Sept. 9, 1947. C. J. SWIGERT 2,427,030

AUTOMATIC CHOKE VALVE

Filed Aug. 29, 1932 2 Sheets-Sheet 1

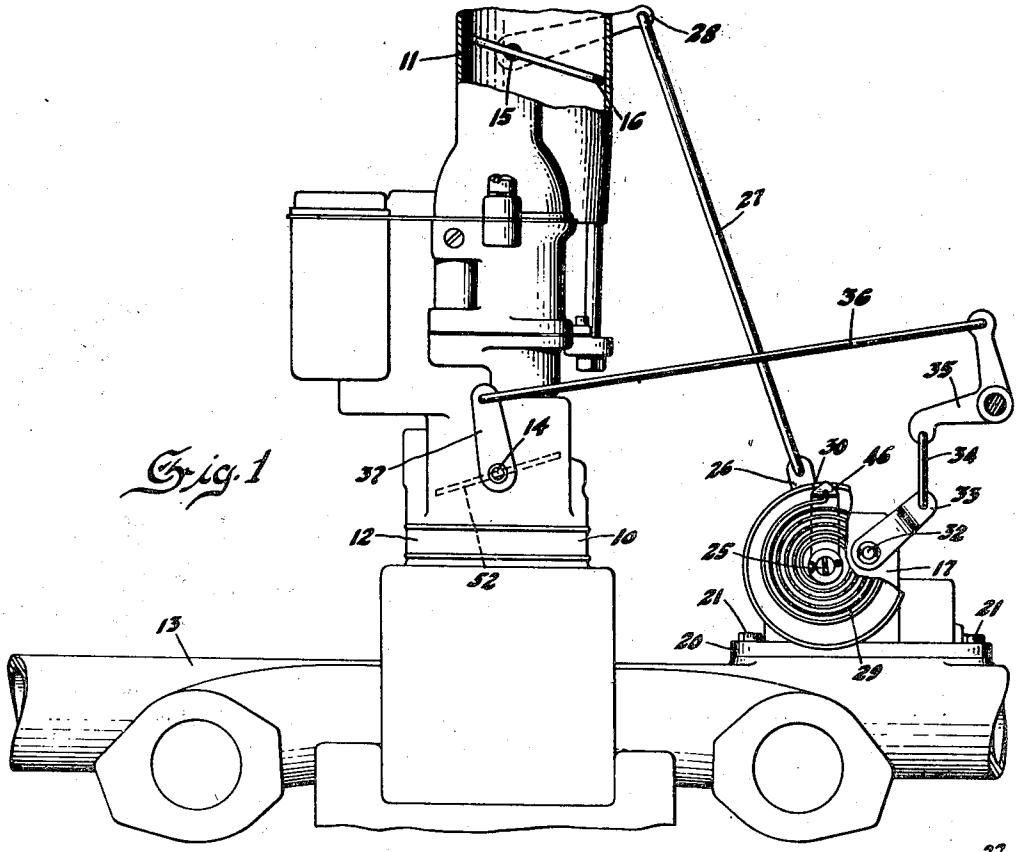


Fig. 1

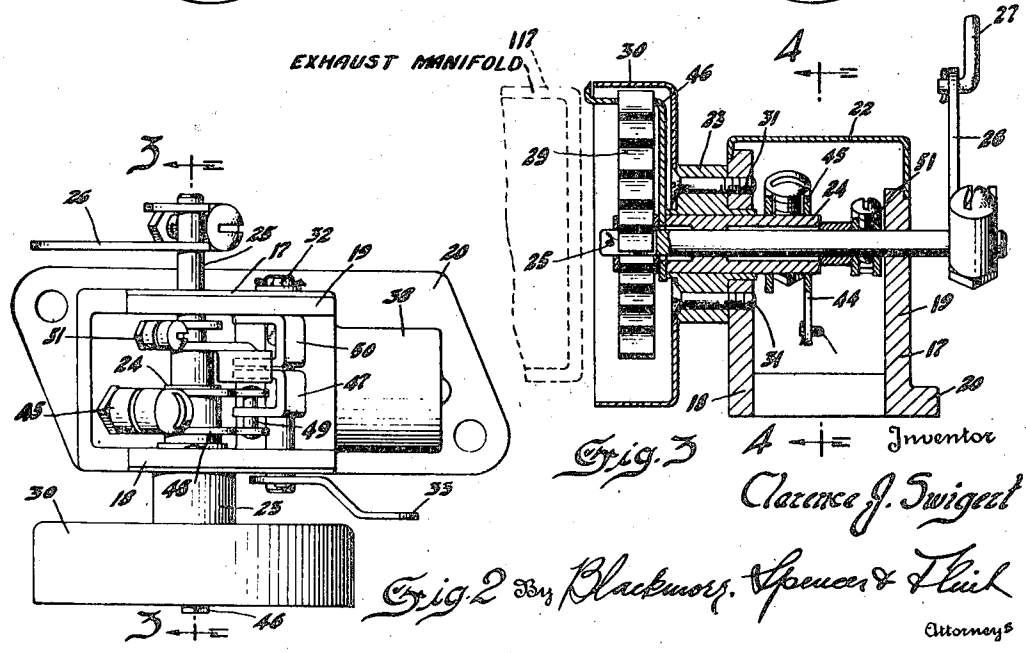


Fig. 3 4 Inventor

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Fig. 2 By Blackmore, Spencer & Flint

Attorneys

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AUTOMATIC CHOKE VALVE

Filed Aug. 29, 1932 2 Sheets-Sheet 2

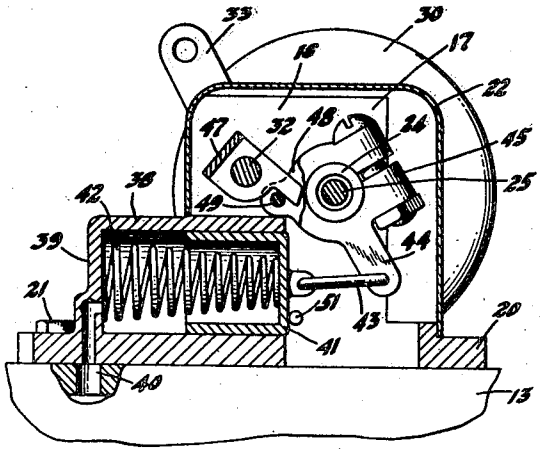


Fig. 4

