

United States Patent

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[54] AUTOMATIC COLD STARTING DEVICES FOR INTERNAL COMBUSTION ENGINES

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[58] Field of Search 261/39 D; 123/179 G, 179 L,
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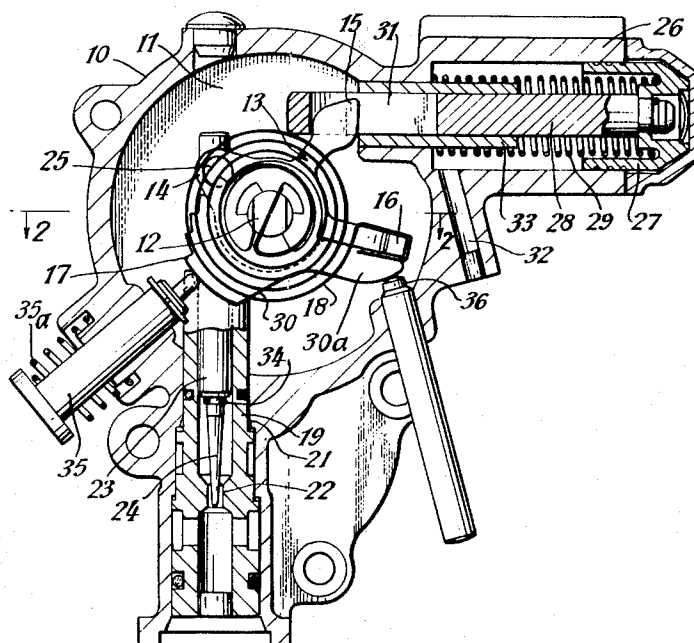
Primary Examiner—Tim R. Miles

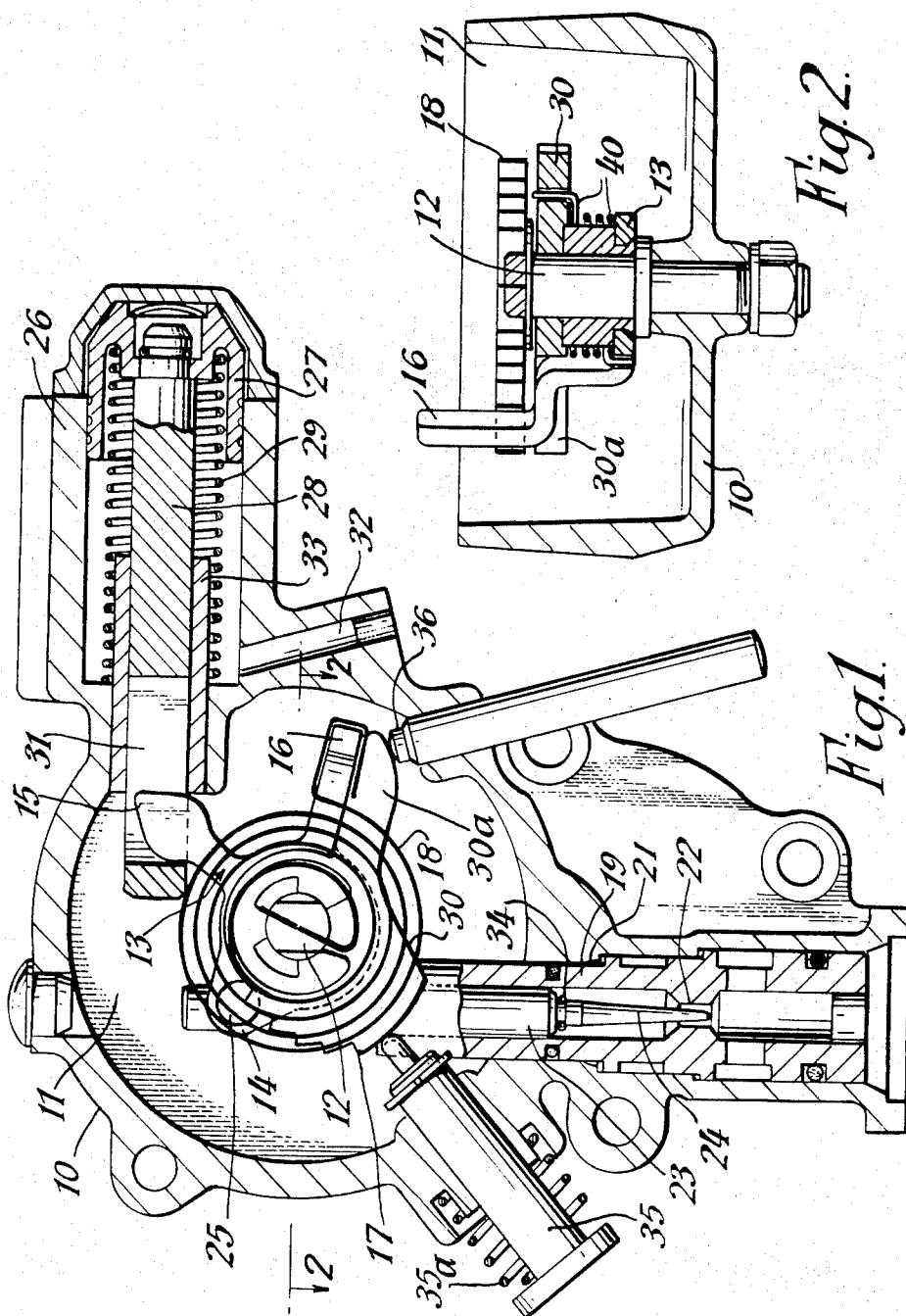
Attorney—Stevens, Davis, Miller & Mosher

