

W. F. ROPER.
 AIR CONTROLLING DEVICE FOR INTERNAL COMBUSTION ENGINES.
 APPLICATION FILED JAN. 22, 1915.

1,205,484.

Patented Nov. 21, 1916.

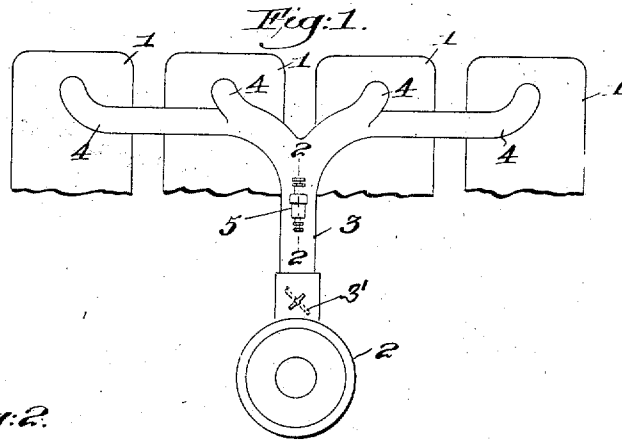


Fig. 2.

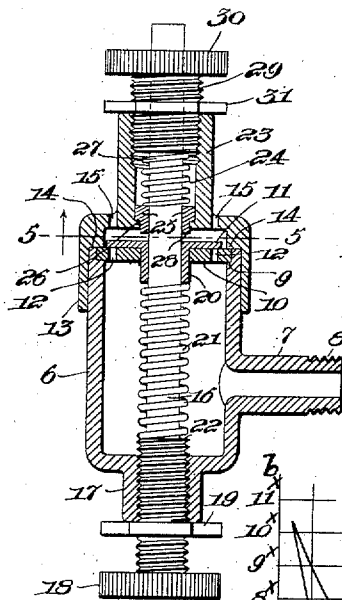


Fig. 3.

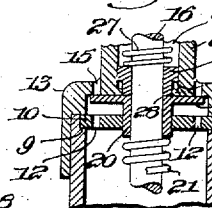


Fig. 4.

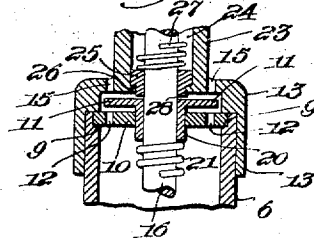


Fig. 6.

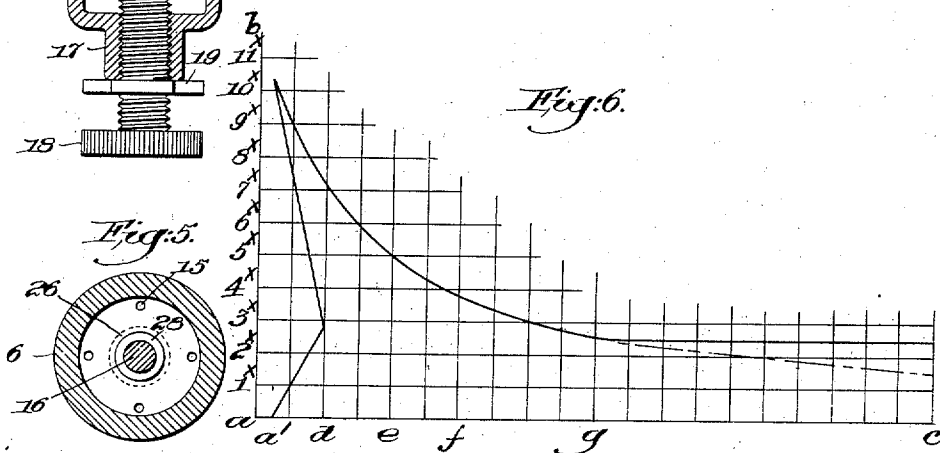
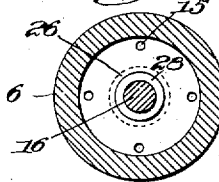


Fig. 5.



Witnesses,
 Edward G. Allen
 Beatrice S. Smith.

Inventor:
 Walter F. Roper;
 by Robert A. Hains,
 Att'y.

UNITED STATES PATENT OFFICE.

WALTER F. ROPER, OF HOPEDALE, MASSACHUSETTS.

