

[54] **IGNITION DEVICES FOR INTERNAL COMBUSTION ENGINES AND ENGINES INCLUDING SUCH DEVICES**

[75] Inventor: **Jean Panhard**, Paris, France

[73] Assignee: **Societe de Constructions Mecaniques Panhard & Levassor**, Paris, France

[22] Filed: **Feb. 27, 1970**

[21] Appl. No.: **15,099**

[30] **Foreign Application Priority Data**

Feb. 28, 1969 France.....6905579

[52] U.S. Cl.123/117 A, 123/117 R

[51] Int. Cl.F02p 5/04

[58] Field of Search.....123/117.1

[56] **References Cited**

UNITED STATES PATENTS

2,596,830	5/1952	Udale.....	123/117.1
2,827,889	3/1958	Smitley.....	123/117.1
3,385,275	5/1968	Burnia.....	123/117.1
3,426,737	2/1969	Walker.....	123/117.1
3,447,518	5/1969	Walker.....	123/117.1
3,456,633	7/1969	Walker.....	123/117.1

3,515,105	6/1970	Soeters.....	123/117.1
3,521,609	7/1970	Kashiwagi.....	123/117.1
3,584,608	6/1971	Shibagaki.....	123/8.09

Primary Examiner—Laurence M. Goodridge

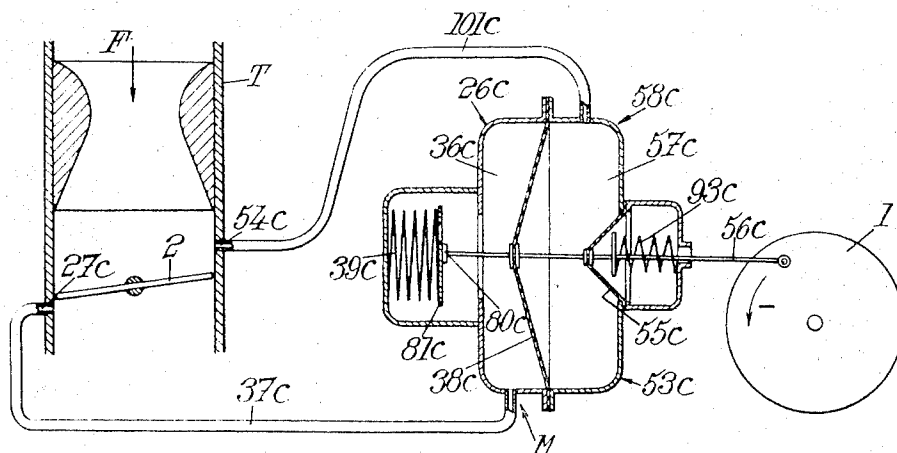
Assistant Examiner—Ronald B. Cox

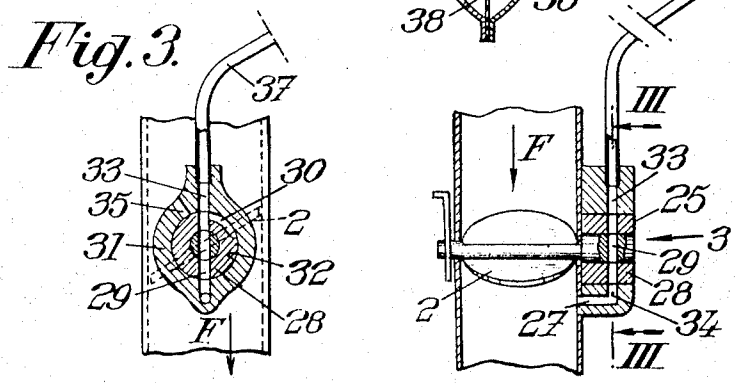
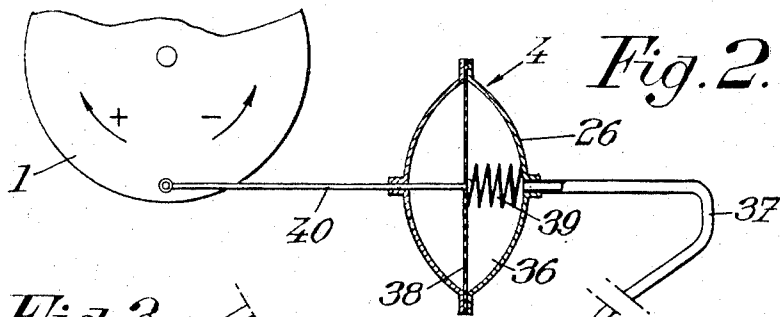
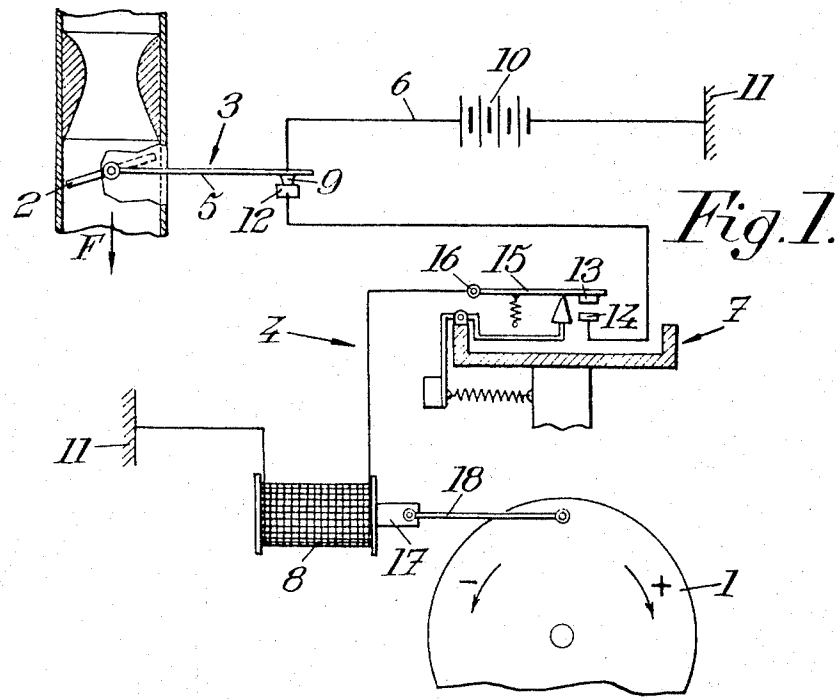
Attorney—Waters, Roditi, Schwartz & Nissen

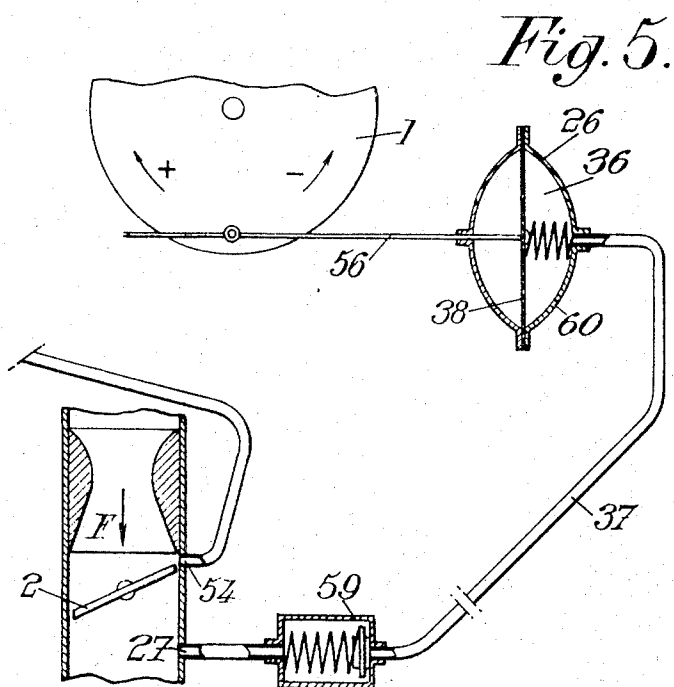
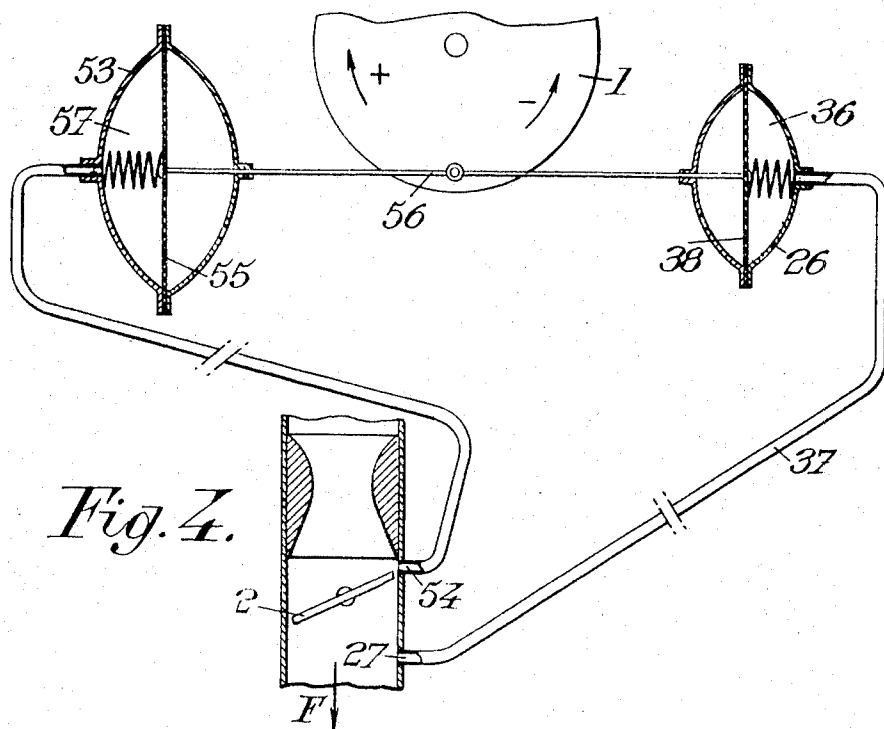
[57] **ABSTRACT**

The device is for use particularly with rotary piston engines in which the combustion chamber is periodically connected with the intake pipe before being isolated from the exhaust. It has means sensitive to the position of the throttle valve and to the rotary speed of the engine. These means move a plate in the direction of ignition retard when the degree of opening of the throttle valve is less than a certain limit P_L and the rotary speed is greater than a certain limit N_L . The means may be constituted by an electrical contact and a centrifugal contact, which when both are closed actuate the ignition retard. The means may also be two suction capsules connected to selected points in the intake pipe, working in opposition and connected to the same stem. The capsules are calibrated to operate beyond certain predetermined suction thresholds.