[57] ABSTRACT

An automatic cold starting device for an internal combustion engine providing an auxiliary starting fuel supply which is a maximum for initial starting and decreases as the engine warms up, in which a fuel supply orifice is controlled by area-varying means the position of which is determined by a temperature sensitive device, a device responsive to actual starting of the engine holding the area varying means in a position to provide the maximum orifice area when the engine is not running and releasing the said means for control by the temperature sensitive device as soon as the engine starts. The temperature sensitive device may also control a fast-idle stop for the throttle valve of an associated carburetor providing the normal fuel/air mixture for the engine.

6 Claims, 5 Drawing Figures





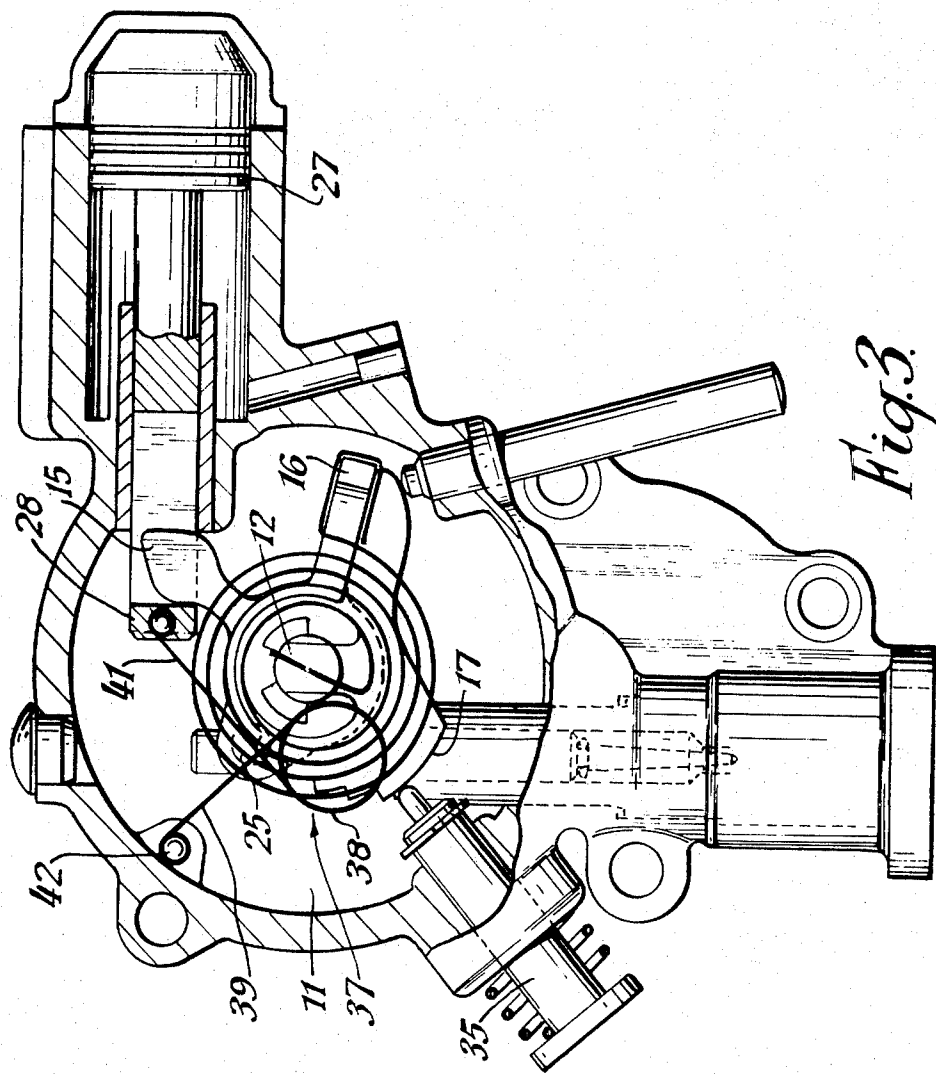
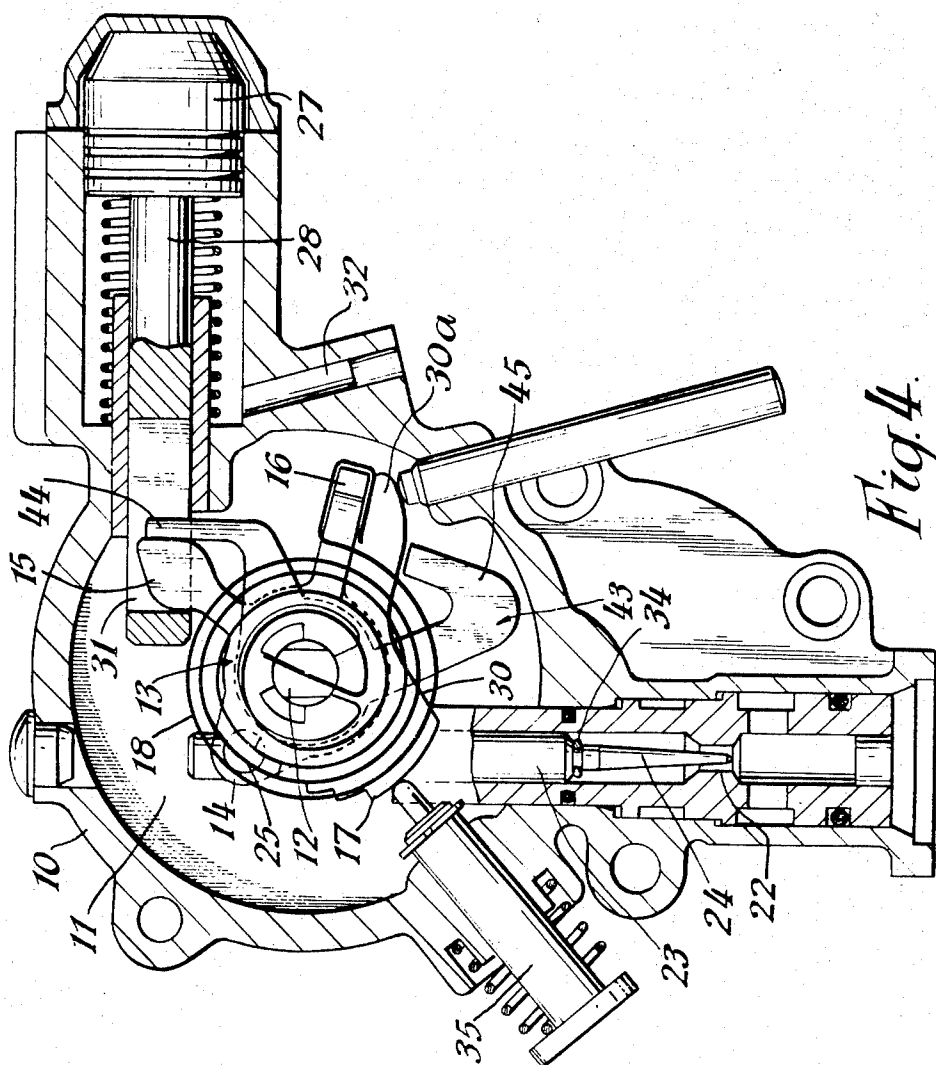


Fig. 3.