AIR-CONTROLLING DEVICE FOR INTERNAL-COMBUSTION ENGINES.

1,205,484.

Specification of Letters Patent. Patented Nov. 21, 1916.

Application filed January 22, 1915. Serial No. 3,812.

To all whom it may concern:

Be it known that I, WALTER F. ROPER, a citizen of the United States, residing at Hopedale, county of Worcester, and State of Massachusetts, have invented an Improvement in Air-Controlling Devices for Internal-Combustion Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

The invention to be hereinafter described relates to internal combustion engines or motors, and more particularly to the means for controlling the character of the mixture or the proportion of air and fuel comprising the mixture.

As well known by those skilled in the art, a mixture of air and fuel is supplied to an internal combustion engine or motor through an intake, and the volume of such supply is regulated by a throttle, while the character of the mixture or the relative proportion of air and fuel is ordinarily controlled by fixed adjustments at the carbureter. While the fixed character of the mixture as determined by the carbureter may be well adapted for certain conditions, it becomes unsuitable for other conditions, and at times results in unnecessary waste of fuel.

Attempts have heretofore been made to overcome the objections noted and economize fuel consumption by the introduction at times of an extra air supply, but such attempts have not satisfactorily responded to the requirements because either the extra air supply had to be regulated by hand or, if automatic means were provided difficulty has been experienced either in starting or idling, or if these have been overcome, then at high speeds with the throttle wide open and consequent low vacuum, the extra air supply has been entirely shut off.

With these generally-stated facts in view, the aims and purposes of the present invention are to provide an automatically-acting valve device which will effectually operate to shut off the extra air supply when the engine is being started, and while it is running idle, and permit a desired supply of extra air or shut it off at times under the demands of the vacuum produced. This characteristic of the invention and other important features thereof will best be made clear from the following description and accom-

panying drawings of one form of means for carrying the invention into practical effect, it being understood that the invention is not restricted to the described and illustrated details, but is definitely set forth in its true scope by the claims.

In the drawings:—Figure 1 is a diagrammatic view showing an internal combustion engine of any usual type, its connected carbureter and intake pipe with the present invention applied; Fig. 2 is an enlarged sectional view of a valve device on the line 2—2, Fig. 1, containing the present invention, the air valve being shown against its inner seat; Fig. 3 is a section similar to that of Fig. 2, with the parts omitted, showing the air valve against its outer seat; Fig. 4 is a similar section showing the air valve in intermediate position; Fig. 5 is a cross-section on the line 5—5, Fig. 2; Fig. 6 is a diagram showing the relation of throttle openings and corresponding cylinder vacuum.

In order that the invention and its operation may be more clearly understood, it is desirable to bear in mind that the amount of vacuum in the cylinder or cylinders with the engine running, is dependent on the amount of throttle opening and engine load or speed. Manifestly, when the engine is not running and at the time of starting, there is no vacuum, but as soon as the engine has started, a vacuum is produced and rapidly reaches a maximum when the engine is running idle with the throttle practically closed. As the throttle is gradually opened more and more, the vacuum drops until, when the throttle is wide open and the engine is running at high speed, it reaches a minimum. The diagram Fig. 6 is intended to illustrate the relation between the vacuum and throttle opening. In this figure, the vertical line *a—b* is supposed to represent the amount of vacuum in pounds from 0 to 11, and the horizontal line *a—c* to represent the proportional degree of throttle opening. With the throttle positioned at *d* for starting, the vacuum produced under the starting action is between 2 and 3 pounds. As soon as the engine has started, however, and the throttle is practically closed, as at *a'*, so that the engine will run idly and slowly, this vacuum at once jumps to about 10½ pounds. Now, as the load is placed upon the engine, which in the case of an automobile, would be in

starting the car over the road, and the speed of the engine is increased by opening the throttle successively to *d*, *e*, *f* and *g*, the vacuum in the engine cylinder or cylinders and intake pipe progressively drops, as indicated by the curved line in Fig. 6, until when the throttle is wide open and the engine is running at high speed, it reaches about 2½ pounds. Should the load upon the engine be increased, as by an automobile going up a grade with the throttle wide open, the vacuum in the cylinder or cylinders and intake pipe drops still farther. To meet the requirements of these varying conditions, the present invention contemplates an extra air controlling valve which shall operate automatically to insure the exclusion of any extra air when the engine is being started, either by the usual crank or a self-starter and also when the engine is idling or running with the car stationary, and to admit extra air in appropriate amounts at all speeds, which are responsive and proportionate to the throttle opening.