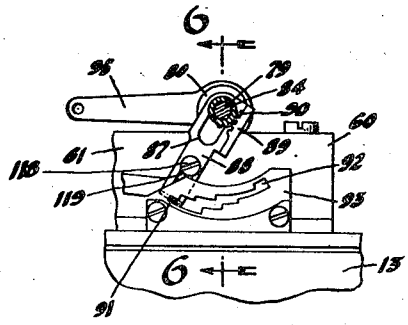


Fig. 7

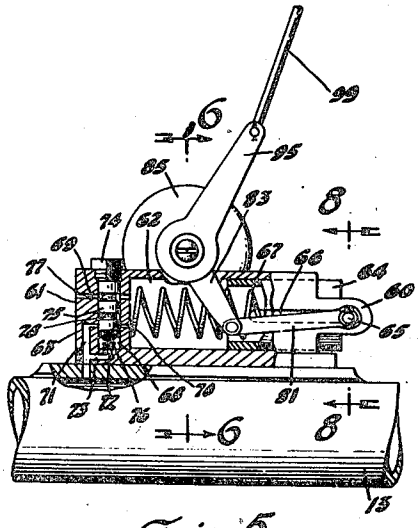


Fig. 5

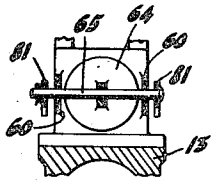


Fig. 8

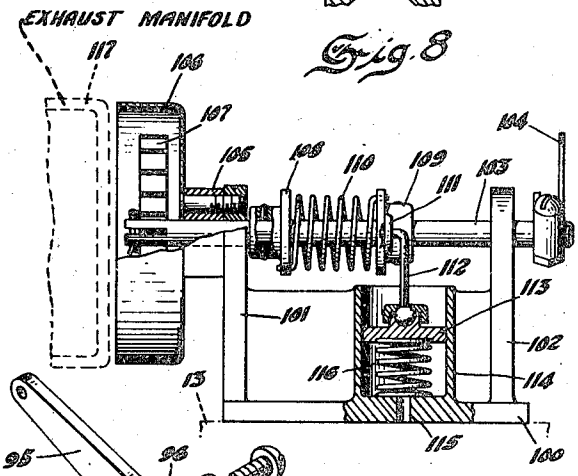


Fig. 9

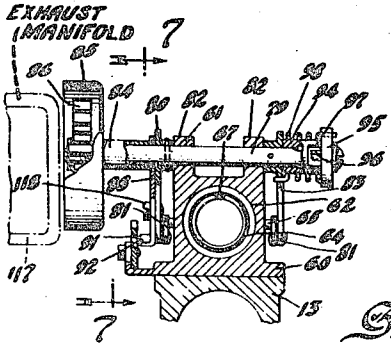


Fig. 6

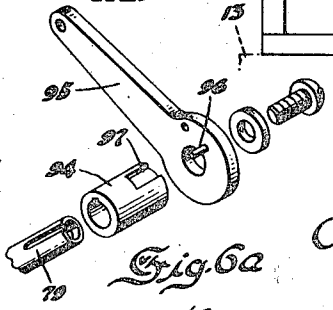


Fig. 6a

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2,427,030

AUTOMATIC CHOKE VALVE

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Application August 29, 1932, Serial No. 630,805

