

Aug. 23, 1938.

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2,127,653

MIXTURE CONTROL FOR INTERNAL COMBUSTION ENGINES

Filed April 23, 1931

3 Sheets-Sheet 1

Fig. 1.

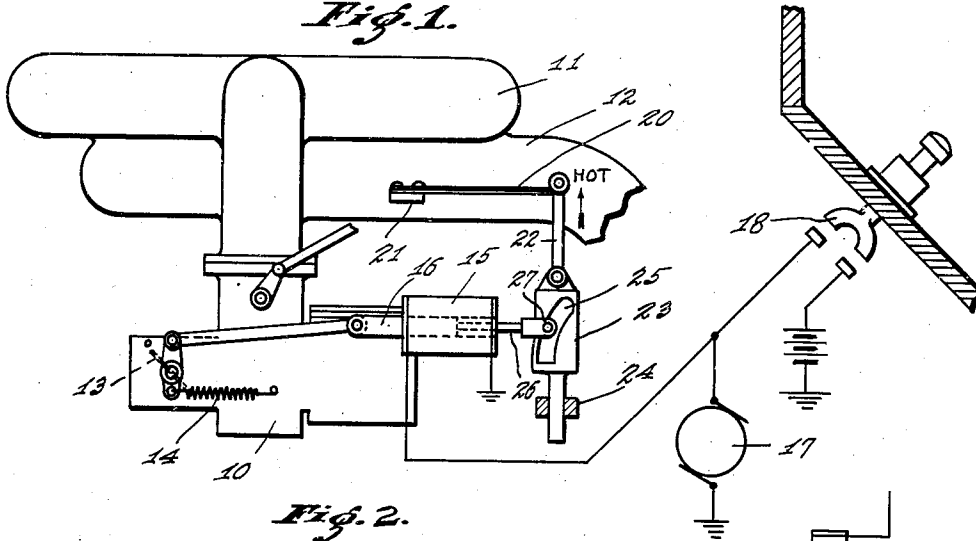
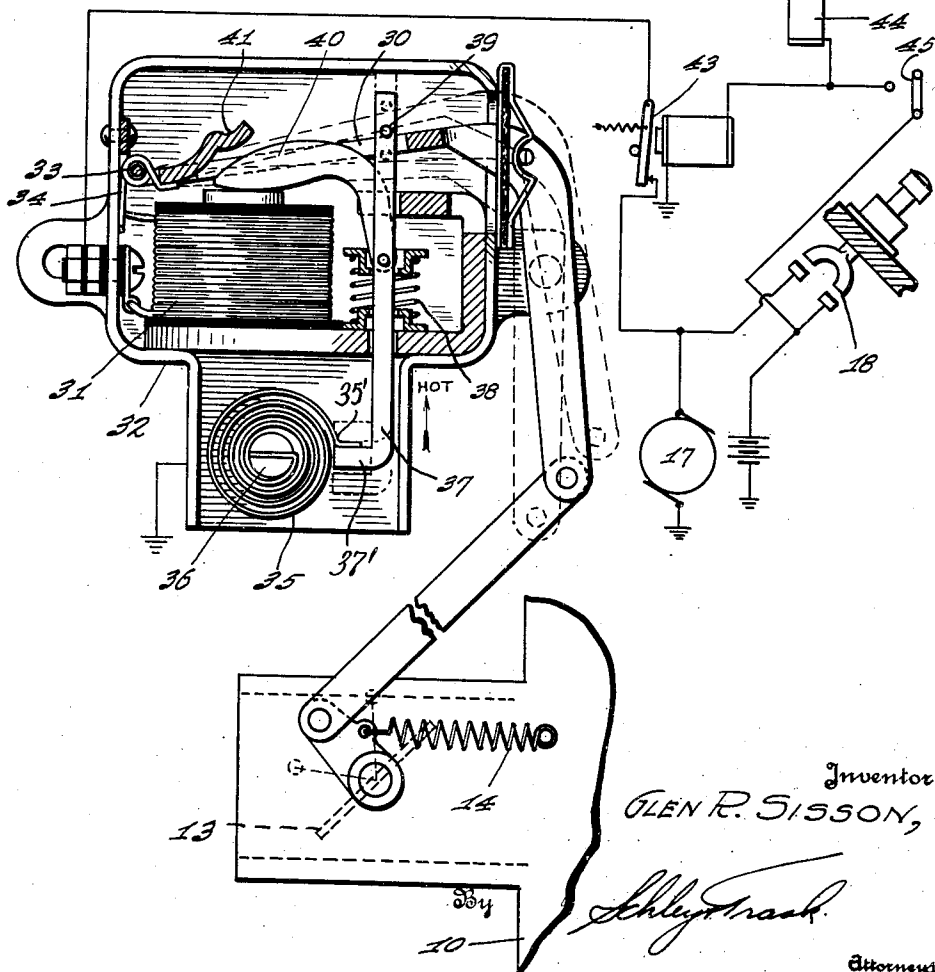


