Aug. 20, 1935. S. R. PUFFER 2,011,651

INTERNAL COMBUSTION ENGINE

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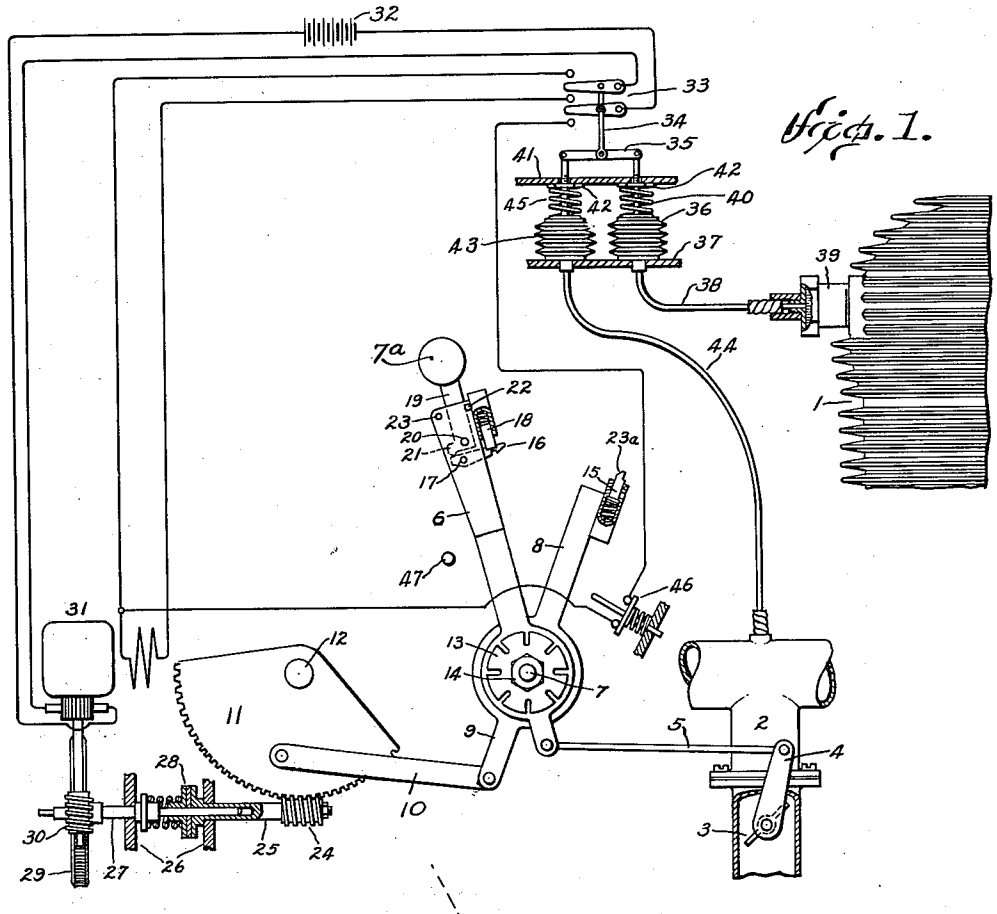

Fig. 1.

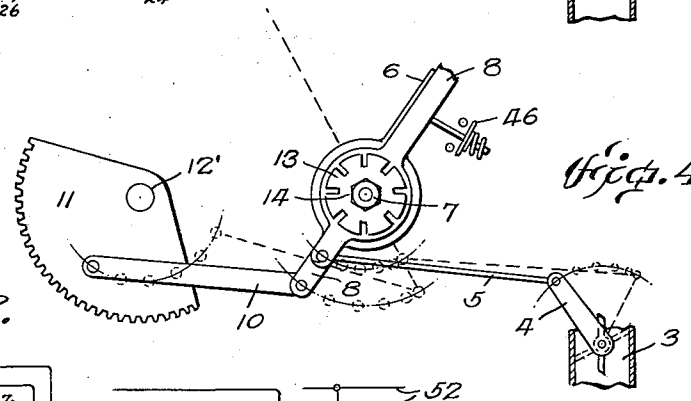

Fig. 4.

Fig. 3.

