73—363 |
| 3,007,029 | 10/1961 | Levine. | |
| 3,118,648 | 1/1964 | Campbell. | |
| 3,131,269 | 4/1964 | Asakawa | 73—363 X |

OTHER REFERENCES

Brenner et al.: High Temperature Plastics, Reinhold, New York, 1962, page 175.



EDWARD J. MICHAEL, *Primary Examiner.*

ALDEN D. STEWART, *Examiner.*