Fig. 2.



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Fig. 3.

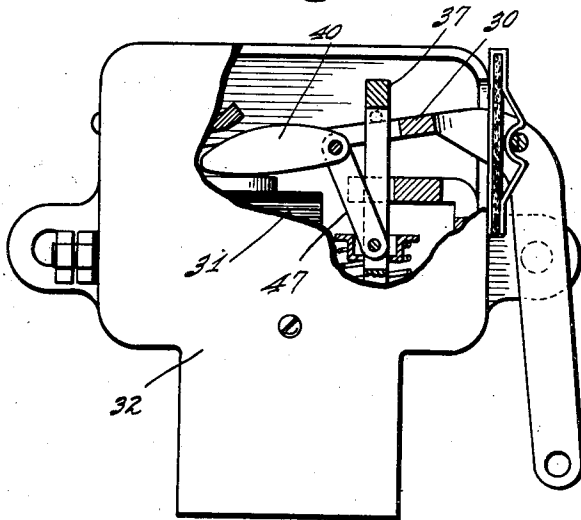


Fig. 5.

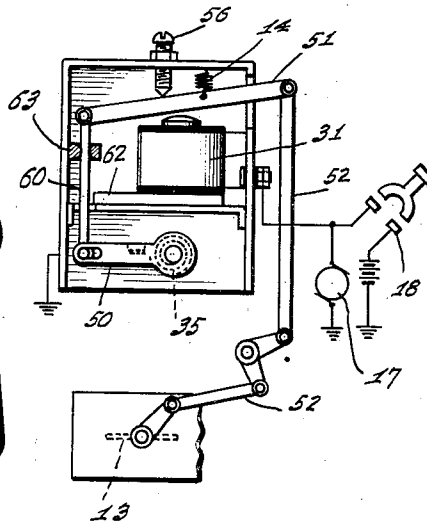
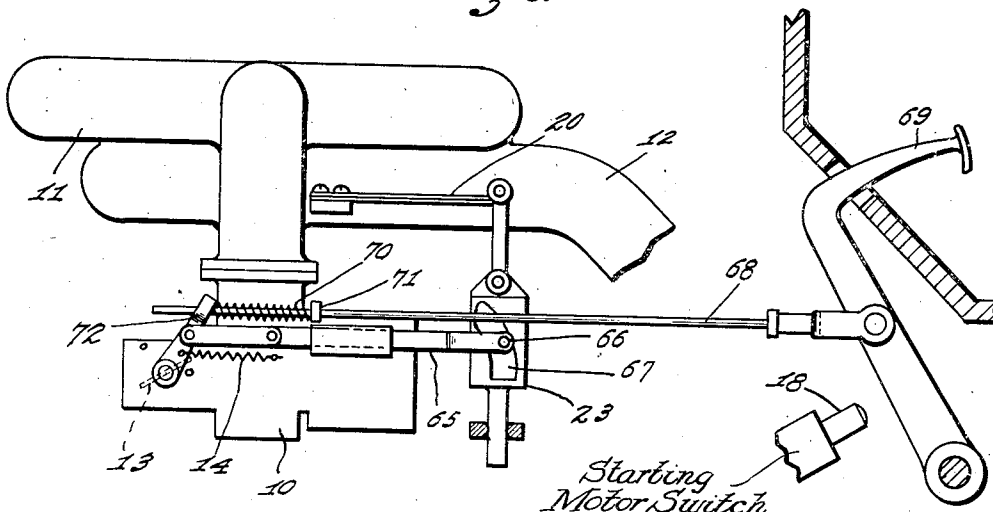


Fig. 6.



Starting
Motor Switch

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Fig. 4.