In carrying the invention into practical effect, it contemplates an extra air-controlling valve which shall be under the influence of spring action and the vacuum produced by the engine, so that when the vacuum is absent and also when it is at its maximum, said valve will be closed; but it will be opened more or less at all other times, except when an extra load is placed upon the engine, such as happens when an automobile is climbing a heavy grade, at which time the engine necessarily runs slower, even with the throttle wide open; and at such times, the present invention contemplates that the supply of extra air shall be interrupted by the valve. One means for carrying the invention into practical effect is shown by the drawings, and will now be described.

Referring to Fig. 1, the cylinders of the engine are represented at 1, and as being four in number, but obviously the number of cylinders is immaterial, and may be increased or diminished as circumstances may dictate. The carbureter from which the fixed mixture of air and fuel is supplied to the engine cylinders, is typified at 2 and connecting the carbureter 2 with the cylinders of the engine is the supply pipe 3 having the branches 4 leading to the various cylinders, and throttle 3'.

The present invention contemplates that the extra air controlling device which constitutes the subject-matter thereof, shall be attached preferably to the intake pipe 3, and this disposition of the parts is indicated in Fig. 1, wherein the air controlling device indicated as a whole by 5, is shown as appropriately secured to the intake

Referring more particularly to Fig. 2 of the drawing, it will be noted that the extra air controlling device comprises a casing

6 having a tubular projecting portion 7 provided with screw threads 8, whereby the casing and the parts carried thereby may be appropriately secured to the intake pipe. At one end of the casing 6 there is an interior shoulder 9, upon which rests the inner seat 10 for an air controlling valve 11. The inner seat 10 preferably is formed disk-shaped, as indicated in Fig. 5, and is provided with a plurality of air inlet openings 12, four being shown in the drawings. In order to appropriately hold the inner seat 10 in place, the end of the casing 6 is closed by a cap 13, Fig. 2, which may be appropriately placed over the end of the casing 6, and be provided with a shoulder 14 to bear against the face of the inner valve seat 10 and maintain it in fixed position within the casing 6. Obviously, other appropriate means might be employed for securing the inner valve seat 10 in position within the casing 6, but the above is found to be a convenient form of device for this purpose.

The cap 13 is provided with air inlets 15 which may be of appropriate number to properly permit the entrance of air to the casing 6 when these inlets are uncovered. The air controlling valve 11 is mounted in the casing 6 for movement toward and from the inner valve seat 10, so that at times the said valve 11 may rest upon the inner seat 10 and close the inlet openings 12 thereof, and at other times, may rest upon the end of the interior wall of the cap 13 and close the inlets 15, as will more fully appear.

Extending longitudinally through the casing 6, is a spindle 16, Fig. 2, which is preferably screw-threaded to the end 17 of the casing for the adjustment of said spindle longitudinally thereof. The spindle 16 may be suitably provided with a finger piece 18 for appropriately turning it for adjusting purposes, and may likewise be provided with a lock nut 19 for holding it in adjusted position.

Mounted upon the spindle 16 is the air controlling valve 11, before-mentioned, which is preferably formed as a disk having a hub portion 20 which is adapted to slide upon the spindle 16 under the influence of a spring 21 which preferably is mounted upon and surrounds the spindle 16, substantially as indicated in Fig. 2. One end of the spring 21 rests against the shouldered portion 22 of the spindle 16 while the other end bears against the face of the hub portion 20 of the air inlet valve 11, the construction being such that the spring 21 normally tends to force the air controlling valve 11 from its inner toward its outer seat against the face of the cap 13.

The cap 13 has projecting therefrom, an end portion 23 which may be formed integral with the cap 13 or, if desired, appropriately secured thereto. In any event, it

is provided with an interior chamber 24 through which extends the spindle 16.

The chamber 24, which may be appropriately termed the secondary chamber, contains a plunger 25 having a shouldered portion 26 adapted to rest upon a corresponding shouldered portion of the projection 23 under the influence of a spring 27, which preferably surrounds the end portion of the spindle 16 as indicated in Fig. 2. The plunger or valve controller 25 is provided with an end portion 28 which, when the plunger or valve controller 25 is held upon the shouldered portion 26 of the projection 15 by the spring 27, projects beyond the face of the outer seat for the air controlling valve 11, substantially as indicated in Fig. 2.