4 Claims. (Cl. 123—119)

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To facilitate starting and to insure most efficient operation of an internal combustion engine under different conditions, there is commonly provided in the air intake passage of the carburetor of the engine a valve (commonly called the "choke valve") which controls the flow of air through the passage and, consequently, the ratio of fuel to air in the combustible mixture supplied by the carburetor to the cylinders of the engine. Many mechanisms, some of which regulated the position of the choke valve in accordance with the temperature of the engine and others of which regulated the position of the choke valve in accordance with the speed and load of the engine, have been suggested for automatically regulating the position of the choke valve of an internal combustion engine. However, since, as my experiments have shown, the ratio of fuel to air which is desirable in the combustible mixture supplied to the cylinders of an internal combustion engine is a function both of the temperature and of the speed and load of the engine, none of these mechanisms has entirely satisfactorily accomplished the result that it was designed to accomplish.

This invention relates to mechanism for automatically regulating the position of the choke valve of the carburetor of an internal combustion engine and resides principally in such a mechanism which is so constructed and/or arranged that the position of the choke valve is affected by both the temperature and the speed and load of the engine.

For a better understanding of the nature and objects of the present invention, reference is made to the following specification in which there are described the preferred embodiments of my invention which are illustrated in the accompanying drawing.

In the accompanying drawing:

Fig. 1 is a view of choke valve regulating mechanism in which my invention is embodied installed on an internal combustion engine.

Fig. 2 is a top plan view of the mechanism shown in Fig. 1 with the cover removed.

Fig. 3 is a section taken on the line 3—3 of Fig. 2.

Fig. 4 is a section taken on the line 4—4 of Fig. 3.

Fig. 5 is a view of a second form of choke valve regulating mechanism in which my invention is embodied installed on an internal combustion engine with the parts in the positions which they occupy when the choke valve is nearly fully closed.

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Fig. 6 is a section taken on the lines 6—6 of Figs. 5 and 7 but showing the parts in the positions which they occupy when the choke valve is fully open.

Fig. 6a is an enlarged exploded perspective view of parts of the mechanism shown in Figs. 5 and 6.

Fig. 7 is a fragmentary view taken as indicated by the line 7—7 of Fig. 6 but showing the parts in the positions which they occupy when the choke valve is fully open.

Fig. 8 is a fragmentary section taken on the line 8—8 of Fig. 5.

Fig. 9 is a view of a third form of choke valve regulating mechanism in which my invention is embodied installed on an internal combustion engine.

In Figs. 1 to 4 of the drawing, there is shown part of the induction system of an internal combustion engine which includes a carburetor 10 into which air is drawn through the conduit 11 and from which combustible mixture is discharged through the conduit 12 and a manifold 13 through which the combustible mixture discharged from the conduit 12 is conducted to the intake ports of the cylinders of the engine. Within the conduit 12 on the shaft 14, there is mounted a throttle valve 52 of the butterfly type, and within the conduit 11 on the shaft 15, there is mounted a choke valve 16 of the butterfly type which is notable only in this, that, as shown in the drawing, the portion thereof which moves inwardly as the valve opens is of greater area than the portion on the opposite side of the shaft 15 and, consequently, that flow of air into the carburetor will tend to open it.

In the form shown in Figures 1 to 4, the mechanism in which my invention is embodied includes a body 17 which consists of a pair of spaced parallel walls 18 and 19 mounted on and formed integrally with a base 20 which is seated on and secured by means of screws, such as 21, to the intake manifold 13. The open sides of the body 17 are closed by a cover 22.

To the outer side of the wall 18, there is secured an element 23 on which there is provided a sleeve-like extension which projects through an opening in the wall into the interior of the body 17. In the element 23, there is journalled a hollow shaft 24 which projects into the interior of the body 17 beyond the mentioned extension of the element 23. Through the hollow shaft 24 and through the wall 19 of the body, there extends a shaft 25 which is journalled in the hollow shaft and in the wall 19. To the end of the shaft 25

which extends through the wall 19, there is fixed, without the body 17, a crank arm 26 which is connected by a link 27 to an operating arm 28 which is fixed to the shaft on which the choke valve 16 is mounted. To the opposite end of the shaft 25, beyond the outer end of the hollow shaft 24, there is secured the inner end of a bimetallic thermo-sensitive coil spring 29 which is located within a cup-shaped housing 30 which is secured to the element 23 by the screws 31 which secure it to the wall 18. The outer end of the thermo-sensitive element 29 is secured to the outer end of an arm 46 whose inner end is fixed to the outer end of the hollow shaft 24. In the walls 18 and 19 of the body, there are provided aligned openings through which extends and in which there is journalled a shaft 32 on one of whose ends, without the body, there is fixed a crank arm 33 which is connected, through a link 34, a bell crank 35 and a link 36, with an arm 37 which is fixed to the shaft on which the throttle valve 52 is mounted.

