(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 343 515 A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 89108969.0

(51) Int. Cl.4: F02D 11/10

(22) Date of filing: 18.05.89

(30) Priority: 27.05.88 IT 5318388 U

(43) Date of publication of application:
29.11.89 Bulletin 89/48

(84) Designated Contracting States:
DE ES FR GB SE

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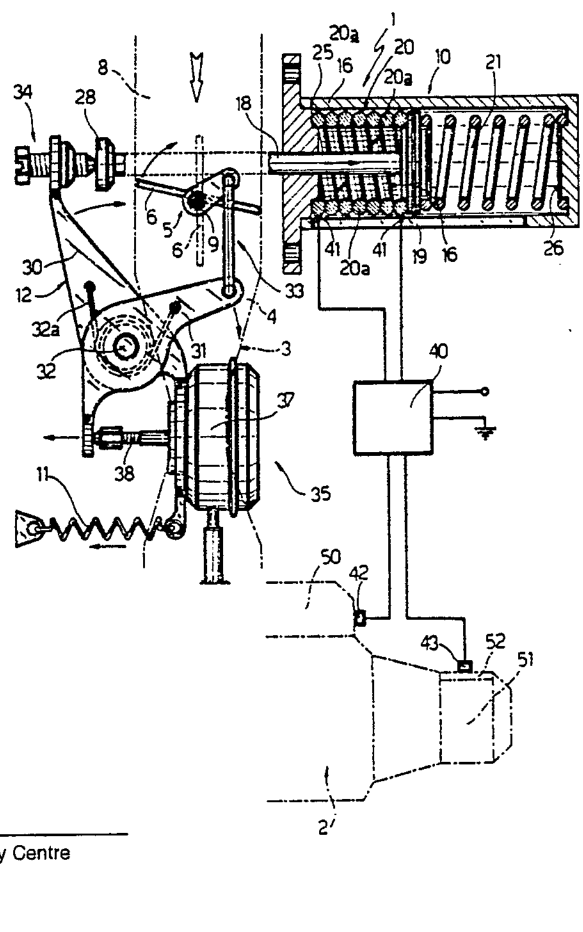
(54) **Device for regulating the air input flow rate to an internal combustion engine carburettor.**

(57) A device for regulating the air input flow rate to an internal combustion engine carburettor during cold-starting is described; the device consists of a butterfly valve disposed upstream of the carburettor diffuser, elastic opposition means, an actuator operated by the engine temperature increase, and mechanical transmission means connecting the actuator, the opposition means and the butterfly valve together in such a manner as to keep this latter normally closed when the engine is cold; the actuator incorporates a shape memory element (SME) arranged to selectively assume, as a function of the instantaneous engine temperature, a plurality of predetermined shapes.



EP 0 343 515 A2

DEVICE FOR REGULATING THE AIR INPUT FLOW RATE TO AN INTERNAL COMBUSTION ENGINE CARBURETTOR

This invention relates to a device for regulating the air input flow rate to an internal combustion engine carburettor, in particular for the purpose of engine cold-starting.

It is well known that when cold-starting an internal combustion engine, the air feed duct upstream of the carburettor diffuser must be valved to suitably regulate the air flow rate in such a manner as to form a richer than normal air-petrol mixture in the diffuser. For this purpose, known carburettors are provided with a regulator device, also known as a choke, consisting of a butterfly valve installed upstream of the diffuser, together with control means to adjust the angular position of the butterfly valve. In the simplest carburettors these means are a draw cable operated manually by the vehicle user. In more improved carburettors the closure of the butterfly valve on starting and its progressive opening as the engine heats up are controlled automatically by an actuator consisting of a temperature-sensitive element, usually a wax bulb of high coefficient of thermal expansion which on expanding operates a linkage which causes the butterfly valve situated upstream of the carburettor diffuser to progressively open.