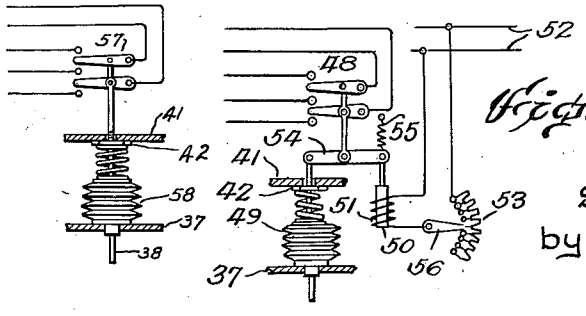

Fig. 2.

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INTERNAL COMBUSTION ENGINE

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16 Claims. (Cl. 123—98)

The present invention relates to internal combustion engines and has for its object to provide an improved construction and arrangement for controlling automatically the regulating means of an internal combustion engine in response to an operating condition appurtenant to the engine, it being understood that by an operating condition appurtenant to the engine I mean an operating condition of the engine itself or of a mechanism driven by the engine or under control of which it is desired to place the engine.

In the operation of internal combustion engines, it is desirable to prevent over-heating, a thing which may be caused due to the use of improper fuel, improper or insufficient cooling, defective lubrication, and in the case of supercharged engine, excessive supercharging, and to prevent this my improved construction and arrangement may be placed under control of the engine temperature. In the case of a supercharged engine, it is required to prevent excessive pressure in the intake manifold of the engine, that is, excessive supercharging, as this causes pre-ignition and over-heating of the engine, and in this connection my improved construction and arrangement may be placed under control of the supercharger pressure.

Again, in certain instances, it may be desirable to place the engine under control of some condition appurtenant to apparatus operated by the engine, for example, in the case of an airplane engine, under some condition appurtenant to an automatic control for the airplane, and my improved construction and arrangement is well adapted for use under these conditions.

Furthermore, in carrying out my invention I may place the construction and arrangement under control of two or more such operating conditions as will be pointed out more fully hereafter.

For a consideration of what I believe to be novel and my invention, attention is directed to the following specification and the claims appended thereto.

In the drawing, Fig. 1 is a diagrammatic view, with parts in section, of an internal combustion engine provided with control mechanism embodying my invention, and Figs. 2 and 3 are detailed views of modifications.

Fig. 4 shows a fragment of Fig. 1 illustrating different positions of the parts.

Referring to the drawing, 1 indicates the cylinder structure of an internal combustion engine, 2 indicates the conduit or manifold through which the mixture of fuel and air is supplied to the engine, and 3 indicates the usual throttle valve for the engine, which is located between the carburetor and the engine. The structure indicated is to be taken as typical of any suitable single cylinder or multi-cylinder internal combustion engine provided with a throttle valve or other control means. In the present instance the cylinder structure 1 is indicated as being an air cooled cylinder, but the invention is equally applicable to cylinders cooled by liquid or other means.

Connected to throttle valve 3 is a lever arm 4 which in turn is connected by a link 5 to the lower end of a lever 6 pivoted on a shaft 7. Lever 6 is the usual hand lever for controlling the throttle valve and is adapted to be moved by means of the handle 7a.

Pivotally mounted on shaft 7 adjacent to lever 6 is a stop arm 8 provided at its lower end with an ear 9 which is connected by a link 10 to a gear segment 11 pivoted on a shaft 12. Lever 6 and stop arm 8 are held in frictional engagement with each other by a spring washer 13 and a nut 14, the arrangement being such that lever arm 6 may be readily moved manually but will remain in any position in which it is left. Lever 6 and stop arm 8 move in adjacent planes so that lever 6 may be moved past the stop arm. On the upper end of stop arm 8 is a spring pressed catch 15 adapted to be engaged by a latch 16 pivotally mounted on the side of lever 6, as is indicated at 17, the latch being in line with catch 15 and in the plane of movement of stop arm 8 and being held down by a spring pressed plunger 18. Handle 7a is carried by an arm 19 pivoted at 20 on lever 6 and provided with a nose 21 which engages the end of latch 16. Arm 19 is adapted to move between stops 22 and 23 on lever 6. Arm 19 is normally held in engagement with stop 22 by spring pressed plunger 18. When moved toward stop 23 it first turns on its pivot 20 to lift latch 16, after which it engages stop 23 to effect movement of lever 6. Latch 16 is adapted to engage catch 15 to lock lever 6 to stop arm 8, whereby the lever and stop arm may be moved together. The rear side of catch 15 is beveled as is indicated at 23a whereby by pushing sufficiently hard on lever 6, the latch 16 may be made to move over catch 15 and the lever 6 moved beyond stop arm 8.