On one end of the base 20 and integral therewith, there is formed a hollow cylinder 38 whose outer end is closed by a head 39 and whose open inner end is located between the walls 18 and 19. The interior of the cylinder communicates with the interior of the intake manifold 13 through a passage 40 which extends through the head 39, the base 20 and the upper wall of the intake manifold. Within the cylinder 38, there is located a piston 41 which is urged away from the head end of the cylinder and toward the abutment 51 which serves to limit its outward movement by a coil spring 42 and whose outer end is connected by a link 43 to the arm 44 of a bracket 45 which is fixed to the portion of the hollow shaft 24 within the body.

On the shaft 32, within the body 17, there is mounted sufficiently loosely as to be freely rotatable thereon a U-shaped element 47. One of the arms of the element 47 extends between the branches of a bifurcated arm 48 which is formed on the bracket 45 and overlies a pin 49 which extends therebetween; and the other of the arms of the element 47 is located between the arm 48 and the wall 19 of the body. Between the element 47 and the wall 19 of the body, there is fixed to the shaft 32 a similar U-shaped element 50. To the shaft 25 between the inner end of the hollow shaft 24 and the wall 19 of the body, there is fixed an arm 51 whose extremity overlies the juxtaposed arms of the elements 47 and 50.

While, as indicated in Figure 3, the choke valve adjusting mechanism illustrated in Figures 1, 2, 3 and 4 of the drawing and hereinbefore described is designed to be installed on an engine with the thermo-sensitive element 29 located in such close juxtaposition to the exhaust manifold 117 thereof that it will be affected by the heat radiated therefrom, it will be understood that, if so desired, the mechanism may be so installed that the thermo-sensitive element will be affected by heat radiated from a part of the engine other than the exhaust manifold.

The thermo-sensitive element 29 is so constructed and arranged that (1) as its temperature rises, it tends to rotate the shaft 25 in such a direction (counter-clockwise, as viewed in Figure 1, or clockwise, as viewed in Figure 4) as to move the choke valve 16 toward open position and to rotate the hollow shaft 24 in such a direction (counter-clockwise, as viewed in Figure 4) as to move the piston 41 away from the head end of the cylinder 38, and (2) as its temperature falls, it tends to rotate the shaft 25 in such a direction (clockwise, as viewed in Figure 1, or counter-clockwise, as viewed in Figure 4) as to move the choke valve toward closed position and to rotate the hollow shaft 24 in such a direction (clockwise, as viewed in Figure 4) as to move the piston toward the head end of the cylinder and (3) when its temperature falls below a predetermined minimum (e. g., 70° F. to 80° F.) it will, if unresisted, maintain the choke valve in fully closed position. From what has been said in the preceding sentence, it will be apparent that the thermo-sensitive element 29, when its temperature is below the mentioned predetermined minimum, tends to maintain the choke valve in fully closed position and when its temperature equals or exceeds the mentioned predetermined minimum, tends to regulate the position of the choke valve in accordance with its temperature and, consequently, in accordance with the temperature of the exhaust manifold 117.

It will, however, be noted that, when the engine on which the mechanism shown in Figures 1, 2, 3 and 4 is installed is operating, two other forces, viz., the flow of air through the conduit 11 and the pressure within the intake manifold may affect the position of the choke valve 16 and, consequently, that the position of the choke valve is a function of both the temperature and the speed and load of the engine. It is obvious that an increase in the rate of flow of air through the conduit 11 will tend to move the choke valve toward fully open position, through the shaft 25, coil up the thermo-sensitive element 29 and through it, the hollow shaft 24, the bracket 45 and the link 43 move the piston 41 toward the head end of the cylinder 38 and that a decrease in the rate of flow of air through the conduit 11 will tend to uncoil the thermo-sensitive element 29 and permit the spring 42 to expand and move the piston away from the head end of the cylinder and to permit the thermo-sensitive element and/or the spring 42 to move the choke valve toward fully closed position. It is also apparent that a decrease in the pressure within the intake manifold of the engine will tend to move the piston 41 toward the head end of the cylinder 38 and, through the link 43, the bracket 45, the hollow shaft 24 and the arm 46 uncoil the thermo-sensitive element 29 and move the choke valve toward fully open position and that an increase in the pressure within the intake manifold will tend to permit the spring 42 to move the piston 41 away from the head end of the cylinder and, through the mentioned elements, coil up the thermo-sensitive element and move the choke valve toward fully closed position.