Manual control devices are clearly of poor efficiency because on the one hand they compel the user to distract his attention from driving while progressively releasing the choke, and on the other hand they do not enable a normal user to apply the necessary precision and reproducibility in the progressive opening of the butterfly valve as the engine heats up. Consequently, engines provided with manually operated chokes usually generate a considerable quantity of unburnt exhaust, with consequent environmental pollution. There is also the danger that, due to an oversight, the choke remains unnecessarily closed when the engine is hot, with consequent greater fuel consumption and the risk of flooding the engine. On the other hand, automatic control devices are very efficient but have the drawback of involving a certain constructional complexity, particularly in terms of the carburettor body, and a considerable overall size. In this respect, to cause the wax bulb to expand as a function of engine temperature, the bulb must be heated by positioning it in contact with the engine cooling liquid. This means that cooling liquid feed and circulation ducts within the carburettor body have to be used from the radiator. In addition, the bulb expansion is usually linear with temperature, whereas the progressive opening of the butterfly valve has to follow a predetermined non-linear relationship. Consequently, complex linkages comprising cams and other such expedients have to be provided for transmitting movement from the wax actuator to the butterfly valve.

The object of the invention is to provide a choke which is free of the described drawbacks by being of small overall size, of simple construction and assembly, and of automatic operation.

Said object is attained according to the invention by a device for regulating the air input flow rate to an internal combustion engine carburettor, in particular for the purpose of engine cold- starting, comprising a butterfly valve disposed upstream of the diffuser of said carburettor, elastic opposition means, an actuator operated by engine temperature variation, and mechanical transmission means connecting said actuator, the opposition means and the butterfly valve together in such a manner as to keep this latter normally closed when the engine is cold; characterised in that said actuator comprises a shape memory element (SME) arranged to selectively assume, as a function of its instantaneous temperature, a plurality of predetermined shapes.

The invention will be more apparent from the non-limiting description of one embodiment thereof given hereinafter with reference to the accompanying drawing, which is a diagrammatic partly sectional illustration of a device for regulating the air input flow rate to a carburettor constructed in accordance with the present invention.

In said drawing, the reference numeral 1 indicates overall a choke for an internal combustion engine 2 of any type, shown schematically by dashed lines, for regulating the air input flow rate to a carburettor 3, also of known type and represented only in part by dashed lines, for feeding the engine 2. The carburettor 3 is provided with a venturi diffuser 4, upstream of which, with reference to the direction of the feed air flow shown by the arrow, there is disposed a butterfly valve 5 of known type forming part of the device 1, the valve plate 6 of which is angularly rotatable about a pin 9 to intercept and constrict an intake duct 8 of the engine 2. The butterfly valve 5, which is shown in its closed position, has its valve plate 6 rotatable in the direction of the arrow, and mobile between the illustrated closed position and an open position, shown by dashed lines, in which the valve plate 6 lies substantially parallel to the feed air flow direction.

In addition to the valve 5, the device 1 comprises a linear actuator 10 operated by the temperature variation in the engine 2, elastic opposition means for the butterfly valve 5 and defined by a spring 11, and mechanical motion transmission means, defined by a linkage of any type, indicated overall by 12 and connecting together the actuator 10, valve 5 and opposition spring 11 in such a manner as to keep the valve 5 in its closed position when the actuator 10 is inactive, ie when the engine 2 is cold. According to the invention, the actuator 10 comprises a casing 16 which can be formed integrally with the carburettor body 3 or can be fixed onto the outside of this latter, a rod 18, a disc 19, a shape memory element 20 in the form of a helical spring, and an opposition spring 21 for the element 20. This latter is constructed of an electrically conducting metal alloy of SME known type such as a beta aluminium bronze, and is able to expand on temperature increase of the engine 2 to selectively assume a plurality of predetermined shapes, depending on its instantaneous temperature. For example, the element 20 can lengthen progressively in the direction of the helix axis as its temperature increases beyond ambient. Elements of this type are known and are able to vary their dimensions to a considerable extent non-linearly for just a few degrees of temperature fluctuation, as the dimension variations are produced by actual discrete variations of the element's shape which occur not on account of thermal expansion but on account of the so-called "shape memory" phenomenon by which if the element is initially formed into different shapes at different temperatures by mechanical coaction, it automatically reassumes these shapes at the same temperatures if left free to do so, this phenomenon being related to martensitic phase transitions which occur in the crystalline structure of the element itself. Consequently, the element 20 is able to act as both sensor and actuator element simultaneously. According to a further characteristic of the invention, the element 20 can be formed in one piece from a single homogeneous alloy or can be formed by joining together several portions or subelements 20a, each of which consists of an SME alloy of different rated thermal sensitivity. This second method makes the element 20 resulting from joining together several portions 20a more sensitive, and if desired it enables an overall element 20 to be obtained having a linear or nearly linear relationship between elongation and temperature.