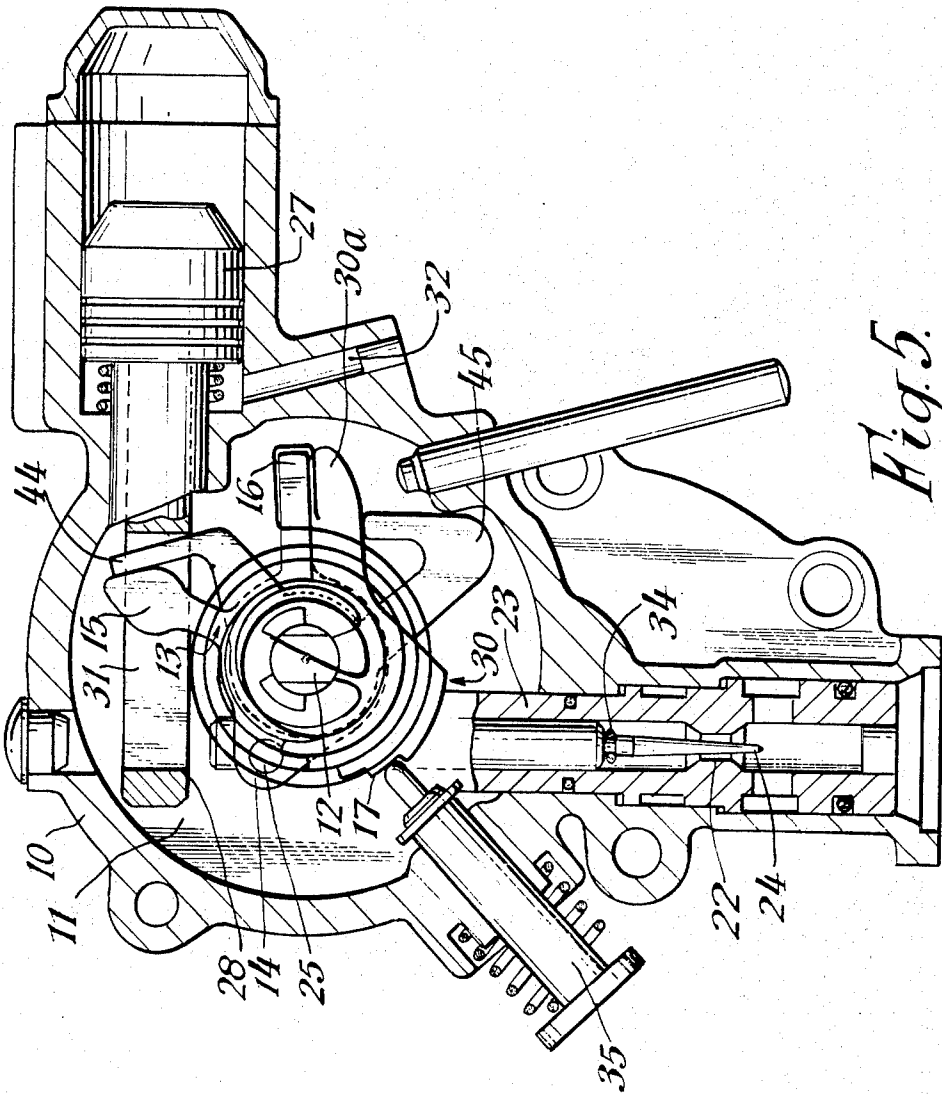


Fig. 5.

AUTOMATIC COLD STARTING DEVICES FOR INTERNAL COMBUSTION ENGINES

This invention relates to automatic cold starting devices for internal combustion engines of the kind in which a rich fuel/air mixture supplied during cranking of the engine is reduced in richness as soon as the engine fires, is subsequently further reduced in richness as the engine temperature increases and finally is shut off completely, the fuel/air mixture supplied by the starting device being independent of the normal mixture supply to the engine.

In most such devices which have been already proposed, the arrangement has been such that once the initial reduction of mixture richness occurring when the engine fires has taken place, a substantial rise in temperature must take place before any further reduction of mixture richness is brought about, whereas the engine would run satisfactorily on a progressively weaker mixture as soon as the temperature begins to rise. Consequently there may be unnecessary consumption of fuel and possibly incomplete combustion leading to atmospheric pollution.

It is the object of the present invention to provide an improved automatic cold starting device in which this disadvantage is minimized or avoided.