As shown in Figure 1, when the choke valve 16 is in fully closed position, the center of the pivotal connection between the arm 26 and the link 27 is located slightly to the side of the line joining the axis of the shaft 25 and the center of the pivotal connection between the link 27 and the arm 28 opposite that on which it is located when the choke valve is in fully or partially open position. Consequently, when the choke valve is in fully closed position, flow of air through the conduit 11 will be ineffective to move the choke valve toward fully open position and if the engine be started with the choke valve in this position, it will continue to operate with the choke valve in fully closed position until the temperature of the thermo-sensitive element 29 has increased and/or the pressure in the intake manifold has decreased

to such an extent that the tendency of either or both of these forces to rotate the shaft 25 in such a direction as to open the choke valve becomes sufficient to move the center of the pivotal connection between the arm 26 and the link 27 "over center" after which the flow of air through the conduit 11 will become a factor in determining the position of the choke valve. The feature of the mechanism described in this paragraph is important because it insures that if the engine on which the mechanism is installed is started when its temperature is lower than the mentioned predetermined minimum, it will be supplied with the very rich combustible mixture which is essential to quick and easy starting under these conditions for a sufficiently lengthy period to avoid a "false" start.

In connection with the mechanism shown in Figures 1, 2, 3 and 4, it will be noted that when the choke valve is in fully closed position, the pin 49 on the arm 48 of the bracket 45 is in engagement with one arm of the element 47 and that the other arm of the element 47 is in engagement with the arm 51 and, consequently, that rotation of the hollow shaft 24 in response to a decrease in the pressure within the intake manifold will be transmitted to the shaft 25 mechanically instead of through the thermo-sensitive element 29, and, therefore, that the considerable force which must be applied to the shaft 25 as a result of a decrease in pressure within the intake manifold to move the center of the pivotal connection between the arm 26 and the link 27 "over center" will not be imposed upon the thermo-sensitive element. In connection with this mechanism, it will also be noted that when the throttle valve 52 is moved toward open position, the shaft 32 will be rotated in a clockwise direction as viewed in Figure 1, with the result that, after the throttle valve has been opened to a predetermined extent, the element 50 on the shaft 32 will be brought into engagement with the arm 51 and will positively partially open the choke valve irrespective of the temperature and speed and load conditions of the engine.

In Figs. 5, 6, 6a, 7 and 8 of the drawing, the reference character 13 indicates the intake manifold of an engine similar to that shown in Fig. 1 and the reference character 60 a choke valve adjusting mechanism which includes a body 61 which is mounted on and secured to the intake manifold.

In the body of the mechanism shown in Figs. 5, 6, 6a, 7 and 8, there is provided a longitudinally extending cylindrical bore 62 which is open at one end and closed at the other by a head 63. In the cylindrical bore 62, there is fitted a piston 64 which is urged away from the head end of the cylinder by a coil spring 67 and to whose head end there is connected a transversely extending pin 65 whose opposite ends project through longitudinally extending slots 66 in the wall of the cylinder distant from the head end.

The pin 65 and the slots 66 serve both to prevent rotation of the piston in the cylinder and to limit the movement of the piston axially of the cylinder in both directions.

Into the head of the cylinder 62 from the upper side thereof, there extends a transverse bore 68 which terminates short of the lower side of the cylinder. The bore 68 is intersected by a bore 69 which extends through the head from the outer to the inner end thereof and by a bore 70 which extends into the head from the inner end thereof and communicates at its outer end with a transversely extending bore 71 which communicates with the interior of the intake manifold 13. The bores 68 and 71 are also interconnected by intersecting bores 72 and 73 which communicate, respectively, with the lower end of the bore 68 and with an intermediate portion of the bore 71. Within the bore 68 whose upper end is closed by a screw plug 74, there is located a piston valve 75 which is urged upwardly by the coil spring 76 and in whose cylindrical wall there are provided two annular grooves 77 and 78.

In upwardly projecting ears 82 which are formed on the body 61, there is journalled a shaft 79 which extends transversely of the cylinder 62 and projects outwardly beyond the ears. This shaft is connected to the piston 64 by arms 80 and 83 which are fixed to the shaft and links 81 whose opposite ends are pivotally connected, respectively, to the arms 80 and the ends of the pin 65.