9 Claims, 25 Drawing Figures







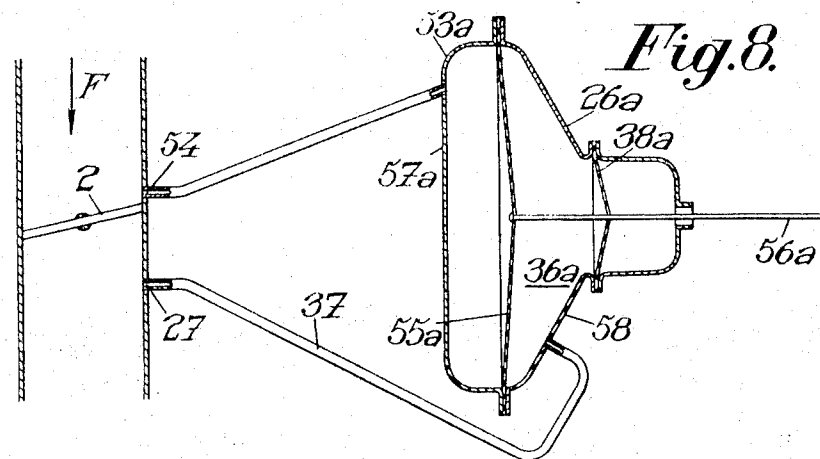
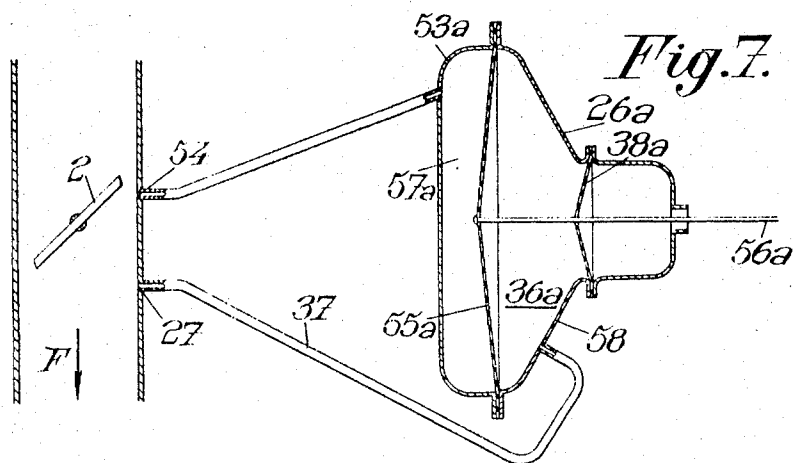
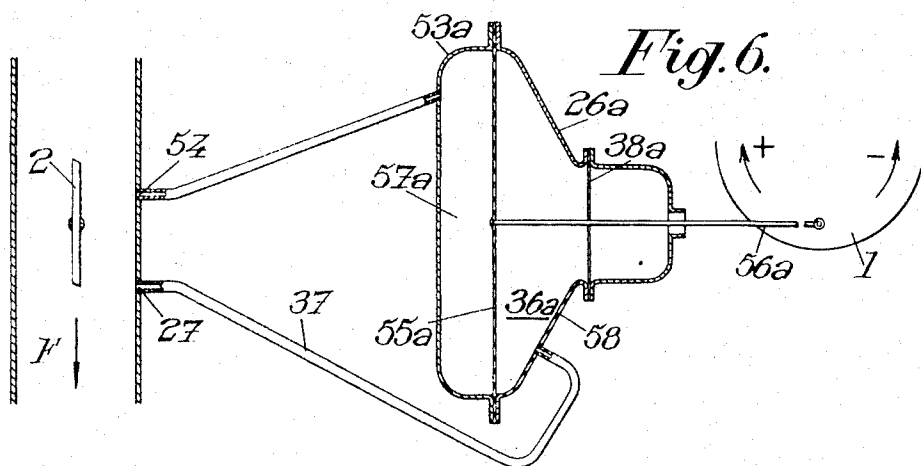


Fig. 9.

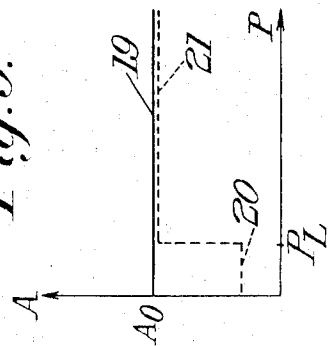


Fig. 17.

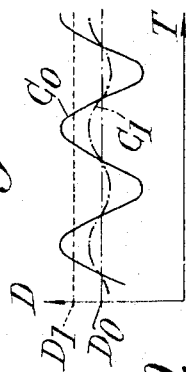


Fig. 10.

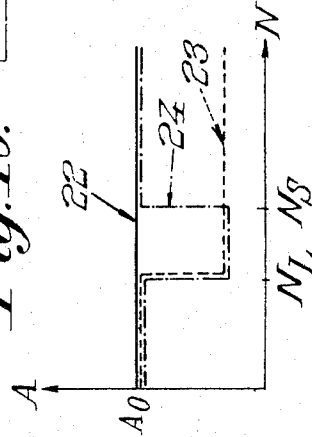


Fig. 11.

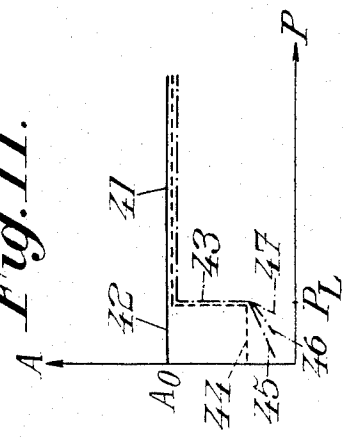
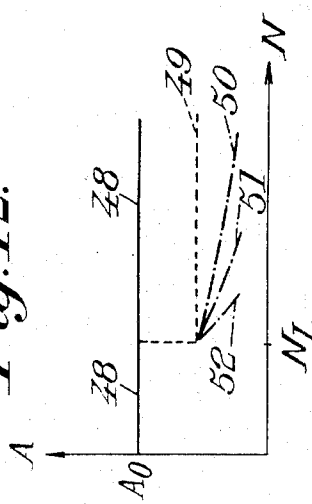


Fig. 12.



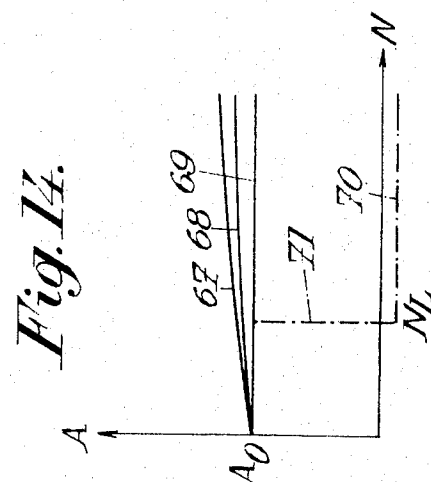
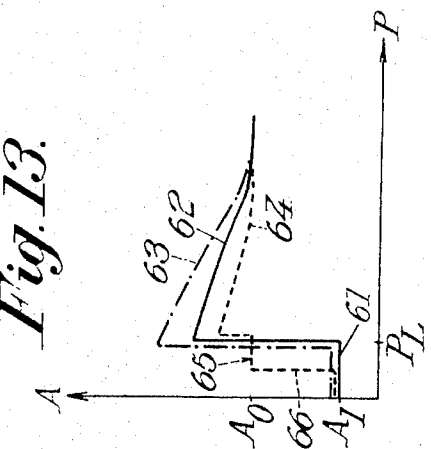
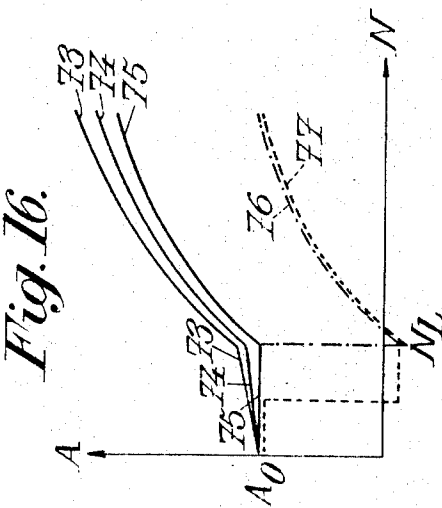
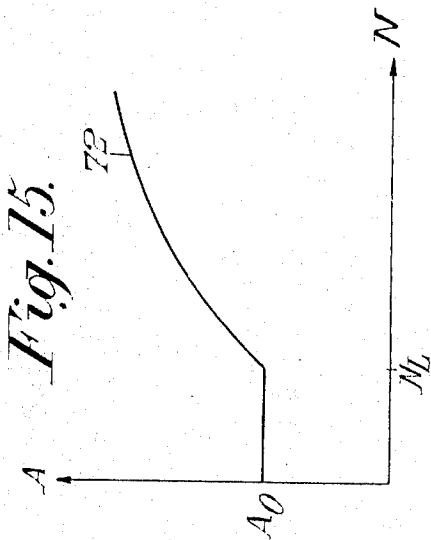


Fig. 18.

