United States Patent

Gifford

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[54] **VALVE REPSONSIVE TO TEMPERATURE CHANGES OVER A LIMITED RANGE**

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[52] **U.S. Cl.** **236/102**

[51] **Int. Cl.** **G05d 23/275**

[58] **Field of Search**....................236/102, 101, 93, 87

[56] **References Cited**

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[57] **ABSTRACT**

A fluid flow metering valve which varies effective flow area in response to temperature changes over a limited temperature range. The valve core, having a conically shaped end positioned in the fluid flow port, expands freely as temperature increases to a predetermined value from a temperature below that value. Thereafter, an abutment in the valve casing is engaged by a shoulder on the valve core to prevent the conically shaped end of the core from advancing further into the port, with additional expansion of the core being accommodated at the opposite end of the casing. A spring retains the core in the casing and returns it to its original position upon a decrease in temperature to and below the predetermined value.

14 Claims, 3 Drawing Figures

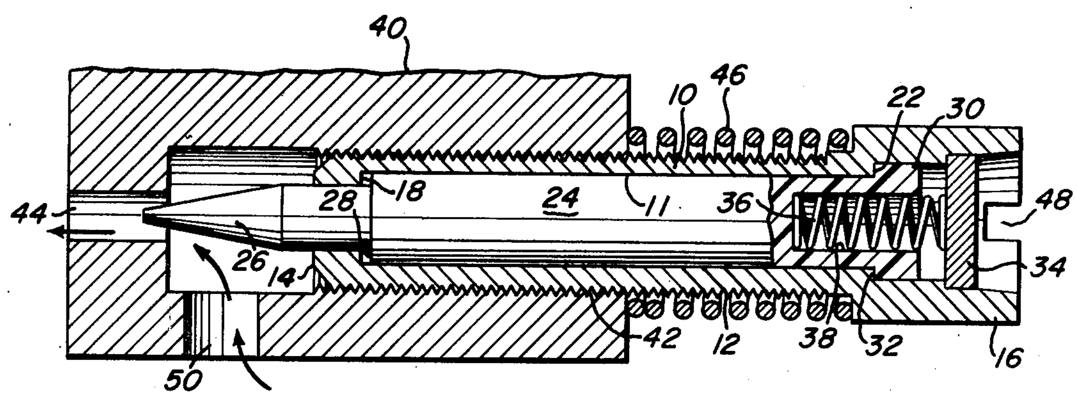

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FIG-1

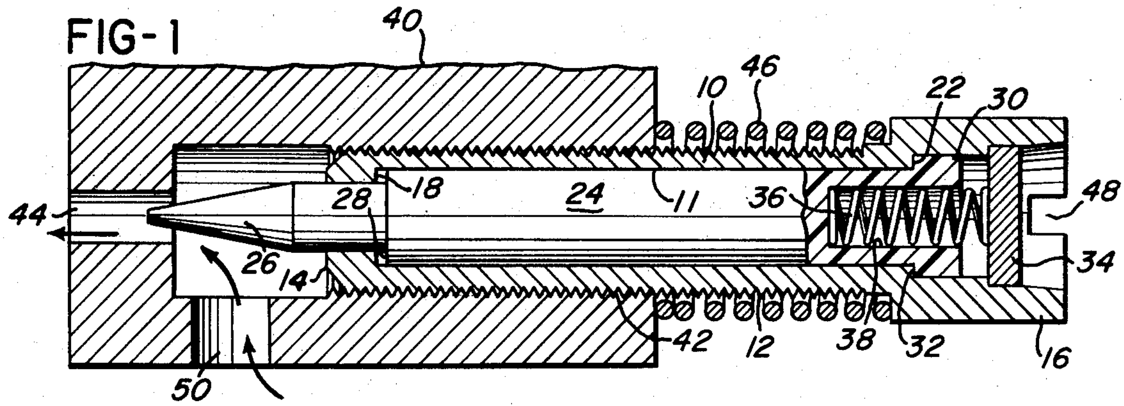


FIG-2

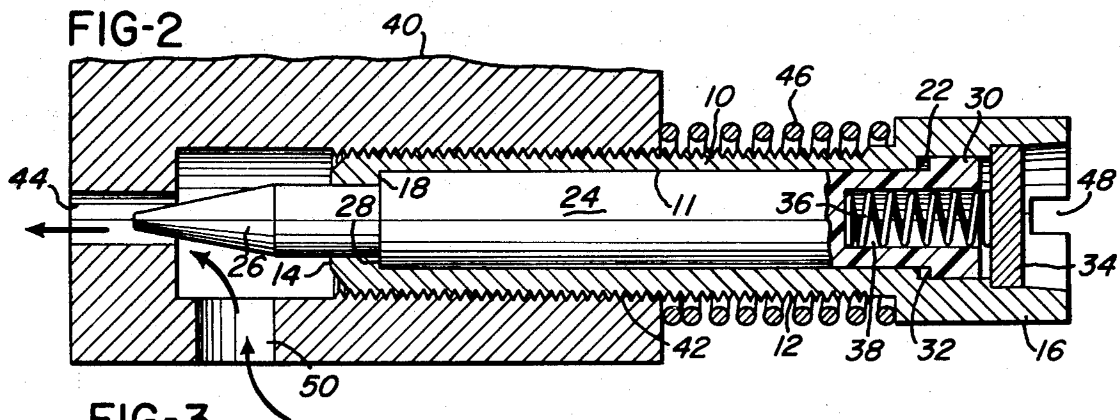
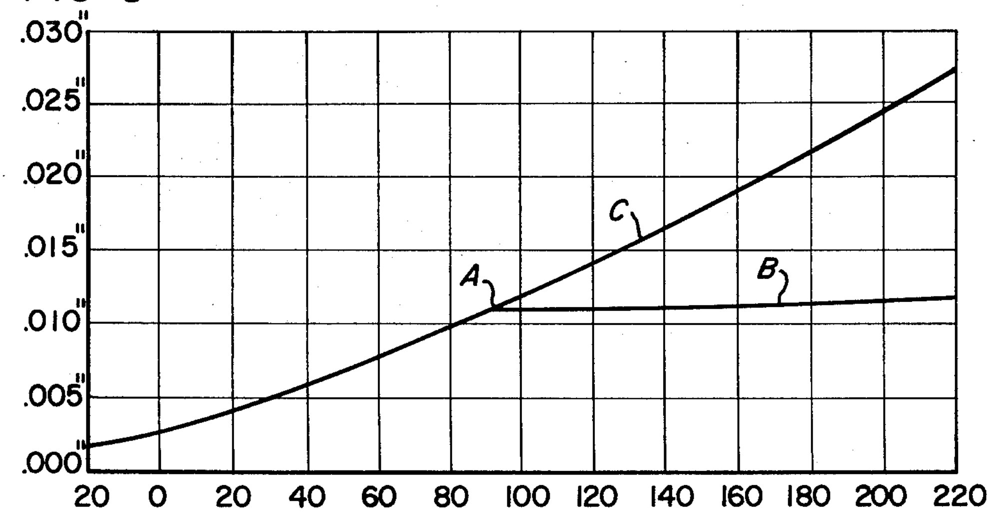


FIG-3



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VALVE REPSONSIVE TO TEMPERATURE CHANGES OVER A LIMITED RANGE

CROSS REFERENCE TO RELATED APPLICATION

THERMALLY RESPONSIVE VALVE ASSEMBLY, by Robert T. Gifford, Ser. No. 132,494, filed Apr. 8, 1971.

BACKGROUND OF THE INVENTION

In the above noted, related application a valve assembly is disclosed in which a unitary, rod-like valve member is received in a valve casing with one end of the valve member attached to the casing and the opposite end projecting outwardly thereof into a fluid flow port. The diameter of the valve member is sufficiently smaller than the internal bore of the valve casing to permit the main body of the valve member to move within the casing and the materials of which the casing and valve member are constructed are selected such that the coefficient of linear thermal expansion of the valve member is appreciably greater than that of the casing.