On the shaft 79 outwardly of the arm 80, there is journalled a sleeve 84 to whose outer end there is fixed a cup-shaped housing 85 to which is secured the outer end of a bimetallic thermo-sensitive coil spring 86 whose inner end is fixed to the outer end of the shaft 79. The portion of the shaft 79 between the arm 80 and the inner end of the sleeve 84 extends through an elongated slot 87 in an arm 88 on which is formed a rack 89 whose teeth mesh with those of a pinion 90 which is formed on the adjacent end of the sleeve 84. On the outer end of the arm 88, there is provided a projection 91 which extends into a curved stepped slot 92 which is formed in a plate 93 which is fixed to the body 61. A screw 118 which extends into the arm 80 through an elongated slot 119 in the arm 88 permits the arm 88 to move parallel to the length of the arm 80 but prevents relative rotation of the arms 80 and 88 about the axis of the shaft 79.

On the shaft 79, outwardly of the arm 83, there is fixed a sleeve 94 and, outwardly of the sleeve 94, there is journalled on the shaft 79 an arm 95 on which there is provided a pin 96 which extends into a notch 97 in the sleeve and limits the angle throughout which the arm can rotate with respect to the shaft. The arms 95 and 83 are connected by a coil spring 98 which surrounds the sleeve 94 and whose ends are fixed, respectively, to the arm 95 and the arm 83. To the outer end of the arm 95, there is pivotally connected a link 99 whose outer end is adapted to be connected to an arm which is fixed to the shaft of the choke valve of the carburetor of an engine similar to that shown in Figure 1.

It will be apparent from the drawing that the mechanism illustrated in Figures 5, 6, 6a, 7 and 8 is adapted to be installed on an engine in the same manner as the mechanism illustrated in Figures 1, 2, 3 and 4.

The thermo-sensitive element 86 is so constructed and arranged that (1) as its temperature rises, it tends to rotate the housing 85 and the sleeve 84 in such a direction (counter-clockwise, as viewed in Figure 7) that rack and pinion 89—90 cause the projection 91 on the arm 88 to move upwardly in the slot 92, (2), as its temperature falls, it tends to rotate the housing 85 and the sleeve 84 in such a direction (clockwise, as viewed in Figure 7) that the rack and pinion cause the projection 91 to move downwardly in the slot 92 and (3), when its temperature falls below a predetermined minimum (e. g., 70° F. to 80° F.) it will maintain the projection 91 in abutment with one of the steps on the lower edge

of the slot 92. It will be apparent from the drawing and from what has previously been said that the thermo-sensitive element 86, when its temperature is below the mentioned predetermined minimum, maintains the projection 91 in abutment with one of the steps on the lower edge of the slot 92 and, when its temperature equals or exceeds the mentioned predetermined minimum, tends to regulate the position of the projection 91 radially of the slot 92 in accordance with its temperature and, consequently, in accordance with the temperature of the exhaust manifold 117 and that, functionally, the thermo-sensitive element 86 differs from the thermo-sensitive element 29 in that it does not directly affect the position of the choke valve.

It will, however, be noted (assuming that the choke valve is of the type illustrated in Figure 1 and hereinbefore described) that, when the engine on which the mechanism shown in Figures 5, 6, 6a, 7 and 8 is installed is operating, the flow of air through the air intake conduit of the carburetor and the pressure within the intake manifold of the engine may affect the position of the choke valve. It is apparent that an increase in the rate of flow of air through the air intake conduit of the carburetor will tend to move the choke valve toward fully open position, increase the tension in the spring 98, and through it rotate the shaft 79 in such a direction as to move the piston 64 toward the head end of the cylinder 62 and through the arm 80 and the screw 118 move the projection 91 to the left (as viewed in Figure 7) in the slot 92 and that a decrease in the rate of flow of air through the air intake conduit will tend to decrease the tension in the spring 98 and permit the spring 67 to expand and, through the piston 64, the links 81 and the arms 80 and 83 rotate the shaft 79, in such a direction as to permit the choke valve to move toward fully closed position and, through the mentioned elements and the screw 118, move the projection 91 to the right (as viewed in Figure 7) in the slot 92.

Assuming that the engine on which the choke valve adjusting mechanism shown in Figures 5, 6, 6a, 7 and 8 is installed is operating under such conditions that the pressure within the intake manifold is sufficiently low to maintain the piston valve 75 in such a position that the ends of the bore 70 are connected by the groove 78, a decrease in the pressure within the intake manifold will tend to move the piston 64 toward the head end of the cylinder 62 and, through the links 81, and the arms 80 and 83, rotate the shaft 79 in such a direction as to decrease the tension in the spring 98 and permit the choke valve to move toward fully open position and as, through the mentioned elements and the screw 118, to move the projection 91 to the left (as viewed in Figure 7) in the slot 92 and that an increase in the pressure within the intake manifold will tend to permit the spring 67 to move the piston 64 away from the head end of the cylinder 62 and through the elements 81, 80 and 83 rotate the shaft 79 in such a direction as to increase the tension in the spring 98 and through it move the choke valve toward fully closed position and as through the elements 81, 80, 83 and 118 to move the projection 91 to the right (as viewed in Figure 7) in the slot 92.

