April 26, 1966 J. H. FURBACHER 3,248,675

COLD WEATHER ENRICHMENT DEVICE FOR AN INTERNAL COMBUSTION ENGINE

Filed July 28, 1964 2 Sheets-Sheet 1

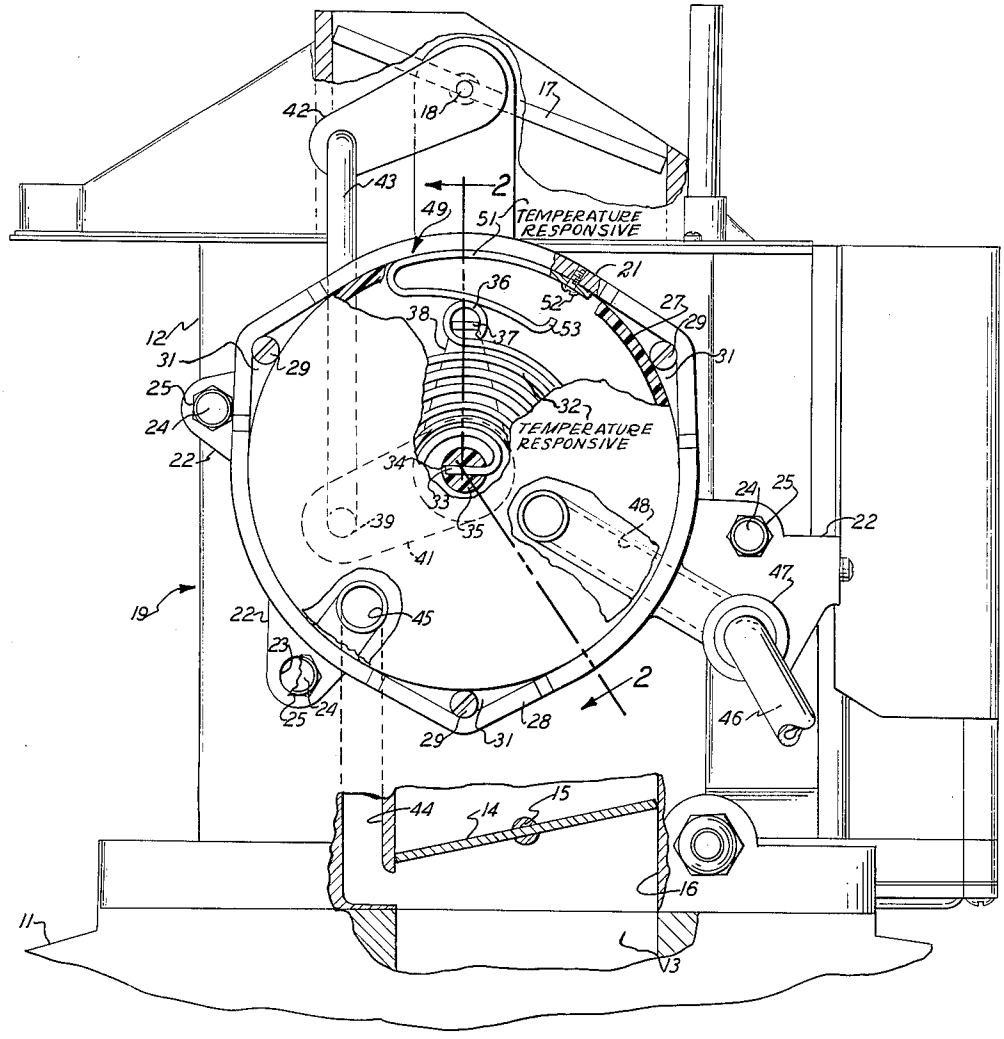


FIG. 1

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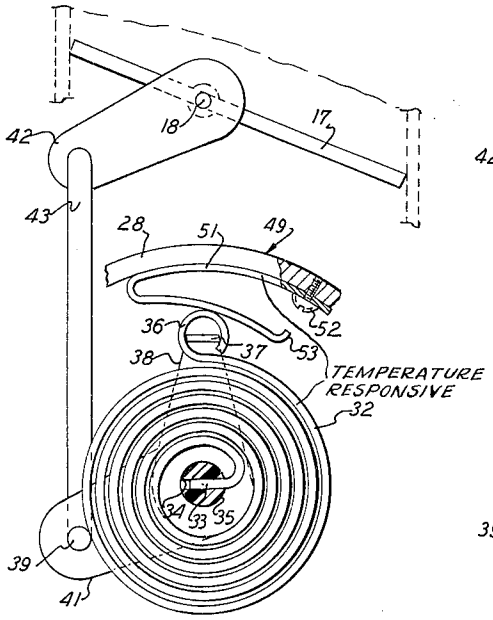