The free end of the valve member projects outwardly of the casing so that when the casing is attached to the wall of a member having a flow port therein through which the fluid flow is to be regulated, the outwardly projecting end of the valve member is positioned in the fluid flow port. With this construction an increase in temperature will cause the valve member to expand and advance its outwardly projecting end farther into the fluid flow port. This results in a decrease in the effective flow area through the port. A decrease in temperature of course, will result in an increase in effective flow area as the valve member contracts and in this way the flow of fluid through the port is regulated in response to temperature changes.

While the above described construction functions effectively in its intended environment, it will be seen that the effective flow area through the flow port will be continuously decreased in response to increases in temperature. In certain installations, however, it is desirable to set a lower limit for effective flow area regardless of further temperature increases. In the idling inlet port of a carburetor, for example, while it is desirable to decrease the effective flow area of the port in response to increases in temperature, there is a certain minimum effective open area which must be maintained regardless of continued temperature increases. Obviously, in a valve construction in which movement of the valve member is unrestrained temperatures may be encountered which are high enough to close the effective flow area below the minimum desired or even close it completely.

SUMMARY OF THE INVENTION

The present invention provides a valve assembly which is responsive to temperature changes over a limited range of values. Thus, as the temperature rises above a first value, which is below some preselected temperature, the valve member will expand, advancing its flow regulating end farther into the flow port with which it is associated, thereby reducing the effective area of the flow port. However, after the valve member has expanded a certain predetermined amount, at which point the valve member will be at the preselected temperature, an outwardly projecting shoulder on the valve member engages an inwardly projecting shoulder on the casing within which it is mounted to prevent further advance of the conically shaped end of the valve member in any appreciable amount.

A further increase in temperature above the preselected temperature, and thus, further expansion of the valve member, is accommodated at the opposite end of the casing, where the opposite end of the valve member advances in opposition to the pressure of a spring mounted in the casing at that point. As a result, after the temperature has reached some predetermined value and the effective open area of the flow port has been reduced to a predetermined amount, the effective area of the flow port remains relatively constant regardless of continued temperature increases.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view, partly in section, showing the valve assembly with the valve core thereof in a first position;

FIG. 2 is a view similar to FIG. 1, but showing the valve core in a second position thereof; and

FIG. 3 is a graph comparing the travel of the valve member of the present invention in response to temperature change to the travel of a valve member in which movement thereof is unrestrained.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference initially to FIG. 1 of the drawings, it will be seen that a valve assembly in accordance with the present invention includes a valve casing **10** having an internal bore **11** and an externally threaded portion **12** extending from adjacent one end **14** thereof to an enlarged opposite end **16**. At the end **14** of the casing a shoulder projects radially inwardly into the bore **11** to define an abutment **18** at that point. At its enlarged end **16** a shoulder or stop member **22** is defined by a portion projecting outwardly of the bore **11**.

Received within the casing **10** is an elongated, unitary, rod-like valve member or core **24** having a conically shaped, fluid flow regulating end **26**. The valve core **24** is also provided with an outwardly projecting shoulder **28** positioned in opposition to the inwardly projecting abutment **18** of the valve casing. The opposite end of the valve core **24** is provided with an enlarged head portion **30** to provide an outwardly projecting shoulder **32** positioned in opposition to the shoulder **22** of the casing **10**.

A retainer **34** is force fitted into the enlarged open end of the casing **16** and serves to retain a spring member **36** mounted in a pocket **38** in the end of the valve member or core **24**. The valve assembly thus described may be readily fixed within a threaded opening of a member **40** with which it is associated by means of the external threads **12** thereof engaging complementary threads **42** formed in the wall of the member **40**.

Thus, the casing **10** is threaded into the portion **42** of the member **40** to obtain the desired clearance between the conically shaped end **26** of the valve core **24** and the flow port **44** at a preselected temperature. A coil spring **46** encircles the outwardly projecting portion of the casing **10** and bears against the member **40** at one end and the enlarged head **16** of the casing at its opposite end and serves to retain the casing in this preset position. It will also be noted that the enlarged head **16** of the casing **10** may be provided with a tool engaging portion, such as the slot **48**, to facilitate adjustment of the casing within the threaded portion of the member **40**.