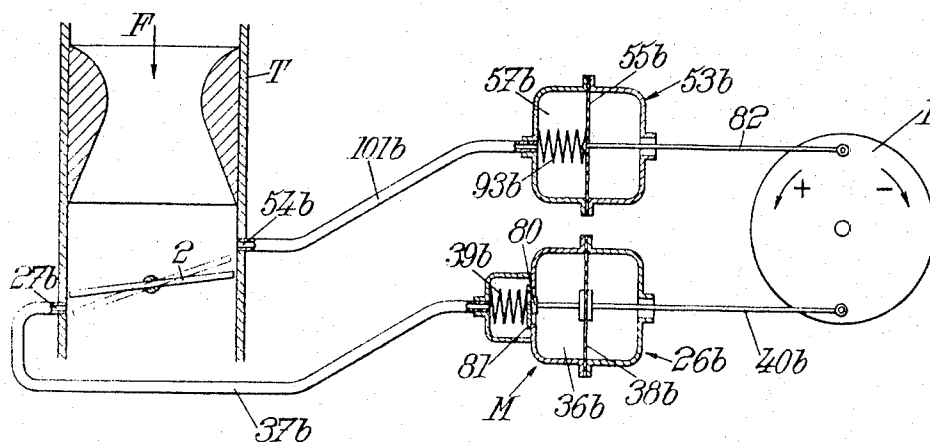


Fig. 19.

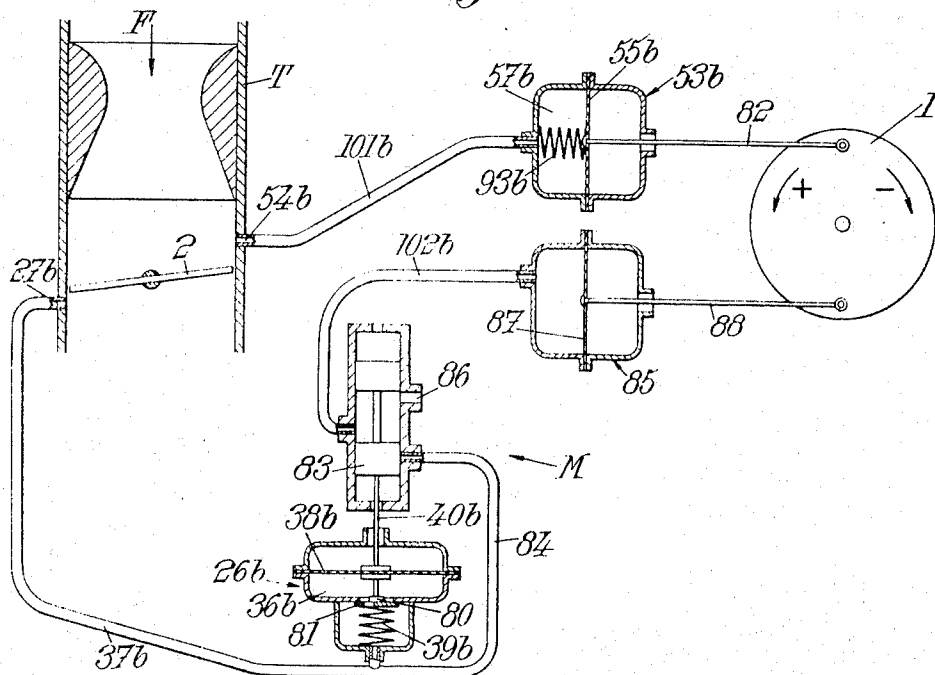


Fig. 20.

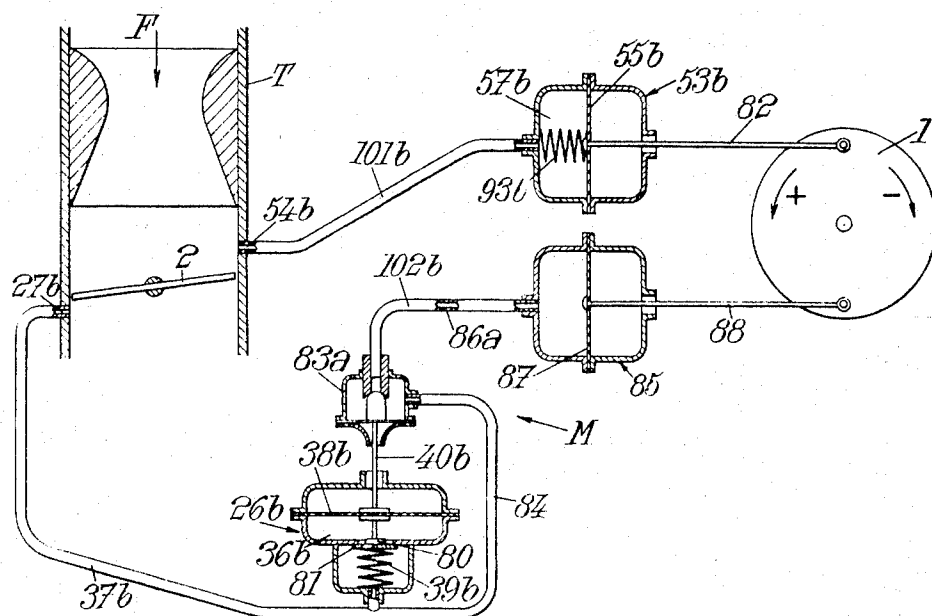
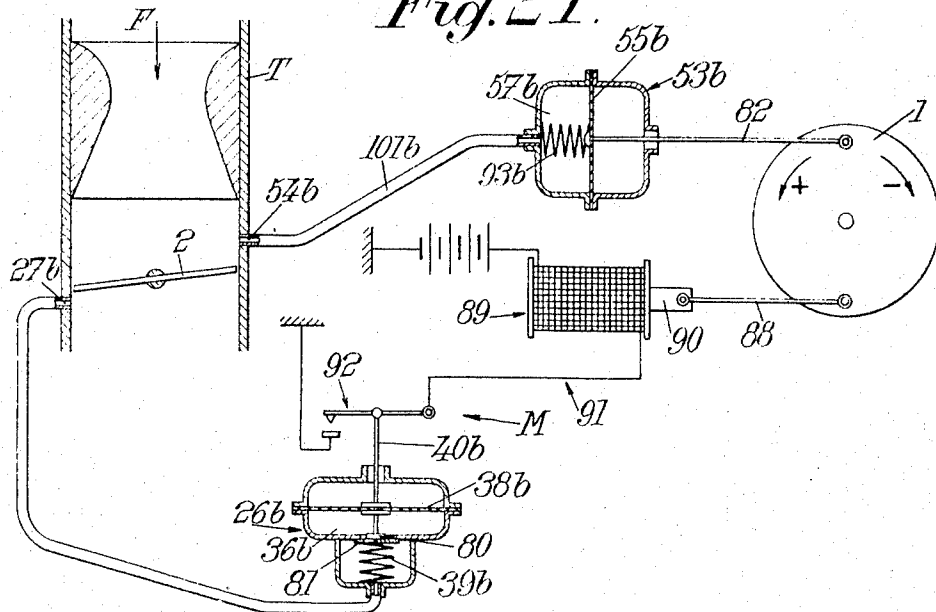


Fig. 21.



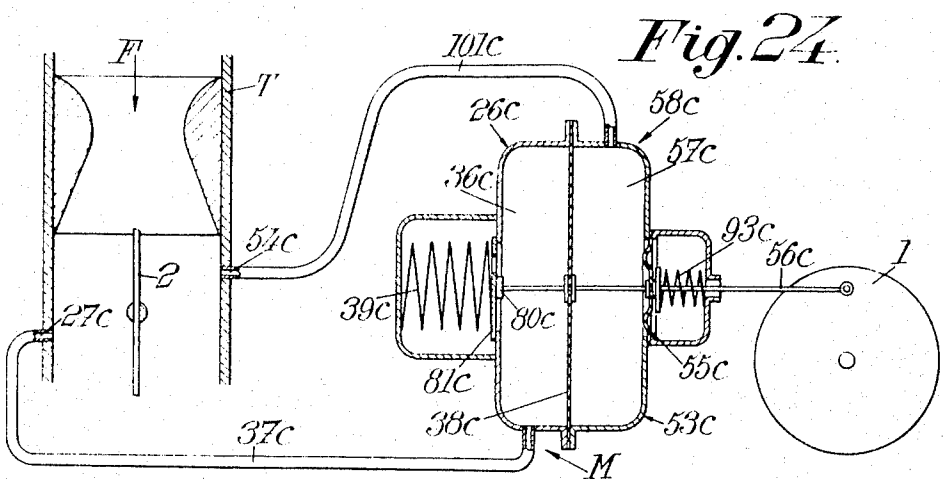
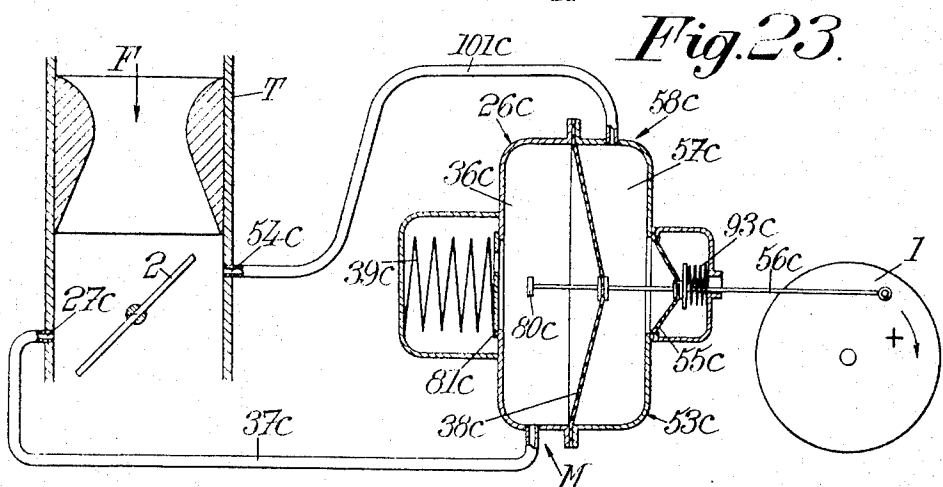
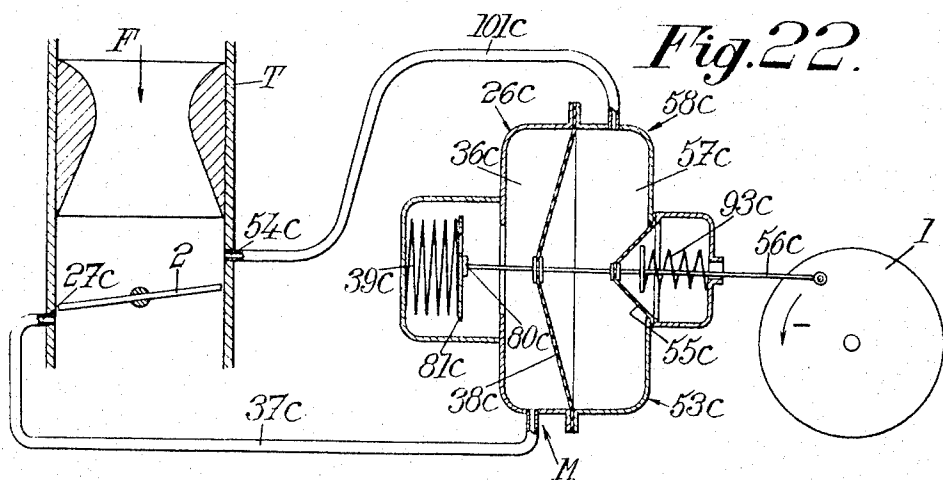
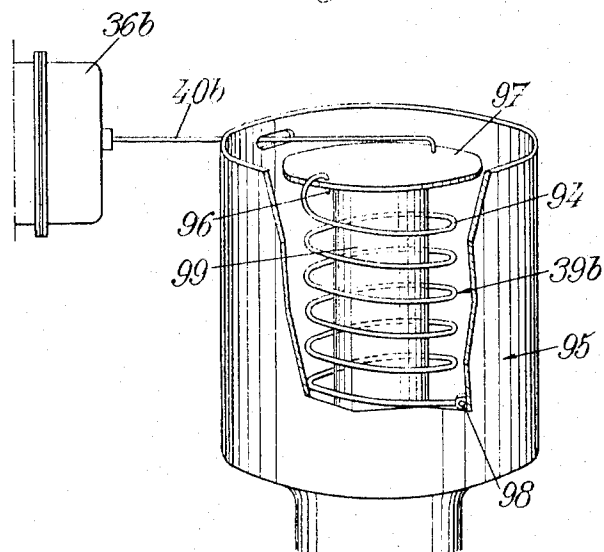