Meshing with gear segment 11 is a worm 24 carried by a shaft 25 pivoted in a frame 26. Pivoted in frame 26 in line with shaft 25 is a second shaft 27 connected to shaft 25 by a spring pressed slip or friction coupling 28. On shaft 27 is a worm wheel 29 with which meshes a worm 30 on the end of the shaft of electric motor 31. It will thus

be seen that motor 31 is connected through the worm gearing and friction coupling 28 to segment 11 so that when operated it moves the segment either forward or backward, to position stop arm 8. By reason of the worm gearing, the stop arm 8 will be held positively in any position to which it is moved by the motor. Motor 31 is connected by suitable wiring to a source of electrical supply 32 and a reversing switch 33, the arrangement being such that when the reversing switch is moved into engagement with the central and upper contacts it operates motor 31 in a direction to move stop arm 8 toward the left, or in the direction necessary to close the throttle, while when it is moved to engage the central and lower contacts it operates motor 31 in a direction to move stop arm 8 toward the right, or in the direction necessary to open the throttle.

The reversing switch may be connected to a device responsive to a single operating condition or to a plurality of operating conditions appurtenant to the internal combustion engine in a manner such that the reversing switch is actuated in the one direction or the other whenever the operating condition, or, in the case of a plurality of operating conditions, whenever one of the operating conditions departs from a desired value.

In the present instance, the reversing switch is shown in Fig. 1 as being connected to a device responsive to engine temperature and to a device responsive to intake manifold pressure.

The reversing switch is connected by an arm 34 to the central portion of a floating lever 35. The right hand end of lever 35 is connected to a pressure responsive device 36, here shown in the form of a flexible bellows supported on a casing wall 37. Flexible bellows 36 is connected by a capillary tube 38 to a bulb 39 in thermal contact with the engine cylinder. In the bulb and capillary tube is a suitable liquid which vaporizes due to the temperature of the bulb and in so doing develops a pressure which varies only with the temperature of the bulb. When the vapor pressure in the bulb increases, it distends bellows 36 to raise the reversing switch, the bellows in distending overcoming the tension of a spring 40. When the vapor pressure in the bulb decreases, it permits the bellows 35 to be collapsed by spring 40 to move the reversing switch downward. Spring 40 is a compression spring arranged between the upper end of bellows 36 and a top casing wall 41. At 42 is an adjustable nut whereby the tension on the spring 40 may be adjusted and through it the operating temperature of the control device regulated.

The other end of lever 35 is connected to a bellows 43 which is connected by a pressure pipe 44 to the intake manifold 2 of the engine. Bellows 43 is controlled by an adjustable spring 45 similar to spring 40. When the pressure in intake manifold increases bellows 43 is distended to move the reversing switch upward, while when the pressure in the intake manifold decreases the bellows is collapsed moving the reversing switch 33 downward.

In the circuit wire which is connected to the lower contact of the reversing switch, there is arranged a limit switch 46 which is opened when stop arm 8 reaches a position wherein the throttle valve 3 is fully opened. This serves to limit the position to which the stop arm may be moved and also to open the circuit when this position is reached, so as to avoid the waste of electric current. Movement of stop arm 8 toward the left is limited by a suitable stop 47, thereby limiting the extent to which throttle valve 3 may be closed by said stop arm. Stop 47 stands in the path of movement of stop arm 8 only and does not stand in the path of movement of lever 6. With this arrangement, after lever 6 has been moved toward closed position by stop arm 8 to the maximum extent, the movement of lever 6 toward closed position manually may be continued at the will of the operator until the throttle valve 3 is completely closed and the engine shut down. With this arrangement, the automatic means can close the engine down to only a predetermined extent, but cannot shut the engine down completely.

As stated above, the regulating mechanism may be placed under the control of a single operating condition appurtenant to the engine or under a plurality of such operating conditions.