In operation, assume that the temperature is below the preselected temperature such that the position of the core **24** within the casing **10** is as shown in FIG. **1** of the drawings. Fluid flow may be in the direction indicated by the arrows in FIGS. **1** and **2** although it will be apparent that the flow direction could be reversed. In this position it will be noted that the outwardly projecting shoulder **28** is spaced from the abutment **18** formed by the inwardly projecting portion of the casing **10** and that the under surface of the enlarged head **30** of the core **24** is seated against the outwardly projecting shoulder **22** of the casing **10** and held in this position by means of the spring **36**.

If the temperature thereafter increases, the core **24** will expand, causing its conically shaped end **26** to advance farther into the flow port **44**. This advance will continue as the temperature increases further until the shoulder **28** engages the abutment **18** at the preselected temperature, with additional advancement being negligible since it is caused only by the expansion of the relatively short section of the core extending from adjacent the outwardly projecting shoulder **28**. Continued increase in temperature and commensurate expansion of the core **24** will be accommodated in the enlarged end **16** of the casing by movement of the head **30** in opposition to the spring member **36**.

This, as seen in FIG. **2**, will cause the under surface **32** of the head **30** to move from engagement with the outwardly projecting shoulder **22**, compressing the spring **36**. Of course, as the temperature thereafter decreases, the spring **36** will first urge the shoulder **32** into engagement with the stop **22** and further contraction of the core **24** will cause the shoulder **28** to become disengaged from the abutment **18**, retracting the conically shaped end **26** of the core **24** from the flow port **44** and thereby increasing the effective flow area therethrough.

With reference to FIG. **3** of the drawings it will be noted that the travel of the conically shaped end of the core **24** in response to changes in temperature is essentially the same as that of a valve assembly of the type described in the above noted related application until some predetermined advancement of the core **26**, as indicated by the letter A on the curve, is reached. Thereafter, continued increase in temperature will result in only negligible travel of the end **26** of the core, as indicated by that portion of the curve labelled B, as contrasted to the continued travel of a corresponding portion of a core in which movement thereof is unrestrained, as indicated by the portion of the curve labelled C in FIG. **3** of the drawings.

Of course, it is necessary to dimension the length of the core **24** with respect to the length of the bore of the casing **10** as well as properly select materials for the core and the casing having coefficients of linear thermal expansion to give the desired results. In this regard it has been found that the valve casing may be formed of a material such as steel having a coefficient of linear thermal expansion of approximately 6×10^{-6} inch/inch/F°., although a 20–40 percent glass filled, relatively rigid, organic polymer, such as nylon, will also function satisfactorily.

The material of which the core is formed must have an appreciably higher coefficient of linear thermal expansion and desirably is at least three times greater than the thermal coefficient of expansion of the valve casing. In constructing the valve core various relatively rigid, organic polymers, such as nylon, polyethylene, acetal resins, acrylics and polyvinylidene fluoride, have been found satisfactory. Thus, using steel as the casing material and forming the core of polyvinylidene fluoride, the coefficient of linear thermal expansion of the core will be approximately thirteen times greater that that of the casing or shell.

Obviously, however, a wide variety of materials may be utilized in practicing the present invention and with various combinations of readily available materials the range of differences in coefficients of linear thermal expansion will range from about **3** to **25**. The only requirements are that the coefficients of linear thermal expansion of the core and the casing are sufficiently different to give appreciable core travel and that the length of the core relative to the length of the internal bore of the casing is such as to permit appreciable travel of the core only within certain predetermined limits.