Fig. 25.



IGNITION DEVICES FOR INTERNAL COMBUSTION ENGINES AND ENGINES INCLUDING SUCH DEVICES

The present invention relates to ignition devices for internal combustion engines and to internal combustion engines equipped with such devices.

More particularly the invention relates to ignition devices of this type, in which the combustion chamber is periodically placed in communication with the intake before being isolated from the exhaust; and it relates more particularly, because it is in this case that its application seems to be most advantageous, but not exclusively, among these ignition devices, to those for rotary piston engines.

In known rotary piston engines, the combustion chamber is regularly placed in communication simultaneously with the exhaust port and the intake port during a fraction of a cycle, by reason of the geometry of the casing and of the piston. In conventional internal combustion engines, there is also produced a crossing (that is to say a simultaneous opening) of the intake and exhaust valves, especially in high speed engines. When the throttle is practically closed, and especially under deceleration, a considerable suction is created downstream of the throttle, in the course of the intake, by the piston movement. This suction favours, on the placing in communication of this exhaust and the intake, in the engines considered, a transfer of a portion of burnt gases towards the intake and their aspiration with the fresh gases. As a result imperfect mixtures of which ignition is uncertain, occur, which causes irregular or "jerky" operation of the engines concerned.

It is an object of the present invention, in particular, to render ignition devices such that they respond better than hitherto to the various exigencies of practice, and especially such that they enable the reduction or elimination of the irregular operation referred to above.

An ignition device, for an internal combustion engine of the type described above, is characterized, according to the invention, by the fact that it comprises means sensitive to the position of the throttle and to the rotary speed of the engine and arranged so as to cause, or not, a relative retard of ignition according as whether the two following conditions are fulfilled simultaneously, or not:

the degree of opening of the throttle valve is less than a predetermined limit P_L ;

the rotary speed of the engine is greater than a predetermined limit N_L .

In a first embodiment of the ignition device according to the invention, the abovesaid means comprise a first member sensitive only to the position of the throttle valve and a second member sensitive to the rotary speed of the engine, the first member being adapted to prevent any action of the second member on the ignition advance whilst the degree of opening of the throttle valve is greater than P_L .

In a second embodiment, the abovesaid means are arranged so as to cause, in addition, a reduction or a progressive increase in the ignition advance, in proportion as the absolute value of the suction in the intake pipe, downstream of the throttle valve, diminishes or increases, when the degree of opening of the throttle valve is greater than the limit P_L .

In order that the control of the relative ignition retard is effected more brusquely, the ignition device according to the invention, may also be characterized by the fact that the said means include a suction capsule, or retard capsule, adapted to control the relative ignition retard, the said capsule being connected to the intake pipe at a point such that it passes from downstream to upstream of the throttle valve when the latter, in opening, passes through the degree of opening P_L .

Preferably, a second suction capsule, or advance capsule, is provided to act in opposite sense and to control, at partial load, when the degree of opening of the throttle valve is greater than P_L , and the absolute value of the suction in the intake pipe increases, a relative ignition advance, the said advance capsule being connected to the intake pipe at a point such that it passes from upstream to downstream of the throttle valve when the latter, in opening, passes through a degree of opening equal or greater than P_L .

The invention also relates to internal combustion engines in which the combustion chamber is placed periodically in communication with the intake before being isolated from the exhaust, characterized by the fact that they are equipped with an ignition device according to the invention such as defined above.

In order that the invention may be more fully understood, a number of embodiments of ignition devices and engines including them are described below, purely by way of illustrative but non-limiting example, with reference to the accompanying drawings in which:

FIG. 1 shows, diagrammatically, one embodiment of an ignition device according to the invention;

FIG. 2 shows, diagrammatically, an embodiment of an ignition device according to the invention which is a variation of the embodiment shown in FIG. 2;

FIG. 3 is a partial section along the line III—III of FIG. 2;

FIG. 4 shows, diagrammatically, a second embodiment of an ignition device according to the invention, the engine equipped with this device being stopped;

FIG. 5 shows, partially, a variation of the embodiment shown in FIG. 3;

FIGS. 6, 7 and 8 show, diagrammatically, in various operational positions, an ignition device which is a variation of the aforesaid second embodiment;

FIGS. 9 and 10 show variations in the ignition advance as a function, respectively, of the degree of opening of the throttle valve and of the rotary speed of the engine, obtained by means of the embodiment of FIG. 1;

FIGS. 11 and 12, similarly to FIGS. 9 and 10, show variations in the advance obtained by means of the embodiments of FIG. 2;

FIGS. 13 and 14, similarly to FIGS. 9 and 10, show variations in the advance obtained by means of the embodiments shown in FIGS. 4 and 6, 7 and 8;

FIG. 15 shows the variations in the advance as a function of the speed obtained by means of a conventional centrifugal regulator;

FIG. 16 shows the variations in the advance as a function of speed obtained by means of the embodiment of FIGS. 6, 7 and 8, combined with a conventional centrifugal regulator giving the curve of FIG. 15;

FIG. 17 shows, in solid line, the variations, as a function of time, of the absolute value of the suction in the intake pipe, when the engine turns at slow speed;

FIG. 18 shows, diagrammatically another embodiment with a portion of the ignition device according to the invention;

FIGS. 19, 20 and 21 show diagrammatically variations of the embodiment of FIG. 18;

FIGS. 22, 23 and 24 show, in various operational positions, a variation of the embodiment of FIG. 18; and finally

FIG. 25 shows in perspective with portions removed, an ignition timing head provided with a return spring;

According to the invention, and in order to construct an ignition device for an internal combustion engine in which the combustion chamber is placed periodically in communication with the intake before being isolated from the exhaust, the procedure is as follows or in analogous manner.

As regards the ignition device as a whole, and excluding the elements adapted to modify the ignition advance, it is constructed in conventional manner by making it include a make-and-break including a cam (not shown) rotated by the engine and a plate 1 (FIG. 1) bearing the breaker lever and a fixed contact (not shown). The cam is arranged to separate the breaker lever periodically from the fixed contact and to thus cause the opening of the primary circuit of an induction coil. The plate 1 can turn around it an axle perpendicular to its plane and passing through its centre, either in the direction of the arrow "plus," which involves a relative ignition advance, or in the direction of the arrow "minus," which causes a relative ignition retard.

As regards the adjustment of the ignition advance, according to the invention, the device is made to include means sensitive to the position of the throttle valve and to the rotary speed N of the engine and arranged so as to cause, or not, an ignition retard according as whether two following conditions are fulfilled:

the degree of opening P of the throttle valve is less than a predetermined limit P_L ;

the speed of rotation N of the engine is greater than a predetermined limit N_L .

In the first embodiment (FIGS. 1, 2 and 3), the abovesaid means include a first member 3 sensitive only to the position of the throttle valve 2 and a second member 4 sensitive to the speed of rotation N of the engine, the first member being adapted to prevent any action of the second member 4 on the ignition advance whilst the degree of opening of the throttle valve is greater than P_L .

The first member 3 may be constituted by an electrical contact 5 (FIG. 1) adapted, according as the degree of opening of the throttle valve is less or greater than P_L , to close or open an electrical circuit 6 in which is arranged in series the second member 4 constituted by the assembly of a centrifugal contact 7, adapted to be closed or opened according as the speed of rotation N is greater or less than N_L and an electromagnet 8, fed by the said electrical circuit 6 and which, when it is energised, that is to say when the contacts 5 and 7 are both closed, actuates the ignition retard.

The electrical contact 5 comprises a movable arm connected in rotation with the throttle valve 2 on the shaft of which it is mounted. This arm bears, at one

end, a conductive pastille (or plate) 9, arranged in the circuit 6 and connected electrically to the positive terminal of a D.C. supply 10 of which the negative terminal is connected to a common ground 11. The plate 9 may come into contact with another plate 12, fixed, when the degree of opening of the throttle valve is less than P_L , that is to say when the throttle valve is closed or substantially closed.

The centrifugal contact 7, rotated by the engine, can place in contact two conductive pastilles 13 and 14 when the rotary speed of the engine is greater than N_L . The pastille 14 is fixed and connected electrically to the pastille 12. The pastille 13 is situated at the end of a lever 15 hinged on a fixed axis 16 and subjected, on one hand, to an elastic force which tends to bring closer the pastilles 13 and 14 to one another and, on the other hand, to an opposing elastic return force which diminishes when the speed increases.