FIG.3

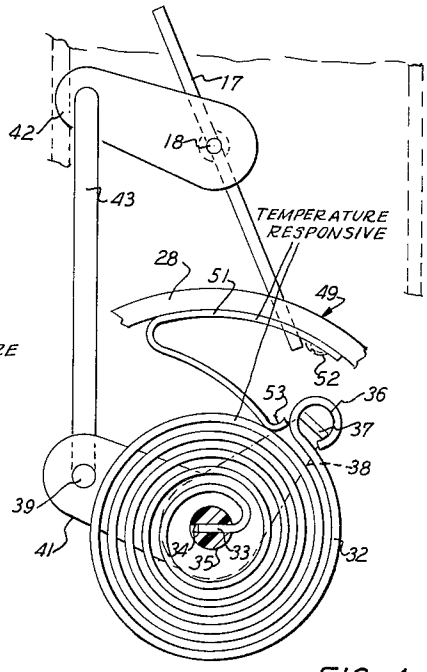


FIG. 4

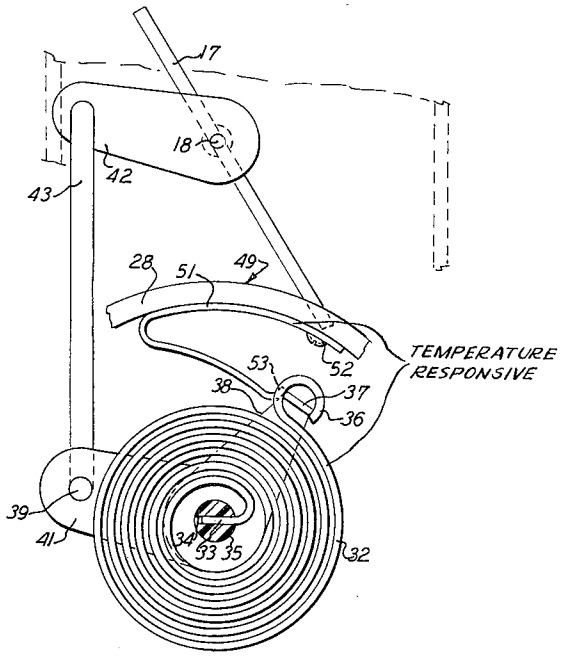


FIG.5

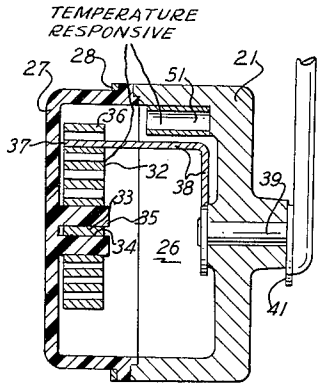


FIG. 2

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COLD WEATHER ENRICHMENT DEVICE FOR AN INTERNAL COMBUSTION ENGINE

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5 Claims. (Cl. 236—101)

This application is a continuation-in-part of my co-pending patent application entitled, "Automatic Choke," Serial Number 79,698, filed December 30, 1960, now abandoned.

This invention relates to an induction system for an internal combustion engine and more particularly to an induction system embodying an improved cold weather enrichment device.

The necessity for providing a richer than normal mixture when starting and operating an internal combustion engine in cold weather is well known and many forms of automatic enrichment devices have been proposed for this purpose. These enrichment devices establish the required fuel-air ratio by discharging additional fuel flow or by restricting the air flow. These devices are made automatic in operation through the embodiment of some form of temperature responsive actuating element. The temperature responsive element is generally heated in an indirect manner during the operation of the engine. For example, it may be heated by circulating engine coolant or exhaust manifold heated air around it. Electric resistance heating elements that are coupled to the engine's ignition circuit also have been proposed.

When some form of indirect heating is provided, the temperature responsive element cools rapidly when the engine is not being operated due to the discontinuance of the heating. Although the thermally responsive element cools rapidly to a point that indicates the need for additional enrichment, the engine mass may still be at or near its operating temperature. The previously proposed cold starting enrichment devices, therefore, provide unnecessary enrichment during the type of engine operation that is experienced in city driving.