In order that the plunger 25 or the auxiliary valve controller, may be appropriately held upon its seat by the desired tension of the spring 27, the end of the projection 23 is preferably provided with an adjusting sleeve 29, Fig. 2, which may be screw-threaded to the interior portion of the projection and be provided with a finger piece 30. A lock nut 31 may serve to hold the threaded sleeve 29 in adjusted position. The spindle 16 may be appropriately extended throughout the entire length of the valve controlling device, as indicated in Fig. 2, but this structure may be changed, if desired.

The tension of the spring 21 which acts upon the air controlling valve 11, may be adjusted, as by the means hereinbefore described, and likewise, may the tension of the spring 27 which bears upon and holds the plunger or auxiliary valve controller 25 on its seat. In their operative relation, the springs 21 and 27 are so adjusted that when there is no vacuum formed in the casing 6, the spring 21 will force the air controlling valve 11 against the plunger or the auxiliary valve controller 25, and force it back against the tension of its spring 27 until such air controlling valve 11 finds its outer seat and effectually closes the inlet openings 15, as represented in Fig. 3. This is substantially the condition of the air controlling device when the engine with which it is associated, is being started, either by hand or by a self-starter, so that at this time, when a rich mixture is desired, no extra air is permitted to pass to the intake pipe through the air controlling device above-described. When, however, the engine has been started and the throttle has been practically closed, the vacuum in the cylinders and intake, as hereinbefore explained, reaches its maximum of approximately 10½ pounds, whereupon the spring 21 yields under the air pressure against the air controlling valve 11 and permits that valve to rest upon its inner seat, as indicated in Fig. 2.

As the throttle is gradually opened, the

vacuum in the cylinders and intake pipe gradually drops as heretofore explained, whereupon the air controlling valve 11 moves from its inner seat where it rested during the idle running of the engine, and assumes a position intermediate the inner and outer seats, substantially as indicated in Fig. 4, so that even with the throttle wide open, and the engine running correspondingly fast, or at high speed, with consequent production of small vacuum, as indicated in Fig. 6, such small vacuum plus the tension of the spring 27, will cause the air controlling valve 11 to still occupy some intermediate position between its inner and outer seats, and thereby permit a desired quantity of air to flow into the intake pipe. Should a load be placed upon the engine while the throttle is wide open, as would happen in the case of an automobile ascending a steep grade, the engine will slow down with a consequent drop of the vacuum to about 1½ pounds, as represented by the dotted lines in Fig. 6, whereupon the spring 21 is enabled to overcome the tension of the spring 27, plus the low vacuum, and seat the air controlling valve against its outer seat to thereby exclude the entrance of extra air, and consequently give to the engine a relatively rich mixture direct from the carbureter, a condition that is desirable when the engine load has been increased, as described.

From the construction and operation of the air controlling device, as hereinbefore described, in connection with one form or embodiment thereof, it will be noted that when the engine is to be started, either by hand or by a self-starter, at which time a relatively rich mixture is desired, no extra air is permitted to enter the intake pipe. Likewise, when the engine is idling, that is, running slowly with the throttle practically closed and the car, in the case of an automobile, stationary, the high vacuum produced changes the position of the valve from its outer to its inner seat, and again closes the supply of extra air. As the throttle is gradually opened, the vacuum gradually drops, as hereinbefore pointed out, and the spring 21 is enabled, therefore, to gradually move from its inner toward its outer seat, until, when the throttle is fully open, it rests upon the plunger or auxiliary valve controller, with the engine and car running at full speed; but when a load is placed upon the engine and it consequently slows down with the throttle still wide open, the decrease or drop of the vacuum in the casing 6 permits the spring 21 to overcome the tension of the spring 27, plus the decreased vacuum, and again the original rich mixture direct from the carbureter is supplied to the engine.

The casing 6 may be of any desired form, but is preferably cylindrical, and the inner valve seat 10 divides the interior of the casing into two compartments, one being connected to the intake pipe 3, and which for identification, may be known as the vacuum chamber, and the other containing the valve 11, and consequently designated the valve chamber. The valve 11, it will be noted, moves in the valve chamber, being guided between the inner and outer valve seats by the hub 20 sliding upon the spindle 16. When the device is adjusted, the spring 21 is of greater active strength than the spring 27, so that with the absence of, or a minimum vacuum in the vacuum chamber, the spring 21 may seat the valve upon its outer seat and exclude the entrance of extra air.