According to the invention, the element 20 is directly exposed to the heat radiated by the engine 2 and is mounted between a fixed shoulder 25 and a mobile shoulder defined by the disc 19, against which the spring 21 acts in the opposite direction to the direction of elongation of the element 20, the spring 21 being mounted between the mobile shoulder 19 and a second fixed shoulder 26 distant from 25 but rigid with it. The rod 18 rigidly carries a mobile stop 28 for said transmission means 12, against which these latter are kept constantly cooperating by the opposition spring 11. Specifically, the transmission means 12 are formed according to the invention in such a manner as to cause the butterfly valve 5 to open progressively as a consequence of the expansion (elongation) of the element 20, and comprise, in this non-limiting example given purely for purposes of illustration, two rocker levers 30 and 31 pivoted on a common pin 32 parallel to the pin 9 and connected angularly together elastically by a spring 32a which is in the form of a flat spiral spring. The lever 31 is connected to the valve plate 6 by a connecting rod 33, and the lever 30, under the thrust of the spring 11, cooperates with the stop 28 by way of a known adjustment screw 34. According to a preferred embodiment of the device, the device 1 also comprises a known vacuum pull-down 35 for the carburettor 1 comprising a pneumatic actuator 37, for example carried rigidly by the lever 30, and connected in known manner to a vacuum source within the engine 2, such as the duct 8 upstream of the valve 5, and an adjustable rod 38 the movement of which is controlled by the actuator 37 and which cooperates radially with that end of the lever 31 distant from that connected to the valve 5 so as to cause the levers to rotate relative to each other by a predetermined amount against the action of the spring 32a, with the result that as any rotation of the lever 30 is blocked by the stop 28 against which it is kept by the spring 11, the lever 31 is caused to rotate in the direction of the arrow and open the butterfly valve 5 by a predetermined amount.

It is in any event clear that, in accordance with a further non-illustrated embodiment, the linkage 12 can be of different type and the spring 11 can be of the same type as the spring 32a and be mounted on the pin 9 to act directly against the valve plate 6 of the valve 5, and cooperate with the transmission means 12 only by entrainment, provided that the spring 11 is able to operate the means 12 in such a direction as to cause the valve 5 to open, while following the stop 28 which is mobile together with the disc 19 along the axis of the helix of the element 20. In the illustrated example, the temperature of this latter does not derive directly from the heat emitted by the engine 2, but is instead controlled with high accuracy, and in accordance with a relationship which can be varied at will, by a control centre, for example of electronic type. In this case the disc 19 and fixed shoulder 25 cooperate in a fluid-tight manner with the interior of the casing 16, to define within this latter a chamber 16a sealed in a fluid-tight manner and internally housing both the element 20 and a fluid (water, oil or the like) which completely fills the chamber 61a. The control centre 40 is arranged to feed an electric current through the element 20 or through said fluid if conducting, by way of respective electrodes 41 connected to the respective opposite ends of the element 20 or dipping into the fluid which fills the chamber 16a, the current intensity being such as to heat the element 20 and said fluid in the chamber 16a to the desired temperature by the Joule effect. This temperature is determined by the suitably programmed control centre 40 in accordance with the temperature of the engine 2, and in particular the temperature of the engine head 50 and of the oil contained in the gearbox 51, these being measured by a temperature sensor 42 disposed on the engine head 50 and a temperature sensor 43 disposed in an oil channel 52 of the gearbox 51. At the same time, the presence of said fluid filling the chamber 16a, and in which the element 20 is immersed, protects it from any thermal disturbances caused by the progressive heating of the engine 2, and/or from the cooling produced by the atmospheric air to which the SME can be exposed during the running of a vehicle which carries the device 1 fitted to its engine 2.