The plate or pastille 13 is connected electrically to a terminal of the electromagnet 8 of which the other terminal is connected to the ground 11. The electromagnet includes a movable plunger core 17 connected mechanically to the plate 1 of the breaker by a stem 18.

When the electromagnet 8 is excited, which occurs when the circuit 6 is closed, the core 17, in being displaced, moves the plate 1 and, with it, the breaker lever in the direction of ignition retard, denoted by an arrow surmounted by the sign "minus."

Before describing the operation of such a device, there will first be examined rapidly under what conditions an internal combustion engine works and, more particularly, an automobile vehicle engine.

The driver of the vehicle acts substantially on the degree of opening of the throttle valve 2 to regulate speed of the vehicle when the ratio of the gear box is selected. But it is obvious that, for a given ratio of the gear box and a given position of the throttle valve, the engine will turn more or less quickly according to the value of the load couple which is opposed to it. It can even happen, especially on deceleration, that the engine operates passively and acts as a brake. It will be possible, in this case, in starting from the maximum rotary speed of the engine and by closing the throttle valve 2, to obtain, as a transient phase, all the rotary speeds possible of the engine through decreasing values, although the throttle valve is closed or substantially closed.

By modifying, in addition, the ratios of the gear box by means of the gear change lever or automatically, it will be possible to obtain even higher rotary speeds of the engine for a given position of the throttle valve.

It is seen therefore that there does not exist, between the rotary speed of the vehicle engine, of which the phases are very often transitory, and the position of the throttle valve 2, a strict correlation.

Now, the advance adjustment according to the invention takes into account the position of the throttle valve and the rotary speed which, in practice, are two independent parameters. To explain the operation of the various embodiments, there will be traced the advance curves at constant rotary speed and variable throttle position and reciprocally. There will thus be obtained the systems of curves traced in the FIGS. 9 to 14. From these systems, and from any law of variation of the speed of the engine as a function of the position

of the throttle valve, which law represents well determined conditions of operation of the engine, it will be possible to express an advance relationship corresponding to this particular case by one curve since at one speed there will correspond well determined values of the degree of opening and inversely.

But in the general case, it will not be possible to establish a curve giving the advance as a function of the throttle valve except for a given rotary speed, or reciprocally.

Apart from this consideration, there will be considered now the operation of the device of FIG. 1.

There is first considered the variations in advance as a function of the position of the throttle at constant rotary speed of the engine (FIG. 9).

It is assumed firstly that the rotary speed is less than N_L . In this case, the contact 7 is open and the electromagnet 8 cannot be energised. The position of the plate 1 is therefore not modified, whatever the position of the throttle 2 and the advance remains equal to A_0 , a value corresponding to the resting position of the plate. In FIG. 9, where the abscissae are graduated in increasing openings of the throttle valve 2, the advance curve, for all speeds less than N_L , is one parallel 19 to the axis of the abscissae.

It is assumed now that the rotary speed is constant but greater than N_L . Under these conditions, the centrifugal contact 7 remains closed.

When the degree of opening of the throttle valve 2 is less than P_L , the contact 5 is closed and the electromagnet 8 is energised. The plate 1 is moved in the retard direction. Inasmuch as the contact 5 is closed, that is to say for degrees of opening of the throttle valve comprised between zero (complete closure) and P_L , the curve representing advance as a function of the degree of opening P is a section of a straight line 20, parallel to the axis of abscissae, located below the segment 19, the difference in ordinates of these two segments corresponding to the amplitude of the retard applied by the energising of the electromagnet 8.

When the degree of opening of the throttle valve 2 becomes equal to P_L and exceeds this value, the contact 5 is opened, the electromagnet 8 is no longer energised and the curve of advance is represented by a section of a straight line 21 parallel to the axis of the abscissae and merged with a portion of the section 19.

There will now be considered the variations in advance as a function of the speed of rotation of the engine for a given degree of opening of the throttle valve (FIG. 10).

It is first assumed that the degree of opening of the throttle valve is greater than P_L . In this case, the contact 5 remains open and, whatever the degree of opening greater than P_L , there is obtained, as representative curve of the advance A as a function of the speed N , the segment of straight line 22 parallel to the axis of abscissae.

It is now assumed that the degree of opening of the throttle valve is less than P_L . There is then obtained, as the relationship of advance as a function of speed, the broken line 23 which has a step for the speed N_L at which the contact 7 closes, which step corresponds to the ignition retard applied by the movement of the plate 1.

There is generally selected for N_L a value greater than the level of slow-speed operation.

There may possibly be provided, in addition to the centrifugal contact 7, a second centrifugal contact arranged in series in the circuit 6 and constructed so as to remain closed as long as the rotary speed of the engine is less than a value N_S greater than N_L and to open when the rotary speed is greater than N_S . The system of curves of advance as a function of speed, at constant opening of the throttle valve, is slightly modified as shown in FIG. 10. The segment 22 is preserved for degrees of opening less than P_L but the line 23 is replaced by the line 24, in mixed line, for degrees of opening greater than P_L . In fact, when the speed N_S is reached, the ignition retard is eliminated and the advance returns to the value which it had for rotary speeds comprised between 0 and N_L . The retard is only introduced for speeds comprised between N_L and N_S .

The appearance of the lines of FIG. 9 is not modified but the regions of validity are changed. The segment 19 shows, in the case where the said second centrifugal contact is used, the variations of advance as a function of the degree of opening for rotary speeds less than N_L or greater than N_S . The two segments 20, 21 relate to rotary speeds comprised between N_L and N_S .

According to a variation of the first embodiment (FIGS. 2 and 3), the said first member 3 may be constituted by a rotary distributor 25 adapted to place in communication or not the second member 4, constituted by a suction capsule 26, with a point 27 of the intake pipe of the engine, situated downstream of the throttle valve 2, according as the degree of opening of the said throttle valve is less than P_L or not.

The distributor 25 comprises a cylindrical rotary slide 28 connected rotatably with the shaft of the throttle valve 2. This slide includes a diametric channel 29 of which one end opens in a hollow 30 extending over a portion of the periphery of the slide.

The distributor comprises, also, a body 31 fixed on the intake pipe and provided with a bore 32 in which the slide 28 can turn. The body 31 is pierced by a radial channel 33, connecting the bore 32 to the outer surface of the body 31, and with a channel 34 opening, on one hand, at point 27 of the intake pipe and, on the other hand, at a point of the bore 32 diametrically opposite to the channel 33. A radial channel 35 slightly separated angularly from the channel 33, ensure the exposure to the open air of the bore 32.

The distributor 25 is arranged so that, for degrees of opening of the throttle valve 2 less than P_L , the channels 33 and 34 are placed in communication via the channel 29, the channel 35 being isolated from the channel 33. For the degrees of opening greater than P_L , the channel 33 is placed in communication with the channel 35, hence with the open air, through the hollow 30, whilst the channel 34 is isolated from the channel 29.

The suction capsule 26 comprises a suction chamber 36 connected by a passage 37 to the channel 33. The chamber 36 is bounded by a deformable diaphragm 38 subject to elastic return means 39. The surface of the diaphragm 38 opposite the chamber 36 is subject to atmospheric pressure. A rigid stem 40 connects the diaphragm 38 to the plate 1. When sufficient suction is established in the chamber 36, there is produced a movement of the diaphragm 38, of the stem 40 and of the plate 1 in the direction of an ignition retard denoted by an arrow surmounted with a sign "minus."

The operation of such device is as follows.

There is first of all considered the variations in advance as a function of the position of the throttle valve constant rotary speed (FIG. 11).

When the degree of opening is greater than P_L , the channel 33 communicates with the channel 35 and places the chamber 36 in communication with the open air. The suction capsule 26 remains at rest. The advance is not modified by the device, whatever the rotary speed and the degree of opening of the throttle valve, being understood that the latter must be greater than P_L . The graphic representation of this result is a straight line segment 41 parallel to the axis of abscissae.

When the degree of opening is less than P_L , the chamber 36 is placed in communication with the intake pipe of the engine at the point 27, downstream of the throttle valve. The direction of flow of the gases is indicated by an arrow F. The chamber 36 is hence subjected to suction with respect to atmospheric pressure, which such in absolute value, and for a given opening of the throttle valve, is an increasing function of the speed and, for a given speed, is a decreasing function of the opening of the throttle valve.

For the diaphragm to be deformed, it is necessary that the suction be sufficient to overcome the resistance of the elastic means 39; it is hence necessary that, for the position P_L of the throttle valve, the rotary speed is greater than a value N_L equal, for example, to the limiting value of the preceding device.

If the rotary speed is less than N_L , the segment 41 is extended for degrees of opening less than P_L by a segment 42 parallel to the axis of abscissae.

If the rotary speed is greater than N_L , the diaphragm 38 is moved, towards the right in case of FIG. 2, the more as at constant rotary speed the degree of opening is less or at constant degree of opening the rotary speed becomes greater.

There may advantageously be provided, as will be explained below in detail, a non-return valve in the passage 37 so as to cause an abrupt movement of the diaphragm 38 on the opening of the valve. To this abrupt movement there corresponds an abrupt ignition retard represented by the segment of the line 43 parallel to the axis of ordinates.

The diaphragm 38 can then come into abutment against a stop (not shown) from the opening of the valve, in which case the advance is no longer changed for degrees of opening less than P_L and there is obtained the segment 44 drawn in dashes, parallel to the axis of abscissae, whatever the speed greater than N_L .

It is also possible that the diaphragm only comes into abutment for a suction greater than that necessary to the opening of the valve. In this case, there is obtained a series of arcs of curves 45, 46, 47 corresponding respectively to constant speeds N_{45}, N_{46}, N_{47} greater than N_L , and such that N_{47} is greater than N_{46} and N_{46} is greater than N_{45} .

There will now be considered variations of ignition advance as a function of the rotary speeds at constant opening of the throttle valve (FIG. 12).

When the degree of opening of the throttle valve is greater than P_L , the advance remains constant, whatever the opening of the throttle valve and the speed. There is obtained that the segment of line 48 parallel to the axis of abscissae, that is to say to the axis on which the speeds are shown.