It will be noted that unless the pressure within the intake manifold of the engine on which the mechanism illustrated in Figures 5, 6, 6a, 7 and 8 is installed is below a predetermined value, dependent among other things on the strength of the spring 76, the pressure within the intake manifold will be ineffective in determining the position of the choke valve because while the pressure within the intake manifold is above this value, the cylinder 62 is vented to the atmosphere through the bore 69 and the bore 71 does not communicate with the cylinder 62.

While, as suggested above, normally, the force exerted on the choke valve by the flow of air through the intake conduit of the carburetor is transmitted to the shaft 79 and the force exerted by the pressure within the intake manifold on the shaft 79 is transmitted to the choke valve through the coil spring 98 which, consequently, functions as a spring load for the choke valve, it will be noted that if these forces exceed a predetermined value, the pin 96 will engage one end of the notch 97 and the forces will be transmitted positively from the shaft 79 to the choke valve and vice versa.

It will be understood from what has heretofore been stated that every change in speed and/or load of an engine on which the mechanism illustrated in Figures 5, 6, 6a, 7 and 8 is installed will tend to shift the position of the choke valve but that no change in the position of the choke valve beyond limits determined by the pin 96 and the notch 97 can be effected without moving the projection 97 lengthwise of the slot 92. Consequently, since movement of the projection 91 lengthwise of the slot 92 throughout any considerable distance cannot occur without movement of the projection past one of the steps of the slot, since movement of the projection past one of the steps cannot occur unless the radial position of the projection is such that it can move lengthwise of the slot without engaging the radial wall of the step and since the thermo-sensitive element tends to regulate the radial position of the projection in accordance with the temperature of the exhaust manifold of the engine on which the mechanism is installed, the position of the choke valve will be affected by the temperature as well as by the speed and load of the engine. It will be apparent from what has been pointed out in this paragraph that the mechanism shown in Figures 5, 6, 6a, 7 and 8 may be considered as a choke valve loading spring 98 whose characteristics are variable in accordance with the temperature and speed and load of the engine on which it is installed.

In the form shown in Figure 9, the choke valve adjusting mechanism includes a base 100 which is adapted to be mounted on the intake manifold 13 of an internal combustion engine and on which there are provided upstanding ears 101 and 102 through which extends and in which is journalled a shaft 103. To the shaft 103, outwardly of the ear 102, there is fixed a choke valve operating arm 104 which is adapted to be connected to the choke valve of the carburetor of an engine similar to that shown in Figure 1. To the outer side of the ear 101, there is fixed an element 105 to which is secured a cup-shaped housing 106 into which the shaft 103 projects and to which is connected the outer end of a bimetallic thermo-sensitive coil spring 107 whose inner end is fixed to the adjacent end of the shaft 103. The portion of the shaft 103 between the arms 101 and 102 is partly surrounded by two hub-like elements 108 and 109, of which the former is fixed to the shaft, and of which the latter, which is connected to the former by a coil spring 110 which surrounds

a portion of the shaft 103 and whose ends are fixed, respectively, to the elements 108 and 109, is rotatably mounted on the shaft 103.

To an arm 111, which is formed on the element 109, there is pivotally connected one end of a piston rod 112 whose opposite end is suitably connected to a piston 113 which is located in a cylinder 114 which is formed on the base 100. Within the cylinder 114 there is located a coil spring 116 which urges the piston upwardly in the cylinder. Through the head of the piston, there extends a passage 115 which is adapted to be connected to the interior of the intake manifold 13 of the engine on which the choke valve operating mechanism shown in Figure 9 is installed.

It will be apparent from the drawing that the mechanism illustrated in Figure 9 is adapted to be installed on an engine in the same manner as the mechanisms illustrated in Figures 1 to 8.

The thermo-sensitive element 107 is so constructed and arranged that (1), as its temperature rises, it tends to rotate the shaft 103 in such a direction as to move the choke valve (to which the arm 104 is adapted to be connected in a manner similar to that in which the arm 26 is connected to the choke valve 16) toward fully open position and as to, through the element 108, the spring 110, the element 109 and the rod 112, move the piston 113 toward the head end of the cylinder 114, (2), as its temperature falls, it tends to rotate the shaft 103 in such a direction as to move the choke valve toward fully closed position and as to permit the spring 116 to move the piston away from the head end of the cylinder and (3) that when its temperature falls below a predetermined minimum (e. g., 70° F. to 80° F.) it will, if unresisted, maintain the choke valve in fully closed position. From what has been said in the sentence next preceding this, it will be apparent that the thermo-sensitive element 107 functions similarly to the thermo-sensitive element 29 in that when its temperature is below the mentioned predetermined minimum, it tends to maintain the choke valve in fully closed position and when its temperature equals or exceeds the mentioned predetermined minimum it tends to regulate the position of the choke valve in accordance with its temperature and, consequently, in accordance with the temperature of the exhaust manifold 117.