According to the present invention, in an automatic cold starting device for internal combustion engines including a fuel supply orifice through which fuel is adapted to be drawn by the suction of an engine to which the device is connected, means for varying the effective area of the said orifice, and a temperature sensitive device acting, in response to increase of temperature, to move said area-varying means in a direction to reduce the effective area of the orifice, there are provided spring means acting on said area-varying means to urge the said area-varying means towards a position in which the effective area of the orifice is a maximum, and means for actuating the engine to which the cold starting device is connected, when said engine commences to run, to remove the load of the spring means from the area-varying means so that it is restrained against movement in the direction to reduce the effective area of the orifice only by the temperature-sensitive device.

The temperature-sensitive device is preferably a bi-metallic coil anchored at one end and coupled at its other end to the area-varying means so that rotary movement of the said other end of the coil, caused by temperature increase, tends to move the area-varying means in a direction to reduce the effective area of the orifice.

The means which is actuated when the engine commences to run may comprise a piston or diaphragm displaceable by the action of engine suction, the piston or diaphragm being urged by the spring means in the opposite direction to that in which it is moved by engine suction and having a one-way connection with the area-varying means such that the spring means, in the absence of suction acting on the piston or diaphragm, urge the said area-varying means towards a position providing a maximum effective area of the orifice.

The spring means may be a coiled compression spring or a torsion spring.

The temperature sensitive device may act on a rotary member angular movement of which rotary member moves the area-varying means to vary the effective area

of the orifice the action of the temperature-sensitive means with increase of temperature tending to rotate the rotary member in a direction to reduce the effective area of the orifice, and the spring means, when the load thereof is not removed by running of the engine, applying a force to said rotary member tending to rotate it in a direction to increase the effective area of the orifice.

Some embodiments of cold starting devices according to the invention will now be described by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a sectional elevation of one embodiment, the parts being shown in the positions they occupy when the engine on which the device is mounted is cold;

FIG. 2 is a section on the line 2—2 of FIG. 1;

FIG. 3 is a view similar to FIG. 1 but with the lower part of the device in elevation, showing a modification;

FIG. 4 is a view similar to FIG. 1 but showing another modification; and

FIG. 5 is a view of the device shown in FIG. 4 with the parts in the positions which they occupy immediately after the engine has started.

In the drawings, corresponding parts are indicated by the same reference numerals in all of the Figures.

Referring to FIGS. 1 and 2, the cold starting device comprises a casing 10, adapted for mounting, in the known manner on the body of a carburetor (not shown) the casing 10 defining a cylindrical chamber 11 in the center of which is mounted a fixed spindle 12. Rotatable on the spindle 12 is a member 13 having three angularly spaced arms 14, 15 and 16. A coiled bi-metal element 18 having its inner end held in a diametral slot in the spindle 12 has its outer end anchored to the arm 16, and heating of the said bi-metal element 18 tends to tighten the turns thereof and so move the member 13 anti-clockwise as seen in the drawing.

A tube 19, mounted in a bore 21 in the casing, which bore 21 is tangential to a circle about the center of the chamber 11, has a restricted portion defining an orifice 22, the bore of the tube below the orifice 22 being connected to a supply of liquid fuel, such as the float chamber (not shown) of the carburetor to which the device is attached, and the bore of the tube above the orifice being connected to the induction passage (not shown) of the carburetor. A plunger 23, slidable in the upper part of the bore of the tube 19, carries a profiled needle 24 extending into the orifice 22, and is pivotally coupled at 25 to the arm 14 of the member 13.

A cylinder 26 integral with the casing 10 and having its axis tangential to a circle about the center of the chamber 11, has slidable in it a piston 27 carried by a stem 28 mounted so as to be capable of self-alignment with the piston, the piston 27 being urged by a coiled compression spring 29 towards the outer end of the cylinder 26. The stem 28 is cut away at 31 to provide an elongated recess at one side thereof and the arm 15 on the member 13 extends into the said recess, the arrangement being such that the spring 29, acting through the piston 27 and stem 28, tends to rotate the member 13 clockwise as viewed in the drawing to an extent limited by the travel of the piston 27, thus withdrawing the needle 23 from the orifice 22 to an extent limited by the opposing force of the coiled bi-metal

element 18 and depending on the temperature to which that element 18 is subjected. In FIG. 1, the needle 23 is shown in the fully withdrawn position, it being assumed that the engine, and therefore the element 18 is cold.