In Fig. 2 reversing switch 48, corresponding to reversing switch 33 of Fig. 1, is placed under the joint control of a corrugated bellows 49 which may correspond either to the bellows 36 or the bellows 43 of Fig. 1, or be a bellows under control of some other operating condition appurtenant to the engine, and under the control of the electromagnet 50, the winding 51 of which is connected to a source of electrical energy 52 through an adjustable resistance 53. The corrugated bellows 49 and the plunger of electromagnet 50 are connected to opposite ends of a floating lever 54 corresponding to the floating lever 35 of Fig. 1. Downward movement of the solenoid plunger is opposed by a suitable spring 55. The movable contact arm 56 of the adjustable resistance may be placed under the control of any suitable mechanism which mechanism may be at any desired location. Otherwise the construction indicated may be the same as that shown in Fig. 1.

Fig. 3 shows the reversing switch 57 under the control of a single corrugated bellows 58 which may correspond, for example, to either the bellows 36 or the bellows 43 of Fig. 1. Otherwise, the construction indicated in Fig. 2 may be same as that in Fig. 1.

The operation is as follows; it being first described in connection with a single operating device, such as the temperature responsive bellows 36 as shown in Fig. 1 or the bellows of Fig. 3:

When the engine is cold, or below the predetermined high temperature, the reversing switch 33 will stand in a position wherein it is in engagement with the middle and lower contacts, and stop arm 8 will be in its extreme right hand position, in engagement with and holding open limit switch 46. This opens the circuit through the motor and prevents waste of current.

The operator is free to operate lever 6 to set the throttle valve in any desired position.

When the engine cylinder reaches a temperature higher than the predetermined maximum, the reversing switch is moved into engagement with the central and upper contacts, thereby effecting rotation of motor 31 in a direction to move stop arm 8 toward the left. Movement of the stop arm will be continued until the throttle valve has been closed to an extent such that the temperature of the engine is reduced below the predetermined maximum, whereupon reversing switch 33 will move away from engagement with the central and upper contacts and assume an intermediate position as shown in the drawing. In moving toward the left, the catch 15 on stop arm 8 will engage the latch 16 on lever 6, thereby locking the stop arm and lever together

so that the lever will follow the movement of the stop arm.

At any time, the operator may move the lever 6 between stop arm 8 and the fully closed position to operate the throttle valve within this range. Stop arm 8, however, serves to limit the maximum opening of the throttle valve.

If the operator wishes to operate the engine continuously at its maximum safe capacity, he may move throttle lever 6 into engagement with stop arm 8 whereby the two are latched together and leave it in this position. The result then will be obtained that when the engine exceeds the maximum temperature the throttle valve will be closed somewhat to bring it back to the maximum value, and when it falls below the maximum value the throttle valve will be opened somewhat to increase the power of the engine up to the maximum value permissible. This is a condition of operation often desirable in connection with an airplane engine where it is desired to operate at the highest permissible speed. When operating this way the aviator need pay no attention to the engine control. At any time, however, the operator may move the throttle toward a closed position by merely grasping the handle 7a and pulling it toward the left. In this connection it will be noted that the first movement of the handle releases the latch 16 from the catch 15, the handle being brought into engagement with stop 23 whereupon further movement of the handle moves lever 6 to effect closing movement of the throttle valve. This arrangement has the advantage that the unlatching of the lever 6 from the stop arm 8 is effected by a movement of the handle in the same direction as that required to move the throttle valve. This is an important consideration, especially in the case of an aviator, as he need give no thought to the unlatching of the lever. He is required merely to operate the lever in the way in which it is operated ordinarily.

In case of an emergency, the operator may, by applying additional pressure to lever 6, move it beyond stop arm 8, the latch 16 sliding over the beveled surface 23a of the catch. This is advantageous especially in the case of an airplane, as occasion may arise when it is desirable, in case of an emergency, to load the engine beyond what would be considered safe under ordinary circumstances.

A throttle valve, such as the throttle valve 3, does not have a straight line characteristic. That is to say, equal movements of arm 4 do not effect equal effective opening movements of the throttle valve, it being understood that by equal effective opening movements is meant opening movements which effect equal increments in the rate of flow past the valve. In the present instance, the link 5 and its connection to lever 6 is so correlated with link 10 and its connection with segment 11 that there is obtained equal effective opening movements of throttle valve 3 for equal movements of the segment 11. This is illustrated in Fig. 4 where successive positions of segment 11 and arm 4 are indicated by the dotted circles. From this, it will be seen that equal movements of segment 11 produce equal effective opening movements (but not equal opening movements) of valve 3.