The operation of the described device 1 is as follows. When the engine 2 is started from cold, the element 20 is contracted into the shape shown on the accompanying drawing, so that the spring 21, which is preloaded such as to generate a force greater than the spring 11, keeps the stop 28 in a predetermined end-of-travel position. The lever 30, which under the action of the spring 11 would tend to rotate on the pin 32 in the direction of the arrow so as to drag (by way of the spring 32a) the lever 31 into rotation in the direction which through the connecting rod 31 would cause the valve 5 to open, is instead blocked against the stop 28 which is kept at rest by the spring 21, and thus the valve remains closed. As soon as the engine 2 has started, a vacuum is created in the duct 8 and operates the actuator 37 to cause the rod 38 to extend and the lever 31 to consequently rotate against the action of the spring 32a relative to the lever 30, which remains at rest against the stop 28. This rotation of the lever 31 is limited but is sufficient to produce a predetermined opening of the valve 5. Consequently the valve plate 6 rotates a few degrees towards the position shown by dashed lines, to reduce the vacuum in the diffuser 4 and thus prevent flooding of the carburettor 3. As the engine 2 heats up, the element 20 is also heated either by direct radiation or, as in the illustrated example, by the current flowing through it (or through the fluid which fills the chamber 16a) from the control centre 40. Consequently the SME 20 reaches its transition temperature and begins to change shape, in the given example it becoming longer so that the winding pitch of its turns increases. Each temperature progressively reached by the element 20 causes it to assume a corresponding predetermined length. Consequently, the mobile shoulder 19 is urged towards the fixed shoulder 26 against the action of the spring 21, to move the stop 28. Thus under the thrust of the spring 11 the lever 30 rotates in the direction of the arrow to follow the stop 30, with which it remains in constant cooperation, to cause rotation of the lever 31 and consequent progressive opening of the valve 5. With the engine hot the element 20 completes its expansion, to move the stop 28 into a position which gives complete opening of the valve 5 (valve plate 56 in the position shown by dashed lines). When the engine 2 is turned off it cools progressively, as does the element 20 which consequently shortens. The shoulder 19 is therefore returned towards the shoulder 21, so moving the stop 28 and causing the lever 30 to rotate in the opposite direction to the preceding, against the action of the spring 11, with consequent progressive closure of the valve 5 until the device 1 returns to its initial state when the engine 2 is cold.

The advantages of the invention are apparent from the aforegoing description. In particular, the use of an SME as actuator gives a device which does not require ducts through which the engine cooling liquid is fed for its operation, and does not require complicated linkages for obtaining a predetermined relationship governing the opening of the valve 5, as this relationship is defined by the chemical composition of the alloy from which the SME is constructed and by the shapes originally given to it during its manufacture, and which can be further manipulated by controlling the temperature of the element 20 electrically. Consequently the device according to the invention is of considerable constructional simplicity, low cost and small overall size.

Claims

1. A device for regulating the air input flow rate to an internal combustion engine carburettor, in particular for the purpose of engine cold-starting, comprising a butterfly valve disposed upstream of the diffuser of said carburettor, elastic opposition means, an actuator operated by engine temperature variation, and mechanical transmission means connecting said actuator, the opposition means and the butterfly valve together in such a manner as to keep this latter normally closed when the engine is cold; characterised in that said actuator comprises a shape memory element (SME) arranged to selectively assume, as a function of its instantaneous temperature, a plurality of predetermined shapes.

2. A device as claimed in claim 1, characterised in that said shape memory element is arranged to expand as a result of engine temperature increase, said transmission means being arranged to cause progressive opening of said butterfly valve as a consequence of the expansion of said shape memory element.

3. A device as claimed in claim 1 or 2, characterised in that said shape memory element is exposed directly to the heat radiated by said internal combustion engine.