Provision is made for connecting the inner end of the cylinder 26 through a passage 32 to the engine induction system so that suction is created in the said cylinder 26 when the engine is running. The stem 28 is guided in a sleeve 33 extending into the cylinder 26 and preventing the entry of air into the cylinder through the recess 31. The sleeve 33 also serves as a stop limiting the travel of the piston 27 and rod 28 when suction is applied to the cylinder 26, and the recess 31, in the arrangement shown, is of such a length that, when the piston has completed its travel, the arm 15, even if no rotation of the member 13 has taken place, does not contact the end of the recess 31 opposite to that which it engages to transmit the load of the spring 29 to the rotary member 13, so that it is left completely free to be positioned by the bi-metal element 18. If desired, the recess 31 may be of shorter length, so that the said end thereof contacts and displaces the arm 15, thus positively reducing the effective area of the orifice 22.

Also mounted to rotate on the spindle 12 is a member 30 having formed on it a stepped edge cam 17 and an outwardly projecting arm 30a. A torsion spring 40, (FIG. 2), one end of which is attached to the member 13 and the other end of which is attached to the member 30, urges the member 30, in an anti-clockwise direction as viewed in FIG. 1, relative to the member 13, tending to hold the arm 30a in engagement with the arm 16.

At its junction with the plunger 23, the profiled needle 24 carries a sealing ring 34 adapted, when the needle 24 has moved to the extreme position opposite to that shown in the drawing, to close and seal the orifice 22.

The stepped edge cam 17, co-operates with a plunger 35 providing a variable fast idling stop for the throttle valve of the carburetor on which the starting device is mounted. A spring 35a being provided which acts to urge the said plunger 35 outwardly away from the cam.

When the engine on which the automatic cold starting device is mounted is stationary and cold, the piston 27, not being subject to suction, will be urged by the spring 29 to the position shown in the drawing, the force of the spring rotating the member 13 clockwise in opposition to any load exerted on the said member 13 by the bi-metal coil 18, which load depends on the temperature, and thus to move the needle 24 to a position of less obstruction of the orifice 22.

Thus, during cranking of the engine, increased enrichment of the fuel/air mixture is provided in a manner which may be controlled. As soon as the engine fires and begins to run under its own power, suction acts on the piston 27 to draw it to the left, compressing the spring 29 and relieving the member 13 of the spring load, so that the said member takes up a position, depending on the temperature, determined only by the bi-metal coil element 18, somewhere between its extreme positions, and the needle 24 reduces the effective area of the orifice 22 as soon as the temperature rises above the value at which the bi-metal coil 18 alone will carry the mechanism to the full rich position.

Rotation of the stepped cam member 30 with the member 13 is prevented by the load applied to the cam 17 by the plunger 35, which, so long as the engine throttle valve is not open beyond the position in which it is held by the cam 17, is subjected to the load of the usual throttle-valve closing spring (not shown). When the engine throttle valve is further opened, the spring 35a moves the plunger 35 out of engagement with the cam 17, which then rotates under the influence of the torsion spring 40 until the arm 30a comes into contact with the arm 16.

Any increase in temperature from that existing when the engine was started is thus immediately effective to move the needle 24 to further obstruct the orifice 22 and, from the moment of starting, the fuel supply is progressively restricted with increase of temperature, until the orifice 22 is finally closed by the sealing ring 34.

Whenever the engine is stopped, the spring 29 will move the piston 27 towards the position shown in the drawing but until the engine has cooled to some predetermined temperature, the bi-metal coil will offer sufficient resistance to prevent full movement of the piston 27 by the spring 29 and the said piston will move to an intermediate position. If the engine is not cold when restarted, the member 13 as soon as the engine starts, will rotate under the influence of the bi-metal element 18 to set the needle 24 to a position appropriate to the actual engine temperature.

As the member 13 rotates to reduce the effective area of the orifice 22, the stepped cam 17 follows its rotation and so presents progressively lower steps opposite to the plunger 35, changing the position of the fast idling stop to reduce the engine idling speed until, when the orifice 22 is fully closed, the fast idling stop becomes ineffective, and the throttle position for idling is determined by the normal throttle stop.

Provision may be made for adjusting the loading of the spring 29 to control the degree of suction necessary to release the member 13 from the load of the said spring 29.

A pin 36 may be provided, acting on the arm 13a to produce rotation of the member 30 in an anti-clockwise direction, thus moving the stepped edge cam 17 out of engagement with the plunger 35 to permit initial setting of the interconnected throttle control mechanism.