It will, however, be noted (assuming that the choke valve is of the type illustrated in Figure 1 and hereinbefore described) that, when the engine on which the mechanism shown in Figure 9 is installed is operating, the flow of air through the air intake conduit of the carburetor and the pressure within the intake manifold of the engine, as well as the temperature of the engine affect the position of the choke valve. It is obvious that an increase in the rate of flow of air through the air intake conduit of the carburetor will tend to move the choke valve toward fully open position and rotate the shaft 103 in such a direction as to uncoil the thermo-sensitive element 107 and the spring 110 and move the piston 113 toward the head end of the cylinder 114 and that a decrease in the rate of air flow through the air intake conduit will tend to rotate the shaft 103 in such a direction as to coil up the thermo-sensitive element 107 and the spring 110 and permit the choke valve to move toward fully closed position and the spring 116 to move the piston 113 away from the head end of the cylinder 114. It is also apparent that a decrease in the pressure within the intake manifold of the

engine will tend to move the piston 113 toward the head end of the cylinder 114, uncoil the spring 110 and through it rotate the shaft 103 in such a direction as to uncoil the thermo-sensitive element 107 and move the choke valve toward fully open position and that an increase in the pressure within the intake manifold will tend to permit the spring 116 to expand, move the piston away from the head end of the cylinder, coil up the spring 110 and through it rotate the shaft 103 in such a direction as to coil up the thermo-sensitive element 107 and move the choke valve toward fully closed position.

While in Figures 5 to 9 the choke valves which the mechanisms shown therein are designed to operate have not been shown, and, consequently, the connections between the choke valves and the mechanisms have been shown incompletely, it will be understood that the mechanisms shown in Figures 5 to 9 will preferably be employed in conjunction with choke valves of the type shown in Figure 1 and will preferably be connected thereto by mechanism of the type illustrated in Figure 1 and hereinbefore described.

It may be well here to mention that, at some sacrifice of efficiency, balanced instead of unbalanced choke valves may be employed in conjunction with the mechanisms herein disclosed and/or throttle position variation actuated elements may be substituted for the manifold pressure variation actuated elements herein disclosed.

Although I have shown and described preferred embodiments of my invention, it is to be understood that this has been done by way of example and not by way of limitation, and that the scope of my invention is to be determined only by the appended claims.

I claim:

1. In a carburetor, an unbalanced choke valve, a thermostat for resiliently closing said valve when cold and opening said valve when hot, a throttle, means for opening said valve upon opening the throttle wide, and a vacuum motor adapted for operation by manifold vacuum, a lost motion connection between said motor and said valve, permitting a minor movement of said motor without affecting said valve, but opening said valve on extreme movement as upon high vacuum.

2. In an internal combustion engine which includes a carburetor in which there is incorporated a choke valve and a passage which connects the carburetor with a cylinder of the engine, mechanism for regulating the position of the choke valve which includes a hollow shaft, a shaft which is connected to the choke valve journalled in the hollow shaft, a thermostat interconnecting the specified shafts, and a member movable in response to changes in the pressure within the mentioned passage connected to the hollow shaft.

3. In an internal combustion engine which includes a carburetor in which there is incorporated a throttle valve and a choke valve, mechanism for regulating the position of the choke valve which includes a hollow shaft, a shaft which is connected to the choke valve journalled in the hollow shaft, resilient means interconnecting the specified shafts, means by which the hollow shaft may be rotated, a shaft to which the throttle valve is connected, and elements on the shafts through which motion of the hollow shaft and the third specified shaft may be positively transmitted to the second specified shaft.

4. In an internal combustion engine which includes a choke valve which flow of air through

the carburetor tends to open, a throttle valve, and a passage which connects the carburetor with a cylinder of the engine, mechanism for regulating the position of the choke valve which includes means for preventing movement of the choke valve from its closed position by flow of air through the carburetor, a hollow shaft, a shaft which is connected to the choke valve journalled in the hollow shaft, a resilient thermostat interconnecting the specified shafts, a member movable in response to changes in the pressure within the mentioned passage connected to the hollow shaft, a shaft to which the throttle valve is connected, and elements on the shafts through which motion of the hollow shaft and the third specified shaft may be positively transmitted to the second specified shaft.

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