It is the principal object of this invention to provide a cold starting enrichment device that is responsive to actual engine temperature.

Various forms of latches have been proposed to restrain the enrichment device from moving to its cold weather position. In my co-pending patent application entitled, "Automatic Choke," Serial Number 79,699, filed December 30, 1960, now Patent No. 3,158,322, issued November 24, 1964, a magnetic latch was illustrated for restraining movement of a choke valve from its fully open to its closed position. Dennison et al. Patent 2,946,577, entitled, "Choke Lock-Out," issued July 26, 1960, illustrates an automatic choke in which a temperature responsive latch is provided to restrain the choke valve from moving to its closed position.

Each of the aforementioned devices will prevent premature operation of the enrichment mechanism, but, these devices can only be considered to be "Fixed." They do not render the enrichment mechanism truly responsive to engine temperature since they only restrain the enrichment device from moving to its operative position for a time that is dependent upon the rate of cooling of a temperature responsive element. In my earlier patent, the device restrains movement until the temperature of the temperature responsive element that actuates the choke valve falls to a predetermined value. In the Dennison et al. patent, the operation is dependent upon the rate of cooling of a temperature responsive latch, which may or may not bear some relationship to the rate of cooling of the engine.

It is a further object of this invention to provide a cold starting enrichment device embodying a latch mechanism for precluding premature operation that is directly responsive to engine temperature.

An internal combustion engine embodying this invention includes an induction passage and a charge forming device for discharging a combustible mixture into the induction passage. A cold starting enrichment mechanism is provided to enrich the fuel-air mixture that is discharged from the charge forming device. The enrichment mechanism includes a temperature sensitive element for moving the enrichment mechanism between a choked and an unchoked position in response to temperature variations. A temperature responsive latch is provided for locking the enrichment device in an unchoked position under certain conditions. The temperature responsive latch includes a temperature responsive element affixed directly to a component of the engine to promote rapid heat conduction from the engine mass to the temperature responsive element through the component. The temperature responsive latch precludes the enrichment device from moving to its choke position until the temperatures of the temperature responsive element and the temperature sensitive element fall below predetermined values.

As a further feature of the invention, a housing may be provided in which both the temperature responsive element and the temperature sensitive element are positioned. The temperature responsive element may be affixed to the housing and the temperature sensitive element may be insulated from the housing. In a still further feature of the invention, means may be provided to heat temperature sensitive element only during the operation of the engine.

Further objects and advantages of this invention may become more apparent when considered in conjunction with the accompanying drawings, wherein;

FIGURE 1 is a side elevational view, with portions broken away, of an internal combustion engine embodying this invention.

FIGURE 2 is a cross-sectional view taken along line 2—2 of FIGURE 1.

FIGURES 3 through 5 are schematic views showing the enrichment mechanism in various positions.

FIGURE 3 illustrates the mechanism in its enrichment position.

FIGURE 4 illustrates the enrichment mechanism in its unchoked position.

FIGURE 5 illustrates the mechanism in an intermediate stage of operation.

Referring now to the drawings and in particular to FIGURE 1, a portion of the induction system of an internal combustion engine is depicted. The induction system comprises an intake manifold **11** and a carburetor **12**. The intake manifold **11** has an induction passage **13** into which the carburetor **12** discharges a combustible mixture of fuel and air that is formed in a known manner. The rate of discharge of the combustible mixture into the induction passage **13** is governed by a throttle valve **14** positioned upon a throttle valve shaft **15** at the lower end of an induction passage **16** formed within the carburetor **12**.

Enrichment for cold starting and cold weather operation is provided by manipulation of a choke valve **17** that is supported upon a choke valve shaft **18** at the upper end of the induction passage **16**. The choke valve **17** is positioned by an automatic choke mechanism, indicated generally by the reference numeral **19**. The automatic choke mechanism **19** comprises a choke housing **21** that is formed from a relatively highly thermally conductive metal. The choke housing **21** has a plurality of

bosses 22 that are apertured, as at 23, for the receipt of studs 24 affixed to the body of the carburetor 12. Nuts 25 are received upon the studs 24 to affix the choke housing 21 in close thermal contact to the carburetor 12.

The choke housing 21 forms a generally cylindrical cavity 26 that is closed by a cup-shaped cover 27. The cover 27 is formed from a plastic that has a relatively low coefficient of thermal conductivity so that it will serve as an insulating closure for the cavity 26. The cover 27 is affixed to the choke housing 21 by a sheet metal clamp 28 and screws 29 that are received in threaded apertures tapped in three equally spaced ears 31 formed around the periphery of the choke housing 21.