While the forms of apparatus herein described constitutes preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. A thermally responsive valve comprising:

a. a valve casing having a first coefficient of linear thermal expansion,

b. means defining a bore extending longitudinally of said casing,

c. a valve core having a coefficient of linear thermal expansion appreciably different than that of said casing slidably received in said bore,

d. abutment means positioned in said bore adjacent one end thereof,

e. abutment engaging means on said valve core positioned in opposition to said abutment means for engagement therewith upon temperature change,

f. stop means positioned adjacent an opposite end of said bore,

g. stop engaging means of said valve core positioned in opposition to said stop means, and

h. means for urging said stop engaging means into engagement with said stop means.

2. The valve of claim **1** wherein:

a. said stop means comprises an enlarged portion of said bore defining an outwardly projecting shoulder.

3. The valve of claim **2** wherein:

a. said means for urging said stop engaging means into contact with said stop means comprises a spring member mounted in said enlarged portion of said bore and pushing said stop engaging means toward said stop means.

4. The valve of claim **3** further comprising:

a. a retainer extending inwardly of said enlarged portion of said bore in spaced relation to said stop means and in engagement with said spring member, and
b. means defining a pocket formed in said core and receiving said spring member.

5. The valve of claim **1** wherein:
a. said stop engaging means comprises an outwardly projecting head formed on one end of said core in overlying relationship to said stop means.

6. The valve of claim **5** wherein:
a. said means urging said head into engagement with said stop means comprises a spring member, and
b. a retainer is mounted in said bore in engagement with said spring member and in spaced relationship to said stop means to retain said spring in contact with said core.

7. The valve of claim **6** further comprising:
a. means defining a pocket in said one end of said core receiving said spring member.

8. A thermally responsive valve comprising:
a. a valve casing having a longitudinally extending bore,
b. means defining an abutment adjacent one end of said bore and a stop adjacent an opposite end of said bore,
c. a valve core slidably received in said bore and having portions adapted to engage said abutment and stop defining means,
d. the length and coefficient of linear thermal expansion of said core with respect to the length of said bore and the coefficient of linear thermal expansion of said casing being such that:
   i. said abutment and stop engaging means engage said abutment and stop, respectively, at a first temperature,
   ii. said abutment engaging means is spaced from said abutment and said stop engaging means engages said stop at a second temperature lower than said first temperature, and
   iii. said abutment engaging means engages said abutment and said stop engaging means is spaced from said stop at a third temperature higher than said first temperature.

9. The valve of claim **8** further comprising:
a. means defining a flow port, and
b. means fixing said valve casing with respect to said flow port with a portion of said valve core positioned in said port,
c. said valve core being operative to vary the effective open area of said flow port over a first temperature range and relatively inoperative to vary said effective open area over a second temperature range.

10. The valve of claim **8** further comprising:
a. a portion of said bore adjacent one end thereof being of reduced cross section, forming an inwardly projecting shoulder defining said abutment,
b. a second portion of said bore adjacent an opposite end thereof being of enlarged cross section, forming an outwardly projecting shoulder defining said stop,
c. a portion of said core adjacent said one end of said bore defining an outwardly projecting shoulder disposed in opposition to and for engagement with said inwardly projecting shoulder of said bore upon expansion of said core,
d. a portion of said core adjacent said opposite end of said bore being of enlarged cross section and defining a head positioned for engagement with said outwardly projecting shoulder of said bore upon contraction of said core, and
e. spring means resiliently urging said head into engagement with said outwardly projecting shoulder.

11. The valve of claim **4** wherein:
a. said valve casing has a relatively low coefficient of linear thermal expansion, and
b. said valve core has a relatively high coefficient of linear thermal expansion compared to said valve casing.

12. The valve of claim **7** wherein:
a. said valve casing has a relatively low coefficient of linear thermal expansion, and
b. said valve core has a relatively high coefficient of linear thermal expansion compared to said valve casing.

13. The valve of claim **10** wherein:
a. said valve casing has a first coefficient of linear thermal expansion, and
b. said valve core a coefficient of linear thermal expansion appreciably different than the coefficient of linear thermal expansion of said valve casing.

14. The valve of claim **13** wherein:
a. said valve core has a coefficient of linear thermal expansion substantially greater than the coefficient of linear thermal expansion of said valve casing.

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