Referring now to FIG. 3 of the drawings, the coiled compression spring 29 acting on the piston 27 is replaced by a torsion spring 37 mounted in the cylindrical chamber 11, the torsion spring 37 having a central coiled portion 38 and end limbs 39 and 41 connected respectively to an anchorage at 42 in the chamber 11 and to the stem 28 of the piston 27. The arrangement is otherwise identical with that shown in FIG. 1. The use of a torsion spring provides a force on the member 13 which varies with the piston position in a manner different from the force applied by a compression spring. For example, it could be arranged to exert a greater load on the piston 27 at lower temperatures, thereby assisting starting under extreme conditions.

In the arrangement shown in FIGS. 4 and 5 of the drawings, a further rotatable member 43 is mounted co-axially with the rotatable members 13 and 30 the rotatable member 43 having two arms 44 and 45, the

arm 44 extending into the recess 31 in the stem 28 on the side of the arm 15 nearer to the piston 27, and the arm 45 being so positioned that, when the arm 44 contacts the arm 15, it engages the arm 30a. The length of the recess 31 is such that, when the stem 28 is moved by suction acting on the piston 27, the end of the recess nearer to the piston engages the arm 44 and rotates the member 43, thus positively rotating the member 30 to the position shown in FIG. 5, to bring a lower step of the cam 17 opposite to the plunger 35. With this arrangement, the fast idling stop can be set to provide, when the plunger 35 engages with the highest step of the cam 17, a degree of throttle opening which would provide too high an initial idling speed, such wide throttle opening, which is advantageous during cranking of the engine under conditions of extreme cold, being immediately reduced when the engine fires.

It will be understood that modifications may be made in the construction of the cold starting device. For example, the piston 27 may be replaced by an annular flexible diaphragm clamped at its outer periphery to the cylinder 26 and at its inner periphery to the stem 28.

I claim:

1. An automatic cold starting device for an internal combustion engine comprising a casing having a fuel supply orifice therein which is adapted to have fuel drawn therethrough by the suction of the engine to which the cold starting device is connected, means for varying the effective area of said orifice, and a temperature sensitive device for positioning the area varying means to control the effective area of the orifice according to the temperature of the engine, to decrease said effective orifice area with increasing temperature and to close the said orifice at a predetermined maximum temperature, biasing means adapted to act independently of said temperature sensitive device to urge said area-varying means towards the position of maximum effective area of the orifice, and means, adapted to be actuated by the engine when said engine commences to run, for removing the load of the biasing means from the area varying means so that the said area-varying means is free to be positioned by the temperature sensitive device and to move to reduce the effective area of the orifice under the control of said temperature sensitive device as the engine temperature increases, wherein the temperature-sensitive device acts on a rotary member, angular movement of which rotary

member moves the area-varying means to vary the effective area of the orifice, the action of the temperature-sensitive means with increase of temperature tending to rotate the rotary member in a direction to reduce the effective area of the orifice, and the spring means, when the load thereof is not removed by running of the engine, applying a force to said rotary member tending to rotate it in a direction to increase the effective area of the orifice.

2. An automatic cold starting device according to claim 1, wherein the area-varying means is a profiled needle co-operating with the orifice, the needle having its axis tangential to a circle about the axis of the rotary member and being engaged by an arm on said rotary member.

3. An automatic cold starting device according to claim 1, wherein the biasing means acts on a stem having its axis tangential to a circle about the axis of the rotary member, a radial arm on said rotary member co-operating with an abutment on the stem to apply the load of the biasing means to said rotary member and the said abutment being moved away from the arm when the engine commences to run.

4. An automatic cold starting device according to claim 6, wherein a stepped cam associated with the rotary member co-operates with a plunger adapted to provide a fast-idle throttle stop for an internal combustion engine in which the cold starting device is mounted.

5. An automatic cold starting device according to claim 9, wherein the stepped cam is provided on a member coaxial with and rotatable independently of the rotary member, a torsion spring connecting the rotary member and the said member carrying the stepped cam providing a force acting on said member carrying the stepped cam to urge it to follow the rotation of the rotary member caused by increasing temperature, and co-operating stops being provided on said members to limit rotation by the torsion spring of said member carrying the stepped cam relative to said rotary member.

6. An automatic cold starting device according to claim 10, wherein means are provided positively to rotate the member carrying the stepped cam through a predetermined angle when the engine commences to run, to move the stepped cam relative to the plunger providing the fast-idle stop and reduce the opening of the throttle valve determined thereby.

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