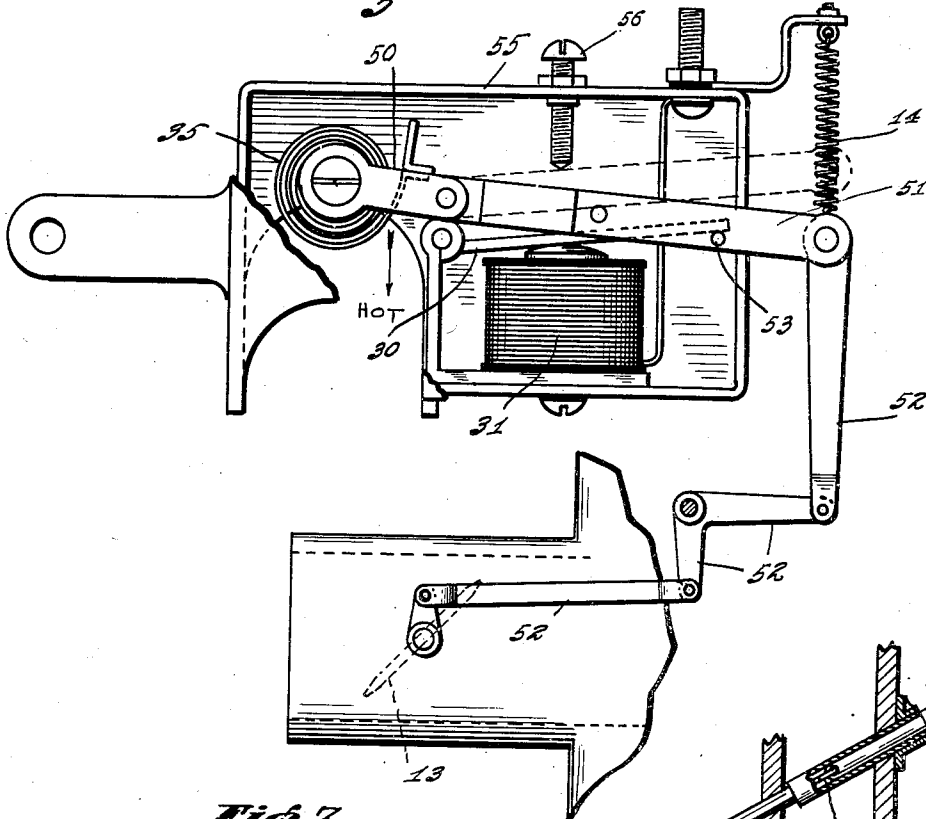
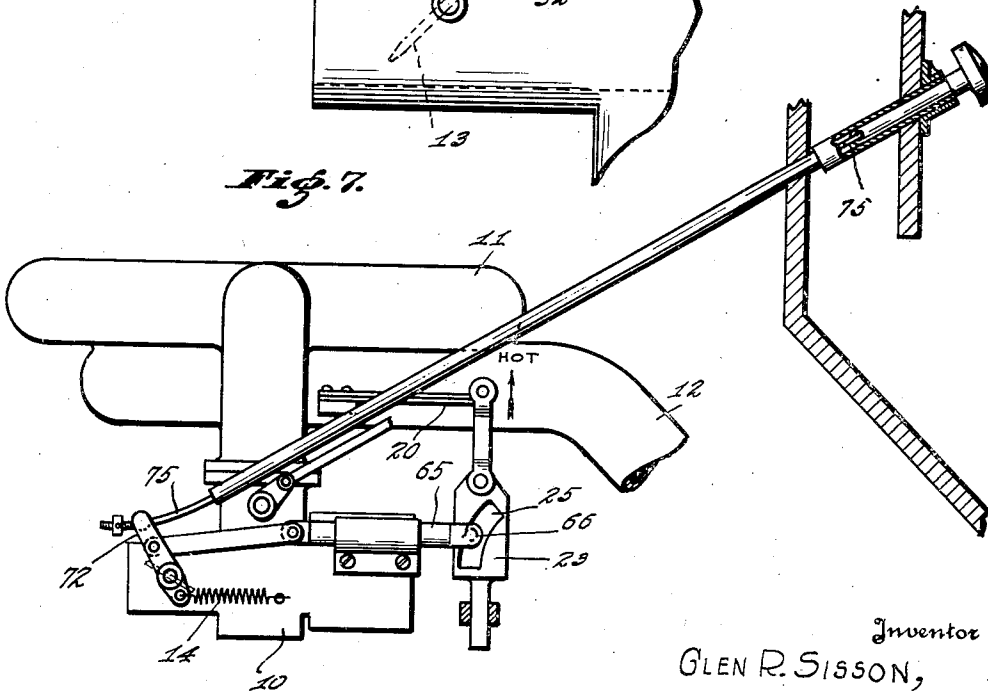


Fig. 7.