Stop 47 is so positioned that the stop arm 8 cannot be moved automatically to an extent such that it stops the engine. However, it does not prevent the operator from moving the throttle valve 3 to a position in which the engine will stop. If motor 31 remains in operation after lever 8 engages stop 47, then the slip clutch 28 permits the motor to continue to run so as to avoid stalling the motor.

Viewed from another aspect, it will be seen that when lever 6 and arm 8 are latched together, motor 31, switch 33 and thermal responsive device 39 constitute a means responsive to an operating condition of the engine for positioning automatically the throttle valve 3, and that the throttle valve may be positioned manually, independently of said automatic means by moving lever 6 by hand.

Any suitable type of reversing switch 33 may be used, the same being shown only diagrammatically in the drawing. In operation, its contacts are set and adjusted so as to give the desired range between the two reversing positions of the switch.

When the reversing switch is under the control of a plurality of conditions appurtenant to the operation of the engine, as shown in Figs. 1 and 2, the operation is the same as that described except that the reversing switch is moved in response to variations of each of such conditions. For example, with the specific arrangement shown in Fig. 1, the switch will be moved and the stop adjusted in response either to excessive engine temperature or excessive supercharger pressure. With the specific arrangement shown in Fig. 2, the switch will be closed and the stop adjusted in response to the operating condition actuating the bellows 49 and the operating condition actuating the adjustable contact arm 56.

By my invention it will be seen that I provide a means whereby the operator may set the engine for automatic control at the maximum safe engine output, or the maximum safe operating condition, and permit it to so operate without further attention. This is of special utility in the case of a supercharged airplane engine for, as already stated, if the throttle of such an engine is opened too wide at sea level or low altitudes, damage to the engine is likely to result. By the invention the operator is relieved of the necessity of watching closely the operation of the engine in order to obtain maximum output from it. At the same time, however, he is in a position to readily throttle or shut down the engine in the usual way. Also, in case of an emergency, he may open the throttle beyond that point which would be considered ordinarily a safe position.

The apparatus is simple in structure and easy to install in connection with an engine; and when installed, it does not interfere with the normal operation of the engine by the operator within the safe range.

In accordance with the provision of the patent statute, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to obtain by Letters Patent of the United States is:

1. The combination with an internal combustion engine, of manually movable means for controlling the engine, a stop movable relatively to and independently of said manually movable means for limiting movement of said means, means for automatically positioning said stop in accordance with an operating condition appur-

tenant to the engine, and means for connecting said manually movable means to said stop, said connecting means being releasable to permit the manually movable means to be moved beyond said stop.

2. The combination with an internal combustion engine having a regulating means and a lever for moving the regulating means, of a stop positioned in the path of movement of the lever and movable relatively to and independently of said lever, an electric motor for moving said stop, and means responsive to an operating condition appurtenant to the engine for causing the motor to position said stop to prevent movement of said lever to a position wherein the regulating means is operated to an extent such that the engine may be injured.

3. The combination with an internal combustion engine having a regulating means for increasing and decreasing admission of fuel thereto, and a lever for moving the regulating means, of a stop positioned in the path of movement of the lever and movable relatively to and independently of said lever, an electric motor for moving said stop, means responsive to an operating condition appurtenant to the engine for causing the motor to position said stop to prevent movement of said lever to a position wherein the regulating means is operated to an extent such that the engine may be injured, and interengaging means carried by the lever and stop for locking them together.

4. The combination with an internal combustion engine having a throttle valve, of movable means responsive to an operating condition appurtenant to said engine, and correlated means connecting said movable means to said throttle valve whereby equal movements of said movable means produce equal effective movements of said throttle valve.

5. The combination with an internal combustion engine having a regulating means for increasing and decreasing admission of fuel thereto, a manually operable lever for moving it, and means for holding the manually operable lever in adjusted position, of an arm which is positioned automatically in accordance with an operating condition appurtenant to the engine, and a latch for connecting said lever to said arm, said latch being released and said lever being moved away from said arm upon an initial manual movement of said lever in a direction to move the regulating means to decrease the admission of fuel to the engine.