A temperature responsive, coiled, bimetallic spring 32 is positioned within the cavity 26. The spring 32 has an inner end 35 that is received in a slot 34 formed in an inwardly extending projection 35 of the cover 27. The outer end of the spring 32 is wrapped in the form of an eye 36 and receives an outwardly extending arm 37 of a lever 38. The lever 38 is affixed to the inner end of a choke actuating shaft 39 that is coaxially journaled in the housing 21. A lever 41 is affixed for rotation with the other end of the choke actuating shaft 39. A choke lever 42 is affixed for rotation with a choke valve shaft 18 and a link 43 is pivotally connected to the levers 41 and 42 to transmit motion from the choke actuating shaft 39 to the choke valve shaft 18 and choke valve 17.

The bimetallic spring 32 is heated during engine operation in the manner now to be described so that its temperature will bear a relationship to the engine operating temperature. A passage 44 that opens into the induction passage 16 below the normal idle position of the throttle valve 14 is formed in the carburetor 12. The passage 44 extends through the carburetor 12 and terminates adjacent the choke housing 21. A mating passage 45 extends through the rear wall of the choke housing 21 so that the cavity 26 is exposed to the pressure in the induction passage 16 posterior to the throttle valve 14. The pressure will normally be sub-atmospheric when the engine is operating. A conduit 46 is secured to a warm air inlet fitting 47 formed in one of the bosses 22. A passage 48 extends through the boss 22 and choke housing 21 and opens into the cavity 26. The lower end of the conduit 46 extends to a refractory stove (not shown) positioned in the engine exhaust manifold. When the engine is running, air that is heated through contact with the exhaust manifold stove will be drawn into the cavity 26 through the conduit 46 and passage 48 by the sub-atmospheric pressure that exists in the passage 45. The heated air impinges upon and heats the bimetallic spring 32.

When the engine and bimetallic spring 32 are cold, the spring 32 contracts to rotate the lever 38 and choke actuating shaft 39 in a counterclockwise direction to move the choke valve 17 to its fully closed or choked position (FIGURE 3). When the engine is running, the flow of heated air through the choke housing 26 heats the bimetallic spring 32 to cause it to expand and rotate the lever 38 and choke actuating shaft 39 in a clockwise direction to move the choke valve 17 toward its fully open position (FIGURE 4). When a thoroughly warm engine is stopped briefly, the bimetallic spring 32 will cool rapidly since the flow of heated air through the cavity 26 has stopped. Since the bimetallic spring is insulated from the housing 21 by cover 27 it will cool much more rapidly than the engine. As a result, there is a possibility that the choke valve 17 will close prematurely.

To prevent premature closing of the choke valve 17, a thermally responsive latch, indicated generally by the reference numeral 49, is provided. The thermally responsive latch 49 is responsive to the temperature of the engine mass and contacts the lever 38 to prevent closing of the choke valve 17. The thermally responsive latch 49 comprises a bimetallic U-shaped spring element

51 that has one of its legs affixed to the inner wall of the choke housing 21, as by a screw 52. The other leg of the spring 51 has a curved end portion 53 that extends adjacent to the arm 38 when it is in the position that corresponds to an opened position of the choke valve 17. Because the spring 51 is affixed to the choke housing 21 that has a high co-efficient of thermal conductivity and a greater cross section of area than that of the spring 51 a rapid heat transfer from the engine through the intake manifold 11 and carburetor 12 will be set-up. The bimetallic spring 51 therefore will be at approximately the same temperature as the engine mass. As the temperature of the bimetallic spring 51 increases, the leg portions separate with the curved end 53 moving away from the inner surface of the choke housing 21.