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UNITED STATES PATENT OFFICE

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MIXTURE CONTROL FOR INTERNAL COMBUSTION ENGINES

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Application April 23, 1931, Serial No. 532,376

7 Claims. (Cl. 123-179)

My invention is concerned broadly with means for producing a temporary enrichment of the mixture supplied to an internal combustion engine while the engine is being started, and it is my object to produce such a device in which a single temperature-responsive means will control the proportions of the mixture both during and subsequent to the starting operation.

In my prior Patents Nos. 1,577,765, 1,577,766, and 1,544,350 I have illustrated means for temporarily enriching the mixture supplied to an engine when it is being started. These prior patents show various forms of temperature-responsive control devices arranged to control the extent of the enrichment which is provided during the starting operation and also for controlling the mixture proportion following the starting operation. The present invention is to a large extent a development of and an improvement on the devices of those prior patents.

In carrying out my invention I provide in association with the carburetor or other charge-forming device mechanism for controlling the proportions of the explosive mixture, such mechanism including an operating member movable in one direction to increase the proportion of fuel to air in the mixture and movable in the other direction to decrease such proportion. Associated with this mechanism I provide a temperature-responsive device which limits movement of the operating member in both directions in such a way that the operating member has a freedom of movement between the limits established by the temperature-responsive device.

The accompanying drawings illustrate several embodiments of my invention: Fig. 1 is an elevation of an internal combustion engine carburetor with its associated parts to which my invention has been applied; Fig. 2 is an elevation of a modified form of mixture-control device; Fig. 3 illustrates a slight modification of the device shown in Fig. 2; Fig. 4 illustrates a device of still another form; Fig. 6 is a view similar to Fig. 1 but illustrating my invention embodying the control device actuated by mechanical connection with the starting mechanism; Fig. 5 is an elevation of another form of electro-magnetically operated device; and Fig. 7 is a view similar to Figs. 1 and 5 showing a mixture-control device which is free from connection with the engine-starting mechanism.

In Fig. 1, a carburetor 10 is shown in association with the intake manifold 11 and exhaust manifold 12 of an internal combustion engine. The carburetor 10 is provided with a mixture-

controlling device, shown as a choke-valve 13 in the main air-inlet of the carburetor. As this valve is moved toward closed from open position, it will cause a decrease in the amount of air supplied to the carburetor and also an increase in the quantity of fuel, the latter occurring as the result of the greater vacuum to which the fuel-jet is subjected as the choke-valve is closed.

The choke-valve 13 is shown as biased to open position by means of a spring 14, and as movable toward closed position under the influence of a solenoid 15, the core 16 of which is operatively connected to the choke-valve. The winding of the solenoid 15 is conveniently connected in parallel with the starter-motor 17 so that it is rendered operative jointly with the starter-motor when the starter-motor switch 18 is closed.

For the purpose of limiting movements of the choke-valve 13 in accordance with temperature, I provide a temperature-responsive element 20 which conveniently is in the form of a strip of bimetal fixed at one end to a bracket 21 by means of which it is held in position adjacent the exhaust manifold 12 of the engine where it will be generally responsive to engine-temperature. The free end of the bimetallic strip is connected through a link 22 to a control member 23 which is longitudinally slidable in a suitable guide 24 and which is provided with a cam slot 25. The core 16 is provided with an extension 26 which overlies the control member 23 and carries a pin 27 that extends into the cam slot 25 in such control member.

The pin 27 is of a diameter considerably less than the width of the cam slot 25, and is normally held in contact with one side of such slot here shown as the left-hand side, by the action of the spring 14. This side of the cam slot is sloped in such a manner that movement of the control member 23 as the temperature of the exhaust manifold 12 increases permits the spring 14 to move the choke-valve 13 toward open position. As long as the solenoid 15 is de-energized, the pin 27 will remain in engagement with the left-hand of the slot 25, and the position of the choke-valve 13 will depend upon the temperature of the exhaust manifold 12.