6. The combination with an internal combustion engine having a regulating means for increasing and decreasing admission of fuel thereto, a manually operable lever for moving it, and means for holding the manually operable lever in adjusted position, of an arm which is positioned automatically in accordance with an operating condition appurtenant to the engine, a latch for connecting said lever to said arm, said latch being released and said lever being moved away from said arm upon an initial manual movement of said lever in a direction to decrease the fuel supply, and being released upon pressure being applied to the lever in a direction to increase the fuel supply.

7. The combination with an internal combustion engine having a regulating means, and a lever for moving the regulating means, of a stop positioned in the path of movement of the lever, an electric motor for moving said stop, means responsive to an operating condition appurtenant to the engine for causing the motor to position said stop to prevent movement of said lever to a position wherein the regulating means is operated to an extent such that the engine may be injured, and a limit switch for the motor which is opened when the stop reaches a predetermined position.

8. The combination with an internal combustion engine, of manually movable means for controlling the engine, means for holding said manually movable means in any adjusted position, a member for limiting the movement of said manually movable means, said manually movable means and said member being movable relatively to and independently of each other, means responsive to an operating condition appurtenant to the engine for positioning said member, and means independent of said holding means for locking said manually movable means and said member to each other at will.

9. The combination with an internal combustion engine and means for regulating the engine, of a stop, means for positioning said stop in accordance with an operating condition appurtenant to the engine, an arm connected to said regulating means and movable in the path of movement of said stop, said arm being capable of being positioned at any point in advance of said stop, and means whereby said arm may be moved beyond said stop for emergency operation.

10. The combination with an internal combustion engine, of manually movable means for controlling the engine, means for holding said manually movable means in adjusted position, a stop movable relatively to said manually movable means and independently of said holding means for limiting the movement of said manually movable means toward open position, said stop being capable of moving said manually movable means against the action of said holding means, and means for automaticlly positioning said stop in accordance with an operating condition appurtenant to the engine.

11. The combination with an internal combustion engine, of manually movable means for controlling the engine, means for holding said manually movable means in adjusted position, a stop movable relatively to said manually movable means and independently of said holding means for limiting the movement of said manually movable means, said stop being capable of moving said manually movable means against the action of said holding means, means for automatically positioning said stop in accordance with an operating condition appurtenant to the engine, and means for connecting said manually movable means to said stop.

12. The combination with an internal combustion engine, of manually movable means for controlling the engine, means for holding said manually movable means in adjusted position, a stop movable relatively to said manually movable means and independently of said holding means for limiting the movement of said manually movable means, said stop being capable of moving said manually movable means against the action of said holding means, means for automatically positioning said stop in accordance with an operating condition appurtenant to the engine, and means for connecting said manually movable means to said stop, said connecting means being released by an initial movement of said manually movable means.

13. The combination with an internal combustion engine, of manually movable means for con-

trolling the engine, means for holding said manually movable means in adjusted position, a stop movable relatively to said manually movable means and independently of said holding means for limiting the movement of said manually movable means toward open position, said stop being capable of moving said manually movable means against the action of said holding means, means for automatically positioning said stop in accordance with an operating condition appurtenant to the engine, and means responsive to intake manifold pressure for automatically positioning said stop.

14. The combination with an internal combustion engine, of manually movable means for controlling the engine, means for holding said manually movable means in adjusted position, a stop movable relatively to said manually movable means and independently of said holding means for limiting the movement of said manually movable means toward open position, said stop being capable of moving said manually movable means against the action of said holding means, and means responsive to engine temperature and to another condition appurtenant to the operation of the engine for automatically positioning said stop.

15. The combination with an internal combustion engine, of manually movable means for controlling the engine, means for holding said manually movable means in adjusted position, a stop movable relatively to said manually movable means and independently of said holding means for limiting the movement of said manually movable means toward open position, said stop being capable of moving said manually movable means against the action of said holding means, and means responsive to intake manifold pressure and to another condition appurtenant to the operation of the engine for automatically positioning said stop.

16. The combination with an internal combustion engine, of manually movable means for controlling the engine, means for holding said manually movable means in adjusted position, a stop movable relatively to said manually movable means and independently of said holding means for limiting the movement of said manually movable means toward open position, said stop being capable of moving said manually movable means against the action of said holding means, and means responsive to engine temperature and to intake manifold pressure for automatically positioning said stop.

SAMUEL R. PUFFER.