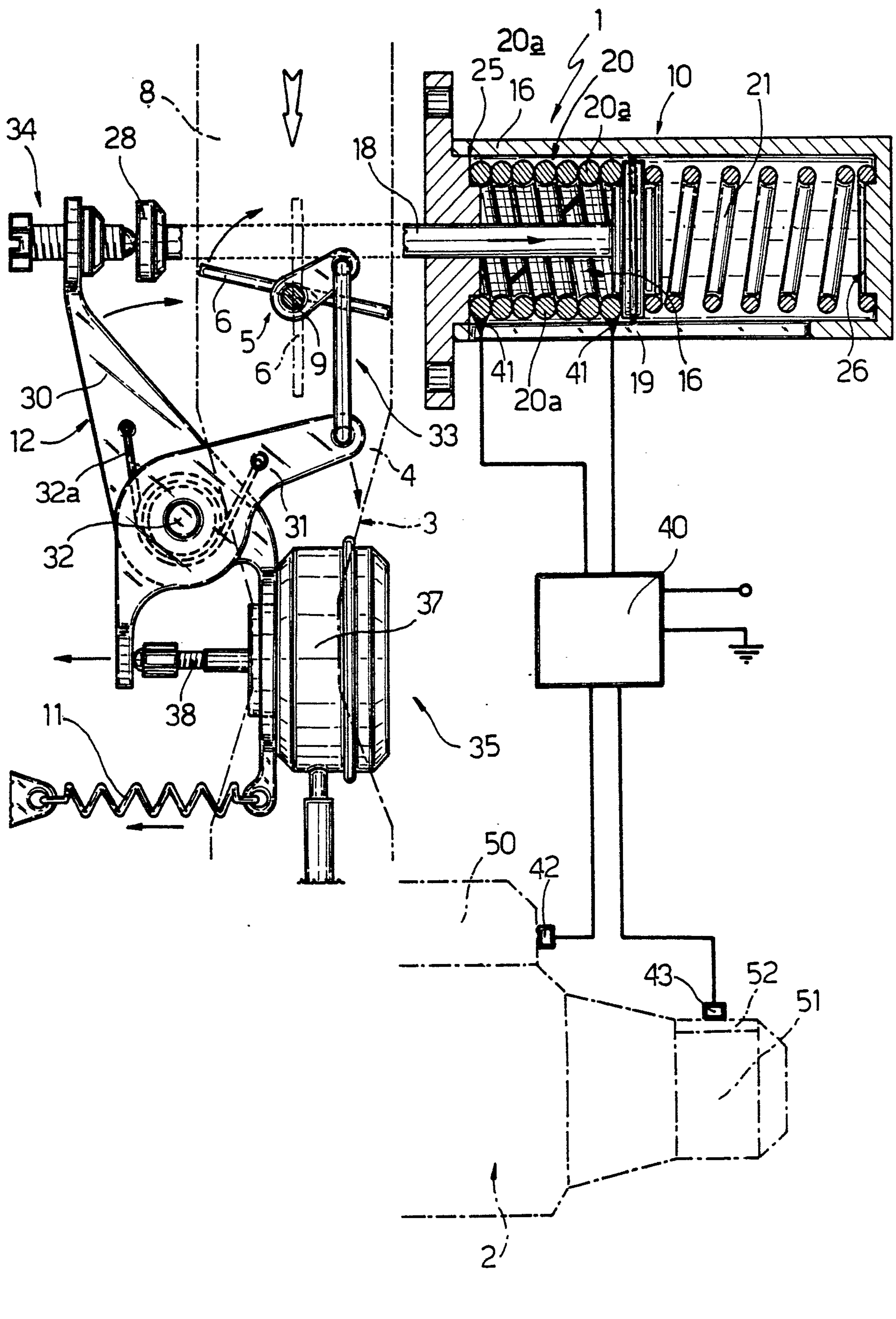
4. A device as claimed in claim 1 or 2, characterised in that said shape memory element is constructed of electrically conducting material and is connected to respective electrodes which are connected to a control centre arranged to feed through said shape memory element an electric current of predetermined intensity such as to heat it by the Joule effect; said control I centre being connected to respective temperature sensors disposed on said engine.

5. A device as claimed in claim 4, characterised in that said temperature sensors connected to said control centre are disposed one on the engine head and one in an oil channel of the engine gearbox.

6. A device as claimed in any one of the preceding claims, characterised in that said shape memory element is in the form of a helical spring which undergoes increase in length when its temperature increases, it being disposed between a fixed shoulder and a mobile shoulder which is opposed by a spring and is rigidly connected to a mobile stop for said transmission means, against which these latter are kept in constant cooperation by said elastic opposition means.

7. A device as clamed in claim 6, characterised in that said elastic opposition means cooperate with said transmission means in such a manner as to operate these latter in the direction which causes said butterfly valve to open while they simultaneously follow said mobile stop.

8. A device as claimed in any one of the preceding claims, characterised by further comprising a carburettor vacuum pull-down comprising a pneumatic actuator connected to a source of vacuum in said engine and cooperating with said transmission means in such a manner as to cause said butterfly valve to open by a predetermined amount.



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