When the degree of opening P is less than P_L , it is necessary that N be greater than N_L for the diaphragm 38 to be deformed.

If the diaphragm quickly comes into abutment, on the opening of the valve, there is obtained, for speeds greater than N_L , the segment of straight line 49.

If the diaphragm does not quickly come into abutment, there is obtained arcs of curves 50, 51, 52 corresponding to constant degrees of opening, less than P_L and increasingly slight.

In a second embodiment (FIGS. 4, 5, 6, 7 and 8), the means sensitive to the position of the throttle valve and to the speed of rotation of the engine are arranged so as to cause, in addition, a progressive reduction or increase of the ignition advance in proportion as the absolute value of the suction in the intake, downstream of the throttle valve, diminishes or increases, when the degree of opening of the throttle valve is greater than the limit P_L .

The abovesaid means may be constituted by two suction capsules, the capsule 26 of small section, or capsule of deceleration, and a capsule 53 (FIG. 4) of large section, or partial load capsule, the capsule 26 being connected to the point 27 of the intake situated downstream of the throttle valve 2, the capsule 53 being connected to a point 54 of the intake situated so as to pass from upstream to downstream of the throttle valve 2 according as the degree of opening of the latter is less than or greater than P_L , the diaphragms 38 and 55 of the respective capsules 26 and 53 working in opposition and being connected to a same stem 56 which actuated the advance changes. The capsule of deceleration 26 is calibrated to operate only when the suction which is applied to it is greater in absolute value than that obtained at point 27 when the degree of opening of the throttle valve is equal to P_L and the rotary speed of the engine is equal to N_L .

The constitution of the capsule 53 is similar to that of the capsule 26, but the surface of the diaphragm 55 is distinctly greater than that of the diaphragm 38. Said diaphragm 55 bounds the suction chamber 57, proper, connected to the point 54.

The capsules are arranged so that the deformation of the diaphragm 38 under the effect of a sufficient suction results in a displacement of the plate 1 in the retard direction ("minus" arrow). On the other hand, a deformation of the diaphragm 55, under the effect of a sufficient suction at the point 54, results in a displacement of the plate 1 in the advance direction ("plus" arrow).

In a variation of this embodiment (FIGS. 6, 7, 8), the two suction capsules are advantageously connected into a single differential capsule 58 with double diaphragm. The elements and members of this differential capsule, analogous or playing identical roles to those shown on FIG. 4, bear the same reference numerals followed by the letter *a*.

The diaphragm 55a, of the element 53a of large section of the capsule, bounds on one hand, a suction chamber 57a of cylindrical shape connected to the point 54, and on the other hand, a chamber 36a, of tronconical form, connected to the point 27.

The section of the chamber 36a diminishes regularly from the diaphragm 55a, located at one end of the chamber, up to the diaphragm 38a, of small section, located at the other end of the chamber.

The diaphragm 38a is subject to atmospheric pressure on its surface opposite the chamber 36a.

The stem 56a connects the two diaphragms to the plate 1.

There may be advantageously provided, on the conduit 37 connecting the suction chamber 36 (or 36a) to the point 27, as previously indicated, a non-return valve 59 (FIG. 5). In this case, it is necessary to provide also an orifice of small section 60 on the capsule 26 to make the chamber 36 communicate with the atmosphere (FIG. 5) and to permit the return of this chamber to atmospheric pressure when the valve is closed.

The valve 59 is arranged in a manner to open when the absolute value of the suction at the point 27, with respect to atmospheric pressure, is greater than that obtained when the degree of opening of the throttle valve is equal to P_L and the rotary speed equal to N_L .

The suction at the point 27 of the intake pipe is not strictly constant on slow-running, and its absolute value varies periodically as a function of the time T (see FIG. 17) on both sides of an average value D_0 . The variations are represented by a curve C_0 on which appear the minimal and maximal values of the suction on slow-running, in correlation with the operational phases of the engine.

The absolute value of the suction for which the valve 59 opens is selected greater than the value D_0 but, preferably, in the neighbourhood of the latter so as to make the ignition retard correction come into play at the lowest rate possible on deceleration. For example, the valve 59 will open for a value D_1 of the suction represented on FIG. 17. As soon as the suction at the point 27 exceeds the value D_1 , the valve 59 will open and the capsule 26 will actuate a displacement of the plate 1 in the "minus" direction.

As is apparent on FIG. 17, certain portions of the curve C_0 are situated above the straight line parallel to the axis of the abscissae and the ordinate D_1 . Hence, on slow-running, the plate 1 will be moved in the direction "minus," from its normal advance position, for the portions of the curve C_0 situated above the line of ordinate D_1 , and the said plate will resume its normal advance position for the portions of the curve C_0 situated below D_1 .

These oscillations of the plate 1 are undesirable and, to stabilize the plate in the normal advance position when the engine turns at slow speed, there is advantageously arranged a diaphragm (not shown) in the suction take-up circuit, especially in the passage connecting the valve 59 to the point 27. In this way, fluctuations of the absolute value of the suction which acts on the valve 59 are reduced. This latter is, however, subject to a suction of which the absolute value varies in time along the curve C_1 situated entirely below the line of the ordinate D_1 . In this way, any movement of the plate 1 in the "minus" direction is not actuated on slow-running.

The operation of the device of FIG. 4 is substantially identical with that of the differential capsule 58 of FIG. 6. Through this fact, only the operation of this latter will be described in detail.

There will be considered first of all the variations of the ignition advance as a function of the degree of opening of the throttle valve, at constant rotary speed.

When the degree of opening P is less than P_L (FIG. 8), the point 54 occurs upstream of the throttle valve 2 and substantially at atmospheric pressure, whilst the point 27 occurs downstream of the said throttle valve and under suction. The chamber 36a is therefore under suction with respect to atmospheric pressure which exists in the chamber 57a and on the surface of the diaphragm 38a opposite to the chamber 36a. The resulting force exerted on the stem 56a will be equal to the product of the difference of the surfaces of the diaphragms 55a and 38a by the absolute value of the suction. When this force is sufficient, the stem 56a is moved towards the right and will drive the plate 1 in the direction of ignition retard or reduction of advance (FIG. 8).

In the case where the valve 59 is arranged on the passage 37, the calibration of this valve is adjusted so that on its opening a relatively strong force is applied on the stem 56a, which causes an abrupt ignition retard. The opening of the valve is produced when the absolute value of the suction at 27 is equal to that obtained for the degree of opening P_L and the speed N_L .

There is advantageously provided a stop (not shown) limiting the movement of the stem 56a in the retard direction. Preferably, the calibration of the valve 59 is such that on opening of the said valve the stem 56a immediately reaches its stop.

When the degree of opening P of the throttle valve 2 is greater than P_L , the two points 54 and 27 pass downstream of the throttle valve and the chambers 57a and 36a occur under suction with respect to atmospheric pressure. The suction in the chamber 57a is besides stronger than in the chamber 36a since the passage offered to gases at the level of the point 54 has a smaller cross-section at the point 27. The stem 56a moves in the direction of ignition advances, all the more as the suction is greater (FIG. 7). When the throttle valve 2 is completely open; the suction is substantially nil, whatever the speed and the stem 56a as well as the diaphragms 55a and 36a occur substantially in their resting position (FIG. 6).

The graphical representation (FIG. 13) of the variations of advance as a function of the degree of opening, at various values of the rotary speed, will enable the operation to be followed more easily. This representation applies to a capsule 58 mounted with a valve 59.

The corresponding advance to the resting position of the plate 1 is noted A_0 as previously.

There will firstly be traced the curve giving the advance as a function of the degree of opening for a constant rotary speed and equal to N_L . For $P = P_L$, a brusque retard is introduced and the advance takes the value A_1 .

For all the values of P less than P_L , the advance remains equal to A_1 and is represented by a segment of straight line 61, in full line, parallel to the abscissae. For values of P greater than P_L , always at the rotary speed N_L , the suction in the intake diminishes when P increases. Consequently, the stem 56a undergoes a maximum displacement, in the direction of advances, on the passage by the throttle valve 2 through the degree P_L , in the direction of opening. In proportion as the throttle valve opens, always at constant speed N_L , the suction at the points 27 and 54 diminishes and the stem 56a comes back progressively towards its resting

position for which the advance A_0 again occurs. The arc of the curve 62 represents graphically these advance variations.

It is clear that for rotational speeds greater than N_L , the suction for a degree of opening of the throttle valve $P > P_L$ is greater than that obtained with the speed N_L . The graphical representation will give a series of arcs of a curve such that 63 located above the arc 62. When the degree of opening is less than P_L , the segment of straight line 61 occurs.

For rotary speeds less than N_L and at a degree of opening of the throttle valve greater than P_L , it is clear that there are obtained arcs of a curve such as 64 located below the arc 62; when the degree of opening is slightly less than P_L , the point 54 is no longer under suction and, due to the fact that the rotary speed is less than N_L , the closure of the throttle valve is not yet sufficient to cause a suction downstream, especially at the point 27, adapted to open the valve 59. The latter will open at a degree of opening less than P_L and even less as the rotary speed becomes less. The graphical representation of these variations of advance is constituted by broken lines such as the line 65 of which the segment 66, parallel to the axis of ordinates, has an abscissae all the smaller as the rotary speed is less.

The study of the variations in advance as a function of the rotary speed will be made with the aid of FIG. 14.

For a constant degree of opening P greater than P_L , the advance increases from A_0 , with the rotary speed. The amplitude of the variation as a function of the speed is maximum when P is substantially equal to P_L and substantially nil for P in the neighbourhood of complete opening. There is thus obtained the curve 67, corresponding to a degree of opening very slightly greater than P_L , the curve 68 corresponding to a degree of opening greater than P_L and the segment of straight line 69 parallel to the axis of abscissae for degrees of opening in the neighbourhood of complete opening.

For a degree of opening less than P_L , there is obtained a broken line 70 of which the segment of straight line 71 parallel to the axis of ordinates, has a maximum abscissa equal to N_L for P very close to P_L . This abscissa diminishes when P diminishes.

By means of these different graphical representations, it is possible to follow what occurs on deceleration.

There will be considered as a specific case that where, just before deceleration, the rotary speed is maximal for the maximum degree of opening and, during deceleration, the degree of opening is substantially nil.