The operation of the thermally responsive latch 49 may be best understood by reference to FIGURES 3 through 5. When the engine is thoroughly cooled, the bimetallic coil spring 32 will have rotated the choke valve 17 to its fully closed position in the manner previously described. When this occurs, the curved end 53 also will have moved to the position closest to the surface of the choke housing 21 so that the latch 49 will not operate with the opening of the choke valve 17. As the engine heats during its operation, the bimetallic coil spring 32 moves the choke valve 17 to a fully opened position (FIGURE 4). During the heating of the engine mass, the thermally responsive spring 51 also will deflect with the curved end portion 53 moving downwardly away from the inner surface of the choke housing 21. At normal engine operating temperature the curved end 53 will contact the arm 38 to lock the choke valve 17 in its fully opened position as shown in FIGURE 4. When the engine is stopped and the flow of heated air through the choke cavity 26 discontinues, the thermally responsive spring 32 will cool rapidly. The thermally responsive spring 51, because of its intimate thermal connection with the engine mass, will not cool as rapidly. Therefore, although the thermally responsive spring 32 tends to close the choke valve 17 the thermally responsive latch 49 will not permit this. The choke valve 17 cannot move to its fully closed or choked position until the thermally responsive spring 51 cools to a point to which the curved end portion 53 moves out of contact with the arm 38. This will not occur until the temperature of the engine mass falls to a point at which choking is actually required.

It is preferred to have the thermally responsive spring 51 have a slower thermal response than the coil spring 32. That is, the movement of the curved end 53 for a given temperature differential is less than the movement of the coil spring 32. The curvature of the end portion 53 also facilitates in the disengagement of the latch when the temperatures of the two thermally responsive elements fall below the point at which choking is required.

It is to be understood that various changes may be made without departing from the spirit and scope of the invention, as defined by the appended claims.

I claim:

1. An automatic choke for an internal combustion engine comprising a choke housing enclosed by a cover, said cover having a lower coefficient of thermal conductivity than said housing, a temperature sensitive element supported within said choke housing, said temperature sensitive element being thermally connected with said cover, a choke plate, an operative connection between said temperature sensitive element and said choke plate including at least one movable part for moving said choke plate between opened and closed positions in response to variations in the temperature of said temperature sensitive element, and a temperature responsive latch, said temperature responsive latch including a temperature responsive element thermally connected to said choke housing and a locking means coupled to said tem-

perature responsive element and movable by said temperature responsive element in response to variations in its temperature for movement into engagement with said movable part of said temperture sensitive element when the temperature of said temperature responsive element and the temperature of said temperature sensitive element exceed predetermined values, whereby the engagement of said locking part with said movable part is effective to preclude closing of said choke plate upon a decrease in the temperature of said temperature sensitive element and until a predetermined decrease in the temperature of said temperature responsive element occurs.

2. An automatic choke as defined by claim 1 wherein the movable part and the temperature responsive latch are contained within said choke housing.

3. An automatic choke for an internal combustion engine comprising a choke housing enclosed by a cover having a lower coefficient of conductivity than said choke housing, a first temperature sensitive spring having one of its ends connected to said cover, an operative connection between the other end of said temperature sensitive spring and said choke plate including at least one movable part for moving said choke plate between opened and closed positions, and a second temperature sensitive spring for locking said choke plate in its opened position under certain temperature conditions, said second temperature sensitive spring having one of its ends fixed to said choke housing, the other end of said second temperature sensitive spring being free to move in response to temperature variations, said other end being movable into engagement with said movable part when the temperatures of said temperature sensitive springs exceed predetermined values, said first and said second temperature sensitive springs having temperature response characteristics such that the other end of said second temperature sensitive spring will not move out of engagement with said movable part of said first temperature sensitive spring until a predetermined temperature of said second temperature responsive spring is reached which is lower than the temperature at which said first temperature sensitive spring would have been effective to close said choke.

4. An automatic choke for an internal combustion engine having a thermally conductive mass comprising a choke plate, a choke housing enclosed by a cover having a lower coefficient of conductivity than said choke housing, a temperature sensitive element thermally connected to said cover, an operative connection between said temperature sensitive element and said choke plate including at least one movable part for moving said choke plate between an open and a closed position, means for heating

said temperature sensitive element during engine operation and applying substantially no heat when the engine is not operating, and a temperature responsive latch for locking said choke plate in an opened position under high engine operating temperature conditions, said temperature responsive latch including a temperature responsive element thermally connected to said housing for heating said temperature responsive element by conduction from the mass of the engine regardless of its state of operation, said temperature responsive latch further including a locking part movable by said temperature responsive element in response to variations in its temperature, said temperature sensitive element and said temperature responsive element including means for moving said locking part into engagement with said movable part when the temperatures of said temperature responsive element and said temperature sensitive element exceed predetermined values and said choke is in an open position and for preventing closing of said choke plate upon a decrease in the temperature of said temperature sensitive element and until a predetermined decrease in the temperature of said temperature responsive element occurs.

5. An automatic choke as defined by claim 4 wherein the movable part and the temperature responsive latch are contained within the choke housing.

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