When the starter switch 18 is closed, the solenoid 15 is energized to draw the core 16 to the right and thereby to move the choke-valve 13 toward closed position. This movement of the core 16 will be limited by engagement of the pin 27 with the right-hand side of the slot 25. This side of the slot 25 is of a shape generally similar to that of the opposite side of the slot to permit

a greater closing movement of the choke-valve when the exhaust manifold 12 is comparatively cold.

In Fig. 1, the parts of the device are shown in the positions they occupy when the temperature of the engine is somewhere between cold and normal operative temperature. As the temperature of the engine decreases, the free end of the bimetallic strip 20 moves downwardly, and the side of the cam slot 25, acting through the pin 27, moves the choke-valve 13 toward closed position. The movement of the choke-valve thus produced is less than that necessary to cause its complete closing. If, with the engine cold, the starter switch 18 is closed to crank the engine, the solenoid 15 will be energized to draw the core 16 to the right and complete closing movement of the choke-valve. Upon opening of the starter switch 18, the solenoid 15 will be de-energized, and the spring 14 will move the choke-valve 13 toward open position, its movement in this respect being limited by engagement of the pin 27 with the left-hand side of the slot 25. As the temperature of the engine increases, the free end of the bimetallic strip 20 and the control member 23 will move upwardly, thus permitting the spring 14 to move the choke-valve 13 nearer to open position. The parts are so proportioned that when the engine has reached normal operating temperature the choke-valve 13 will be substantially completely open.

If the engine is warm when the starter-switch 18 is closed, the resultant energization of the solenoid will not move the choke-valve to completely closed position; for this movement of the choke-valve will be limited by engagement of the pin 27 with the right-hand side of the slot 25. The partial closing of the choke-valve which is produced by energization of the solenoid 15 when the engine is hot is desirable; for a greatly enriched mixture is not only unnecessary but is usually undesirable when the engine is hot.

In the modification of my invention illustrated in Fig. 2, the choke-valve 13 of the carburetor 10 is operatively connected to the armature 30 of the electro-magnet 31. The electro-magnet 31 and the parts associated therewith are conveniently located in an enclosing casing 32 adapted to be mounted adjacent the exhaust manifold of the engine or in any other position in which it will be generally subject to engine temperature. The armature 30 is pivoted as at 33 to one side of the casing 32 and extends across the pole of the magnet 31 in order to be drawn downwardly when the magnet 31 is energized. A spring 34 may be provided for biasing the armature 30 upwardly.

In the device illustrated in Fig. 2, the temperature-responsive element 35 is a spirally coiled bimetallic strip the inner end of which is anchored to a stud 36 on the casing 32 and the free end of which engages a vertically slidable member 37. Preferably, the end of the bimetallic strip and the member 37 are provided with co-operating abutments 35' and 37' adapted to be held in engagement by means of a spring 38 which acts between the member 37 and some fixed point.

At its upper end, the member 37 is provided with an abutment, conveniently in the form of a transverse pin 39 which overlies the armature 30 and limits its upward movement under the influence of the springs 34 and 14. As the temperature to which the element 35 is subjected increases, such element partially unwinds and permits upward movement of the member 37 under

the influence of the spring 38. This movement of the member 37 raises the abutment 39 and permits the spring 14 to move the choke-valve 13 toward open position.

For the purpose of limiting the closing movement of the choke-valve 13 which occurs when the magnet 31 is energized, I employ a wedge 40 which rests on the face of the pole of the magnet 31 and which is pivotally connected to the member 37 at a point below the plane of this pole-face. The armature 30 is provided with an abutment 41 which is adapted to engage the upper surface of the wedge 40 to limit downward movement of the armature 30. As the member 37 moves upwardly under an increase in temperature, the wedge 40 will be moved slightly across the face of the pole of the magnet 31 toward the pivotal axis 33 of the armature 30. In addition, the wedge 40 will be rocked slightly in such a direction that its upper face, at the point where the abutment 41 engages it, will be raised. The net result of these two movements is that the extent to which the armature 30 is moved downwardly upon energization of the magnet 31 decreases with an increase in the temperature to which the element 35 is subjected.