The conditions before deceleration, P maximum and speed maximum, are known, and it is possible to determine, on the graphs of FIGS. 10, 12 and 14, the various points representative of the advance for each device which are situated respectively on the segments 22, 48, 69 and have an abscissa corresponding to N maximal.

The conditions in the course of deceleration are also known and, since P is minimum, there will be described in the direction of decreasing speeds, in FIGS. 10, 12 and 14, the curve corresponding to P minimum, that is to say respectively the segments 23 (or 24), 49, 70.

It is seen that in all cases, except that of the broken line 24, the advance undergoes a sudden reduction at the moment when P passes from maximal value to

minimal value. In the case of the broken line 24, the reduction is only produced at speeds greater than N_L but less than a limit N_S . In the case of FIG. 10, for N maximal, passage from the segment 22 to the segment 23 (or 24); in the case of FIG. 12, passage from the segment 48 to the segment 49; in the case of FIG. 14, passage from the curve 69 to the segment 70.

This diminution of advance enables the "jerky" operation which is produced until now in engines of the type concerned, to be considerably reduced, especially on deceleration.

Obviously, the ignition device can comprise, in addition to the means constructed according to the invention, which act preferably on the plate 1 of the breaker, an advance regulator sensitive only to the rotary speed and acting on the breaker cam. Used alone, this advance regulator could give a conventional relationship of the advance as a function of the speed such as that shown by curve 72, FIG. 15.

To obtain relationships as a function of the speed, at various openings of the throttle valve when this regulator is associated with a device according to the invention, it must compound the advance relationships as a function of speed, that is to say the curves of FIGS. 10, 12, 14 with the curve of FIG. 15.

In the case where the regulator is associated to the device of FIG. 6, the compounding of relationships of FIG. 14 and of FIG. 15 gives the system of curves of FIG. 16. The curve 73 corresponds to a degree of opening very slightly greater than P_L , the curve 74 has a degree of opening distinctly greater than P_L and the curve 75 to the maximum degree of opening, that is to say that which is currently called the "full load." The curve 76 corresponds to a degree of opening very slightly less than P_L and the curve in dashes 77 corresponds to a degree of opening less than P_L .

Advantageously, the regulator sensitive only to the speed and which acts on the cam can be constituted by the device described in U.S. patent application Ser. No. 883,945 filed Dec. 10 1969.

Thus, whatever the embodiment adopted, there is obtained an ignition device which answers well for the purpose for which it is intended and enables, by a sudden reduction of the advance on deceleration, reduction of irregular or "jerky" operation of internal combustion engines in which the combustion chamber is placed periodically in communication with the exhaust and, especially, in rotary piston engines. Moreover, the advance resumes a normal value for slow-speed operation.

In the embodiments of FIGS. 18 to 24, the means M sensitive to the position of the throttle valve 2 and to the rotary speed of the engine comprise a suction capsule 26b (FIG. 18), or retard capsule, adapted to actuate a relative ignition retard, that is to say a rotation of the plate 1 in the direction of the "minus" arrow. This capsule 26b is connected to the intake pipe T at a point 27b, situated so that it passes from downstream to upstream of the throttle valve 2 when this latter, in opening, passes through the degree of opening P_L . The degree of opening P_L corresponds to a slight opening of the throttle valve 2 shown in mixed lines in FIG. 18. The direction of flow of the gases in the intake pipe is indicated by the arrow F .

A second suction capsule 53b, or advance-capsule, is provided to act in opposite sense to that of the capsule 26b and to actuate, on partial load, when the degree of opening of the throttle valve is greater than P_L and the absolute value of the suction in the intake pipe increases, a relative ignition advance, that is to say a rotation of the plate 1 in the direction of the "plus" arrow. Said capsule 53b is connected to the intake pipe at a point 54b located in such a way that it passes from upstream to downstream of the throttle valve 2 when the latter, in opening, passes through a degree of opening equal or greater than P_L .

The suction capsule 26b comprises a suction chamber 36b, connected by a passage 37b to the point 27b. The chamber 36b is bounded by a deformable diaphragm 38b.

The surface of the diaphragm 38b, opposite the chamber 36b, is subject to atmospheric pressure. A rigid stem 40b connects the diaphragm 38b to the plate 1 so that, when the diaphragm 38b is deformed, a rotation of the plate 1 is actuated by the stem 40b. The latter is extended into the chamber 36b and is supported at its end 80 against a plate 81 subject to the action of elastic return means 39b.

The plate 81 which, in the embodiments of FIGS. 18 to 22, occurs between the passage 37b and the chamber 36b, does not isolate this chamber from the passage since the said plate 81 comprises passages enabling equality of pressures in the chamber 36b and the passage 37b.

When a sufficient suction is produced in the intake pipe T at the point 27b, the diaphragm 38b is deformed by reason of the reduction of pressure in the chamber 36b with respect to atmospheric pressure and the stem 40b pushes the plate 81 by compressing the elastic return means 39b. The latter, advantageously constituted by a spiral spring, are precompressed so that when the degree of opening of the throttle valve 2 is equal to P_L , the suction sufficient to cause deformation of the diaphragm 38b and the concomitant displacement of the plate 81 is obtained for a rotary speed of the engine equal or greater than the limit N_L . This limit N_L is selected greater than the level of slow-speed of running and is substantially comprised between 1,000 and 2,000 turns/minute of the engine shaft. Thus, when the engine turns at slow speed, the capsule 26b does not act on the plate 1.

When the degree of opening of the throttle valve 2 is greater than P_L , the point 27b occurs upstream of said throttle valve and the chamber 36b is practically no longer under suction with respect to atmospheric pressure. The capsule 26b remains then without action on the plate 1, whatever the rotary speed of the engine.

The capsule 53b is substantially analogous to the capsule 26b and comprises a diaphragm 55b which bounds a suction chamber 57b connected to the point 54b of the intake pipe by a passage 101b.

It is not necessary that the electric return means 93b of the capsule 57b, which act against the diaphragm 55b, are precompressed.

The diaphragm 55b is connected to the plate 1 by a rigid stem 82 substantially parallel to the stem 40b, the pivoting points of the said stems on the plate 1 being symmetrical with respect to the centre of the said plate. The lever arms of the forces exerted by the stems 82

and 40b on the plate 1 are hence equal in absolute value. There could however be provided unequal lever arms.

In the embodiment of FIG. 18, the surfaces of the diaphragms 38b and 55b are equal but there could also be provided different surfaces.

When the throttle valve 2 is slightly open, and especially, when its degree of opening is less than P_L , the point 54b occurs upstream of the said throttle valve and the chamber 57b is not placed under suction with respect to atmospheric pressure. The capsule 53b does not act on the plate 1.

Thus, any correction of relative advance is not actuated by the capsule 57b when the engine is under pure deceleration (throttle valve 2 closed) or when the throttle valve is only very slightly open.

The operation of the device of FIG. 18 is as follows.

There is considered first of all the case where the degree of opening of the throttle valve 2 is less than P_L . The point 27b is downstream of the throttle valve, whilst the point 54b is upstream thereof. When the rotary speed of the engine passes through, by crossing values, the limit N_L , the suction at the point 27b passes through, by crossing values the sufficient value for the capsule 26b to come into action and actuate a rotation of the plate 1 in the direction of relative retard ("minus" arrow). When the rotary speed of the engine passes through the limit N_L by decreasing values the reverse phenomenon is produced.

There will now be considered the case where the degree of opening of the throttle valve 2 is greater than P_L .

The point 27b being then situated upstream of the throttle valve 2 no longer occurs practically under suction with respect to atmospheric pressure and the capsule 26b does not act on the plate 1.

If the degree of opening of the throttle valve 2 is not still sufficient to make the point 54b pass downstream of the said throttle valve, the capsule 53b does not act on the plate 1.

But, as soon as the point 54b passes downstream of the throttle valve 2, a suction is produced in the chamber 57b, which suction actuates a rotation of the plate 1 in the direction of the "plus" arrow and a relative ignition advance.

This relative advance is only obtained under partial load, that is to say when the throttle valve 2 is not completely open. On the other hand, when the said throttle valve is completely open, the points 27b and 54b occur substantially at atmospheric pressure and neither the capsule 26b nor the capsule 53b act on the plate 1. The passage of the point 27b from downstream to upstream or reciprocally of the throttle valve 2 is accompanied by a sudden variation of pressure in the chamber 36b and a sudden actuation of the plate 1.

In particular, on deceleration, when the engine turns still at high speed and the throttle valve 2 comes back towards its closed position, the passage by the said throttle valve through the degree of opening P_L will be accompanied by an abrupt relative ignition retard. As explained above, this retard enables the reduction of irregular or "jerky" operation of the engine in the course of deceleration.

The elements of the device of FIG. 19, identical or playing a similar role to the elements of FIG. 18, are denoted by the same reference numerals.

In a variation of the embodiment of FIG. 19, to favour a brusque actuation of relative ignition retard by the capsule 26b, there is arranged a slide valve 83 on a branch 84 of the passage 37b.

The slide valve 83 is actuated by the capsule 26b, through the stem 40b, and may occupy two different positions.

In a first position, shown in FIG. 19, the said slide valve places in communication, through a pipe 102b the suction chamber of a capsule 85 with an exhaust 86 which is placed at atmospheric pressure. The diaphragm 87 of the capsule 85 is connected by a stem 88 to the plate 1 so that said capsule 85 works in opposition with the capsule 53b.

In a second position, the slide valve 83 places in communication the pipe 102b and the suction chamber of the capsule 85 with the branch 84. Simultaneously, the said slide isolates the capsule 85 from the exhaust 86.

When the suction at the point 27b is insufficient for the capsule 26b to act on the slide valve 83, the latter occupies the abovesaid first position.

It will be noted that it is not indispensable to provide elastic return means in the capsule 85, the diaphragm 87 resuming itself its equilibrium position.

The device of FIG. 20 is substantially identical with that of FIG. 19, the slide valve 83 having been replaced by a diaphragm valve 83a which, when the suction in the branch 84 and in the pipe 37b is not sufficient, isolates the suction chamber of the capsule 85 with respect to the said pipe 37b.