Various changes in the general form and construction of the parts may suggest themselves to those skilled in the art, and the invention is therefore not restricted to the particular details shown and described, although those illustrated by the drawing have been found to embody a good, readily-adjustable and practical auxiliary air controller.

Claims.

1. In an internal combustion engine, the combination of the cylinders and intake pipe, a casing having a vacuum chamber in communication with the intake pipe; inner and outer valve seats independent in relation to each other having air passages, a single valve between said seats operating without relation to the chamber walls, a spring adapted to seat the valve against the outer seat and close the air passage thereof when there is a minimum vacuum in the said chamber and permitting the valve to rest against the inner seat when a maximum vacuum exists in said chamber, and means acting upon the valve to hold it from the outer seat when there is a vacuum between maximum and minimum in said chamber.

2. In an internal combustion engine, the combination of the cylinders and intake pipe, a casing having a vacuum chamber in communication with said intake pipe, an inner valve seat having air passages, an outer valve seat having inlets for the admission of air to said chamber, a valve movable between the inner and outer valve seats, a spring acting on the valve in one direction to force the valve against the outer seat when the engine is at rest and also when a minimum vacuum exists in said chamber during the slow operation of the engine and permitting the valve to rest against the inner seat and close the air passages thereof when a maximum vacuum exists in said chamber, and an auxiliary spring-actuated device operated to act upon the valve to

hold it from its outer seat when the vacuum is near but above the minimum.

3. An air controlling device for internal combustion engines, comprising a casing having a chamber, an inner valve seat adjacent one end of said chamber and having an air passage, an outer valve seat having an air inlet, a valve between said seats, a spring for forcing the valve toward its outer seat, and an auxiliary spring for modifying the action of said first-named spring when the valve is moved toward its outer seat.

4. An air controlling device for internal combustion engines, comprising a casing having a chamber, an outer valve seat having an air inlet passage, an inner valve seat within the casing having an air passage, a valve movable between said outer and inner valve seats, a spring for moving the valve toward one of said seats, a spring plunger extending beyond one of said valve seats and adapted to modify the action of the first-named spring on said valve.

5. An air controlling device for internal combustion engines, comprising a casing, an inner and outer valve seat in said casing forming a valve chamber between them, a valve movable in said valve chamber, said valve seats having air passages, a spring for moving the valve toward the outer valve seat to close the air passages thereof, a plunger having a part extending into the valve chamber adapted to be engaged by the valve as it moves toward the outer valve seat to modify the action of the first-named spring.

6. An air controlling device for internal combustion engines, comprising a casing, an outer valve seat having an air inlet, and an inner valve seat dividing the interior of the casing into a vacuum chamber and a valve chamber and having an air passage leading from the valve chamber to the vacuum chamber, a valve movable in the valve chamber between the inner and outer valve seats, a spring for forcing the valve against the outer valve seat, a plunger projecting into the valve chamber, and a spring acting upon said plunger to decrease the action of the first-named spring as the valve approaches the outer valve seat.

7. An air controlling device for internal combustion engines, comprising a casing, an outer valve seat having an air inlet, an inner valve seat dividing the interior of the casing into a vacuum chamber and a valve chamber and having an air passage leading from the valve chamber to the vacuum chamber, a valve movable in the valve chamber between the inner and outer valve seats, a spring for forcing the valve against the outer valve seat, a plunger projecting into the valve chamber, a spring acting upon said plunger to decrease the action of the first-named

spring as the valve approaches the outer valve seat, and means for adjusting the tension of each of said springs.

8. An air controlling device for internal
5 combustion engines, comprising a casing, an outer valve seat having an air inlet, an inner valve seat dividing the interior of the casing into a vacuum chamber and a valve chamber and having an air passage leading from
10 the valve chamber to the vacuum chamber, a valve movable in the valve chamber between the inner and outer valve seats, a

spring for forcing the valve against the outer valve seat, a plunger projecting into the valve chamber, and a spring of less 15 strength than the first-named spring and acting upon said plunger.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

WALTER F. ROPER.

Witnesses:

WM. O. PERKINS,
E. M. MURRAY.