As in the device illustrated in Fig. 1, the electro-magnet 31 is connected in parallel with the starter motor 17. The circuit of the electro-magnet 31, however, is shown as including a normally open magnetic switch 43. This switch is controlled jointly with the ignition switch 44 of the engine by the usual manually operated switch 45, the control being effected in such a manner that the switch 43 will be closed when the ignition switch 45 is closed and open when the ignition switch is open.

Except for the effect of the magnetic switch 43, the device illustrated in Fig. 2 operates in substantially the same way as that shown in Fig. 1. That is, when the starter switch 18 is closed, the electro-magnet 31 and the starter motor 17 are jointly energized. The energization of the magnet 31 draws the armature downwardly and moves the choke-valve 13 toward closed position, the movement of the choke-valve being limited by the position of the wedge 40. Upon opening of the starter switch 18, the magnet 31 is de-energized, and the armature 30 moves upwardly under the influence of the springs 14 and 34 to open the choke-valve. Opening movement of the choke-valve is limited by the abutment 39 which moves upwardly and permits a greater opening of the choke-valve as the temperature of the engine increases. Because of the presence of the magnetic switch 43, the magnet 31 can not be energized and the choke-valve 13 can not be closed unless the ignition switch 45 is closed. This prevents the carburetor from being flooded if an attempt is made to start the engine without first closing the ignition switch.

The device illustrated in Fig. 3 is very similar to that shown in Fig. 2 except that the wedge 40, instead of being directly connected to the member 37 is connected thereto through a link 47. This device operates in substantially the same way as does the device shown in Fig. 2, upward movement of the member 37 tilting the wedge 40 and decreasing the extent to which the choke-valve can be closed when the magnet 31 is energized.

In the device illustrated in Fig. 4, the temperature-responsive element 35, instead of operating a stop, co-operates with the electro-magnet 31 in the control of linkage which is operatively con-

nected to the choke-valve. For this purpose, the inner end of the element 35 is stationarily supported while the outer end bears against an abutment on a pivotally mounted arm 50. A link 51 is pivotally connected to the outer end of the arm 50 and extends outwardly therefrom above the pole of the electro-magnet 31, its outer end being connected through suitable operative connections 52 with the choke-valve 13 in such a way that downward movement of the outer end of the arm 51 will move the choke-valve toward closed position. The armature 30 of the electro-magnet is pivotally mounted at one end and extends across the pole of the magnet. The armature 30 is connected with the link 51 in order that the link may be moved downwardly when the electro-magnet 31 is energized. To this end, the armature 30 may overlie a pin 53 or other abutment on the link 51.

The parts described are conveniently mounted in an enclosing case 55 adapted to be mounted in such a position that the temperature-responsive element 35 will be generally responsive to the temperature of the engine.

In the upper wall of the casing 55 and directly above the link 51 there is an adjustable screw 56, the lower end of which engages the link 51 and serves as a fulcrum therefor when the magnet 31 is de-energized. The spring 14, which is provided for the purpose of biasing the choke-valve 13 to open position, also serves normally to hold the link 51 in engagement with the lower end of the screw 56.

The electrical connections for the electro-magnet 31 are not shown in Fig. 4. Such connections may be arranged as indicated in Figs. 1 or 2, or they may be otherwise arranged to provide for energization of the magnet 31 jointly with the starter-motor of the engine.

When the magnet 31 is not energized, the link 51 occupies an elevated position illustrated approximately by the dotted lines in Fig. 4. In this condition, the spring 14 exerts an upward pull on the outer end of the link 51 and holds the link in engagement with the lower end of the screw 56. The inner end of the link exerts a downward pressure on the arm 50, tending to rotate such arm in a clockwise direction about its pivotal axis; but this tendency is opposed by the temperature-responsive element 35. As the engine temperature increases, the element 35 unwinds and permits the inner end of the link 51 to move downwardly and its outer end to move upwardly under the influence of the spring 14, with the result that the choke-valve 13 is moved toward open position. If the engine temperature decreases, as it would if the engine were idle, the element 35 would swing the arm 50 in a counter-clockwise direction to raise the inner end of the link 51, lower the outer end of such link, and to move the choke-valve 13 toward closed position.

During the operation of cranking the engine, the magnet 31 will be energized, and will draw the armature 30 downwardly. Because of its engagement with the pin 53 on the link 51, the armature, in moving downwardly, will swing the link 51 about its axis of pivotal connection to the arm 50, or to the full-line position illustrated in Fig. 4. This downward movement of the link 51 will move the choke-valve 13 toward closed position. Downward movement of the armature 30 is limited by its engagement with the pole of the magnet 31, and therefore the position of the choke-valve when the magnet 31 is energized depends upon the position of the arm 50. If the

engine is cold when cranked the inner end of the link 51 will be higher than if the engine is hot, with the result that the choking effect produced is less when the engine is hot than when it is cold.