A leak 86a of reduced section is provided at the outlet of the chamber of the capsule 85 between this latter and the valve 83a so that, when the said valve is closed and the chamber again occurs under suction, an entry of air may occur in the said chamber and enable the return of the diaphragm 87 to its equilibrium position.

The operation of the devices of FIGS. 19 and 20 is analogous to that of FIG. 18 but the actuation of the ignition retard by the capsule 26b is rendered more brusque by the presence of the slide 83 or of the valve 83a, which enable the brusque application of suction in the chamber of the capsule 85.

According to a variation of the embodiment of FIG. 21, there is provided an electromagnet 89 of which the plunger core 90 is connected to the plate 1 by the stem 88. The energising circuit 91 of the electromagnet may be closed or opened by a switch 92 actuated by the suction capsule 26b.

When the capsule 26b is subjected to an insufficient suction to overcome the elastic return means 39b, the switch 92 is opened, the electromagnet 89 is not energised and no rotation of the plate 1 in the "minus" direction is actuated.

When the suction is sufficient to overcome the means 39b and to cause a deformation of the diaphragm 38b, the switch 92 is closed, the electromagnet 89 is energised and actuates the rotation of the plate 1 in the "minus" direction and a brusque relative ignition retard.

The operation of the device of FIG. 21, in addition, is similar to that of the devices of FIGS. 18 to 20.

FIGS. 22 to 24 show a variation according to which two elements 26c and 53c, analogous to the two suction capsules previously described, are united into a single differential capsule 58c with double diaphragm. The members of this differential capsule similar or playing

identical roles with those shown on the preceding figures are designated by the same reference numerals, generally followed by the letter c in place of the letter b.

The differential capsule 58c comprises two substantially parallel diaphragms 38c and 55c. The surface of the diaphragm 38c is greater than that of the diaphragm 55c.

The diaphragm 38c limits, with the walls of the capsule 58c, a suction chamber 36c, substantially cylindrical, connected by the pipe 37c to the intake pipe at a point 27c. The position of this point is identical to that of the point 27b of the previous figures.

Diaphragms 38c and 55c bound between them and with the rigid walls of the capsule 58c the chamber 57c, substantially cylindrical, connected to the intake pipe at a point 54c. *The position of this point is identical to that of the point 54b of the preceding figures.*

The diaphragm 55c is subject to atmospheric pressure on its surface opposite to the chamber 57c.

A common stem 56c connects the diaphragms between them and to the plate 1.

The end of the stem 56c situated in the chamber 36c can come to bear against the plate 81c, which serves as a stop for the elastic return means 39c. These latter are precompressed and are provided to oppose the displacement of the stem 36c in the direction which actuates a relative ignition retard.

The initial tension of these means 39c determines, for the degree of opening P_L of the throttle valve 2, the rotary speed of the engine N_L above which the suction in the chamber 36c is sufficient to actuate a rotation of the plate 1 in the "minus" direction.

Elastic return means 93c are also provided to oppose the displacement of the stem 56c in the direction which actuates a relative ignition advance. These means 93c are arranged on the side of the diaphragm 55c opposite to the chamber 57c.

The operation of the device of FIGS. 22 to 24 is as follows.

There is first of all considered the case where the degree of opening of the throttle valve 2 is less than P_L (see FIG. 22). In this case, the point 27c occurs downstream of the throttle valve 2 whilst the point 54c occurs upstream of the said throttle valve. The chamber 57c therefore occurs substantially at atmospheric pressure whilst the chamber 36c is under suction.

When the rotary speed of the engine is greater than the limit N_L , the suction in the chamber 36c is sufficient to overcome the resistance of elastic means 39c. The diaphragm 38c is deformed and the stem 56c, in being displaced, actuates rotation of the plate 1 in the "minus" direction.

FIG. 22 shows the device in the position corresponding to this case of operation.

If the rotary speed of the engine is slight and less than N_L and if the suction in the chamber 36c is insufficient to overcome the resistance of elastic means 39c, the capsule 58c does not act on the plate 1 which occupies, then, a neutral position shown in FIG. 24.

There will now be considered the case where the degree of opening of the throttle valve 2 is greater than P_L .

When the point 54c has passed downstream of the throttle valve 2 and the latter is only partially opened

(see FIG. 23), the chamber 57c is placed under suction with respect to atmospheric pressure.

The point 27c, having passed to upstream of the throttle valve 2, is practically no longer under suction. The pressure which exists in the chamber 36c is hence substantially equal to atmospheric pressure. The diaphragm 38c will hence have a tendency to be deformed so that the stem 56c displaces the plate 1 in the direction of relative ignition advance, but the diaphragm 55c has a tendency to be deformed in the opposite sense. Due to the fact that the surface of the diaphragm 38c is greater than that of the diaphragm 55c, the force of the first will be preponderant and the plate 1 will be displaced in the direction of relative ignition advance.

It may be noted that the end 80c of the stem 56c occurring in the chamber 36c is separated from the plate 81c which rests in abutment against the wall of the capsule.

When the load of the engine increases, that is to say when the degree of opening of the throttle valve 2 increases, the suction at the point 54c diminishes.

When the throttle valve 2 is completely open (see FIG. 24), the point 54c occurs practically at atmospheric pressure and it is the same for chamber 57c. There is hence equilibrium of pressures on both sides of the diaphragms 38c and 55c so that the stem 56c resumes its equilibrium position and the plate 1 occurs in its neutral position.

In FIG. 25, there is shown a particularly advantageous embodiment of the elastic return means 39b of the retard capsule 26b (or means 39c of the capsule 26c).

The elastic means 39b are constituted by a spiral spring 94, housed in the ignition control device 95. One end 96 of the spring 94 is hooked directly onto a disc 97 connected rotatably with the plate 1. The other end 98 of the spring is hooked to the wall of the head of the ignition control device. The spiral spring 94 is wound around a cylindrical sleeve 99 extending perpendicularly to the plane of the disc 97. The rotation of this latter around the geometrical axis of the sleeve 99, in any direction, causes the winding or unwinding of the spring 94 which opposes a resistance to the said rotation. This latter is controlled, as in the devices of the preceding figures, by the capsule 36b, either directly, as in the case of FIG. 1, or indirectly, through an electromagnet, as in the case of FIG. 4 or through devices like those of FIGS. 2 and 3.

The spiral spring 94 is used preferably to constitute the elastic means 39b since these latter may be precompressed, but the said spring 94 or a similar spring could also constitute the elastic return means of the advance capsule 53b (or 53c).

The diaphragms of the different suction capsules may be flat or of the bellows type according to the amplitudes which they must have.

Whatever the embodiment adopted, there is obtained an ignition device of which the relative ignition control, especially on deceleration, is brusque due to the passage from upstream to downstream of the point 27b (or 27c) where the passage 37b (or 37c) connecting the suction chamber 36b (or 36c) of the retard capsule opens. This sudden actuation of the retard improves the operation of the engine and reduces possible "jerky" operation on deceleration.

The actuation may be rendered even more sudden by the addition of means such as a slide valve 83 (FIG. 19), a valve 83a or an electromagnet operating wholly or not at all.

Naturally an ignition device for an internal combustion engine according to the embodiments of FIGS. 18 to 24 may be used with a centrifugal ignition relationship in a V according to that described in the above-said U.S. patent application Ser. No. 883,945 filed Dec. 10 1969.

As is self-evident, and as emerges already besides from the preceding description, the invention is in no way limited to those of its methods of application, nor to those of its methods of production of its various parts, which have been more particularly indicated; it embraces, on the contrary, all variations.

What I claim is:

1. In a rotary piston internal combustion engine, an ignition device, comprising means sensitive to the position of the throttle valve and to the rotary speed of the engine and arranged so as to be able to cause ignition retard, according to whether the two following conditions are simultaneously fulfilled: the degree of opening of the throttle valve controlling the intake pipe of the engine is less than a predetermined limit P_L , and the rotary speed of the engine is greater than a predetermined limit N_L , said means comprising a first suction capsule adapted to control the relative ignition retard, said first suction capsule being connected to the intake pipe of the engine at a point which passes from downstream to upstream of the throttle valve when the latter, in opening, passes through a degree of opening P_L , and a second suction capsule provided to act in opposite sense from said first suction capsule and to control, at partial load, when the degree of opening of the throttle valve is greater than P_L and the absolute value of the suction in the intake pipe increases, a relative ignition advance, said second suction capsule being connected to the intake pipe at a point which passes from upstream to downstream of the throttle valve when the latter, in opening, passes through a degree of opening equal or greater than P_L , means for effecting advance and retard of the ignition, said capsules including respective diaphragms, rigid connecting means coupling the diaphragm of each said capsule and the ignition advance and retard means, and alternatively operable resilient means for resisting the relative ignition retard or advance during a degree of movement of the ignition.

2. Ignition device for internal combustion engine according to claim 1, wherein the limit N_L is comprised between 1,000 and 2,000 revolutions/minute of the engine shaft and the degree of opening P_L corresponds to a throttle valve position near the closure of said throttle valve.

3. Ignition device according to claim 1, wherein the diaphragms of the capsule have equal surfaces and said capsules act separately on the ignition advance and retard means, in opposition.

4. Ignition device according to claim 3, wherein the ignition advance and retard means comprises a rotatable place, said connecting means being connected to said place to exert forces thereon over lever arms with respect to the axis of rotation of said plate which are equal in absolute value.

19

5. Ignition device according to claim 1, wherein supplementary means controlled by the retard capsule are provided to cause abrupt control of the ignition retard.

6. Ignition device according to claim 5, wherein the supplementary means are constituted by a valve or a slide arranged so as to establish connection between a third suction capsule and the intake when the suction in this latter has reached a predetermined value or to connect said third capsule to the atmosphere when the suction in the intake pipe is less than said predetermined value.

7. Ignition device according to claim 5, wherein the supplementary means are electromagnetic and include

20

an electrical switch adapted to be controlled by the retard capsule, the ignition advance and retard means comprising a rotatable plate, said electrical switch actuating the plate.

8. An ignition device according to claim 7, wherein said electrical switch actuates an electromagnet which acts on said plate.

9. Ignition device according to claim 1, wherein the two suction capsules are arranged so as to form a single differential capsule with two diaphragms of different areas.

* * * * *

15

20

25

30

35

40

45

50

55

60

65