It will thus be seen that the device illustrated in Fig. 4, under the control of a single thermostat, limits the extent to which the choke-valve is closed during the operation of cranking the engine and limits the opening movement of the choke-valve after the cranking operation is completed.

It will be noted that in the device shown in Fig. 4 the thermostat is subjected to a distorting force when the magnet 31 is energized. In certain carburetors, where a considerable effort is necessary to close the choke-valve, the reaction on the element 35 may be sufficient to cause its permanent distortion. To prevent this, I may employ the arrangement illustrated in Fig. 5.

In the device illustrated in Fig. 5, the link 51, instead of being directly connected to the thermostatically-controlled arm 50 is connected thereto through the intermediate member 60. As indicated in the drawings, the temperature-responsive element 35 and the arm 50 are conveniently located below the magnet 31, the member 60 extending vertically upward beside such magnet and being pivotally connected at its upper end to the inner end of the link 51. The arrangement of the thermostat 35 and the arm 50 illustrated in Fig. 5 is substantially the same as that of the correspondingly numbered parts in Fig. 4, the thermostat acting, under changes in temperature, to control the angular disposition of the arm 50. In this instance, the link 51 is of magnetic material to serve as an armature for the magnet 31. The link 51, from its point of pivotal attachment to the member 60, extends outwardly across the upper pole of the magnet 31, and its outer end is connected through suitable connecting mechanism 52 with the choke-valve 13 in such a way that the choke-valve will be moved toward closed position when the outer end of the link 51 is depressed.

The lower pole of the magnet 31 is provided with a pole-piece 62 which projects outwardly toward the member 60. The latter, like the link 51, is of magnetic material in order to co-operate with the link 51 in providing a closed magnetic circuit between the two poles of the magnet.

Near its upper end, the member 60 is supported in a guide 63 so arranged as to permit a limited amount of swinging movement of the member 60. The connection of the member 60 to the arm 50 is of the pin-and-slot type to permit a slight movement of the member 60 toward or away from the pole-piece 62.

The parts are shown in Fig. 5 in the position they occupy when the engine is hot and is not being cranked. The position of the inner end of the link 51 is determined by the temperature-responsive element 35, and the spring 14 holds the choke-valve 13 in open position. When the engine stops and begins to decrease in temperature, the temperature-responsive element 35 swings the arm 50 in a clockwise direction to raise the inner end of the link 51. The same screw 56 which has been described in connection with the device illustrated in Fig. 4 acts as a fulcrum for the link 51 with the result that clockwise movement of the arm 50 lowers the outer end of the link 51 and moves the choke-valve 13 towards closed position.

When the starter switch 18 is closed to actuate

the starter motor 17, the electro-magnet 31 is energized and draws the link 51 downward until it strikes the upper pole of the magnet. Simultaneously, the member 60 is drawn into engagement with the pole-piece 62, thus preventing the imposition of a distorting force on the temperature-responsive element 35. The extent to which the choke-valve 13 is moved toward closed position when the magnet 31 is energized depends upon the position of the inner end of the link 51, which in turn depends upon the position of the arm 50, the arrangement being such that the choke-valve is moved more nearly to closed position when the engine is cold than when it is hot.

In the arrangement illustrated in Fig. 6, the joint control of the choke-valve with the starter-motor is effected through mechanical rather than electrical means. In this arrangement, the thermostat 20 and control member 23 are employed as shown in Fig. 1. The choke-valve 13 is operatively connected to a longitudinally slidable member 65 having at its opposite end a pin 66 which is received in a cam slot 67 similar in purpose to the cam slot 25 illustrated in Fig. 1. The choke-valve 13 has associated with it the spring 14 which tends to move the choke-valve toward open position. Movement of the choke-valve under the influence of the spring 14 is limited by engagement of the pin 66 with the right-hand side of the cam slot 67, this side of the cam slot being so shaped as to increase the extent of choke-valve opening as the temperature-responsive element 20 responds to increased engine temperature.

For the purpose of closing the choke-valve during the starting operation, I provide a rod 68 which is connected to the starter pedal to be moved to the left when the starter pedal is depressed to close the starter switch 18. The rod 68 is yieldingly connected to the choke-valve 13 as by means of a compression spring 70 which acts between an abutment 71 on the rod 68 and an arm 72 movable with the choke-valve.

In the device illustrated in Fig. 6, depression of the starter pedal 69 will move the rod 68 to the left, thus causing the spring 70 to bear against the arm 72 to move the choke-valve 13 toward closed position. Movement of the choke-valve in this direction, however, is limited by engagement of the pin 66 with the left-hand side of the slot 67. Thereafter, the spring 70 will be compressed to permit such movement of the starter pedal 69 as is necessary to close the switch 18.

As in the devices previously described, the device illustrated in Fig. 6 embodies a single thermostat which controls both the extent to which the choke-valve is closed when the starter is energized and the extent to which the choke-valve opens after the cranking operation.

In the arrangement illustrated in Fig. 7, joint control of the choke-valve with the starter is eliminated, the choke-valve being arranged to be under manual control by a Bowden wire 75 which has a lost-motion connection with the arm 72. The same temperature-responsive element 20 and control member 23 are employed as are shown in Figs. 1 and 6. The control member 23 has a cam slot 25 which, by co-operation with the pin 66 and the member 65, limits the extent to which the choke-valve may be opened under the influence of the spring 14 or the extent to which it can be closed by operation of the Bowden wire 75. As in the other modifications, the slot 25 is shaped to provide for greater opening

and less closing of the choke-valve as the engine temperature increases.

I claim as my invention:

1. In combination with an internal combustion engine having a carburetor provided with a choke-valve having a control member, mechanism for limiting both opening and closing movements of said choke-valve, said mechanism including abutments between which said control member is received and which define the limits of choke-valve movement, and a single temperature-responsive means responsive to engine temperature for moving said abutments simultaneously to increase the extent to which the choke-valve may be opened and to decrease the extent to which it may be closed as the temperature of the engine increases.

2. In combination with an internal combustion engine having a carburetor provided with a choke-valve having a control member, mechanism for limiting both opening and closing movements of said choke-valve, said mechanism including abutments between which said control member is received and which define the limits of choke-valve movement, and a single temperature-responsive means for jointly adjusting the respective positions of said abutments.

3. In combination with an internal combustion engine having a carburetor provided with an adjustable mixture-proportioning device having a control member, mechanism having abutments between which said control member is received for limiting adjustment of said mixture-proportioning device in both directions, and a single temperature-responsive means for jointly adjusting said abutments to control simultaneously both limits of adjustment of said mixture-proportioning device.

4. In combination with an internal combustion engine, means for forming an explosive mixture for said engine, said mixture-forming means being adjustable to vary the proportions of the mixture formed, provisions for confining such adjustment between upper and lower limits, a single temperature-responsive means responsive to engine temperature operating said provisions to control simultaneously such upper and lower limits of adjustment of said mixture-forming means, and adjusting mechanism connected to said mixture-forming means independently of said temperature-responsive means and of said provisions for adjusting said mixture-forming means between the limits established by said provisions.

5. In combination with an internal combustion engine, means for forming an explosive mixture for said engine, said mixture-forming means being adjustable to vary the proportions of the mixture formed, provisions for confining such adjustment between upper and lower limits, a single temperature-responsive means operating said provisions to control simultaneously such upper and lower limits of adjustment of said mixture-forming means, and adjusting mechanism connected to said mixture-forming means independently of said temperature-responsive means and of said provisions for adjusting said mixture-forming means between the limits established by said provisions.

6. In combination with an internal combustion engine having a carburetor provided with a choke-valve having a control member, yielding means for moving said choke-valve toward open position, said choke-valve being movable toward closed position in opposition to said yielding

means, adjustable provisions including abutments between which said control member is received for limiting both opening and closing movements of said choke-valve, and a single temperature-responsive device for adjusting said provisions to control simultaneously both limits of movement of said choke-valve.

7. A device for controlling the choke-valve of an internal combustion engine carburetor, comprising a movable member adapted to be con-

nected to the choke-valve, electro-magnetic means for moving said member in a direction to close said choke-valve, adjustable provisions for limiting movement of said member in both directions, and a single-temperature responsive device for adjusting said provisions to control simultaneously both limits of movement of said movable member.

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