United States Patent

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[54] **VALVE ACTUATING MECHANISM FOR INTERNAL COMBUSTION ENGINES**
4 Claims, 6 Drawing Figs.

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[51] Int. Cl. F01l 9/02, F01l 9/04, F01l 1/34
[50] Field of Search 123/90, 102

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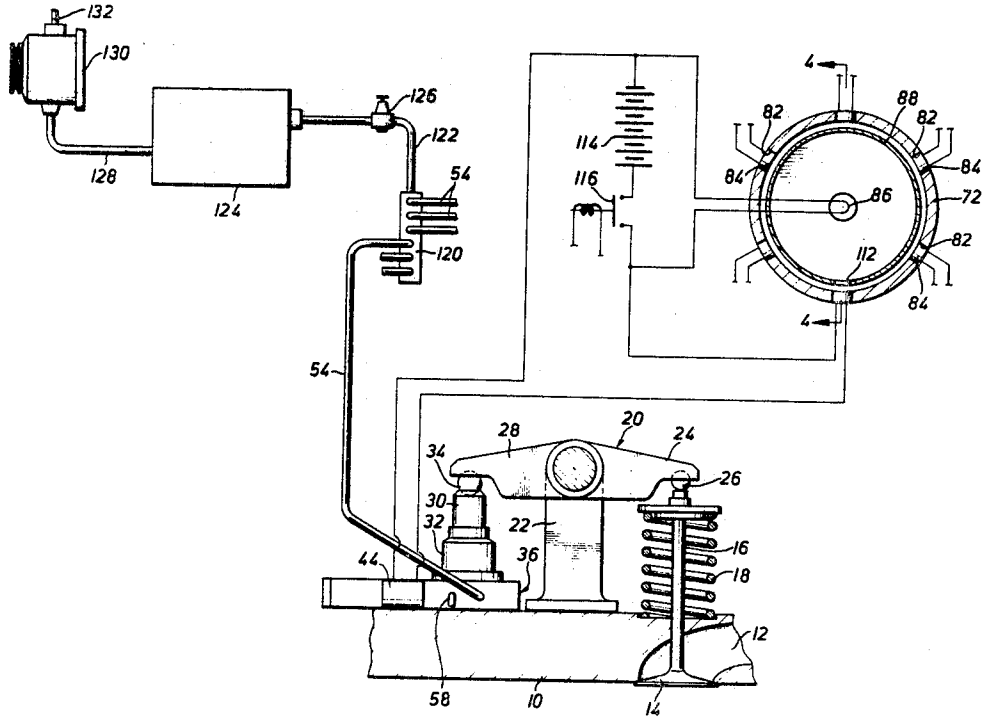
ABSTRACT: Valve actuating and timing mechanism for internal combustion engines embodying hydraulic means for opening the engine valves under the control of electrically operated hydraulic valve mechanism responsive to photoelectric timing mechanism whose timing is varied in accordance with engine speed. The mechanism includes a hydraulically operated valve-opening system having solenoid actuated hydraulic valves which are responsive to timing mechanism embodying a photoelectric cell for each engine valve to be opened, a light source, and rotary shutter means which is variable with engine speed to automatically vary the exposure of the photoelectric cells to light from said source to control the timing and duration of opening of the engine valves.



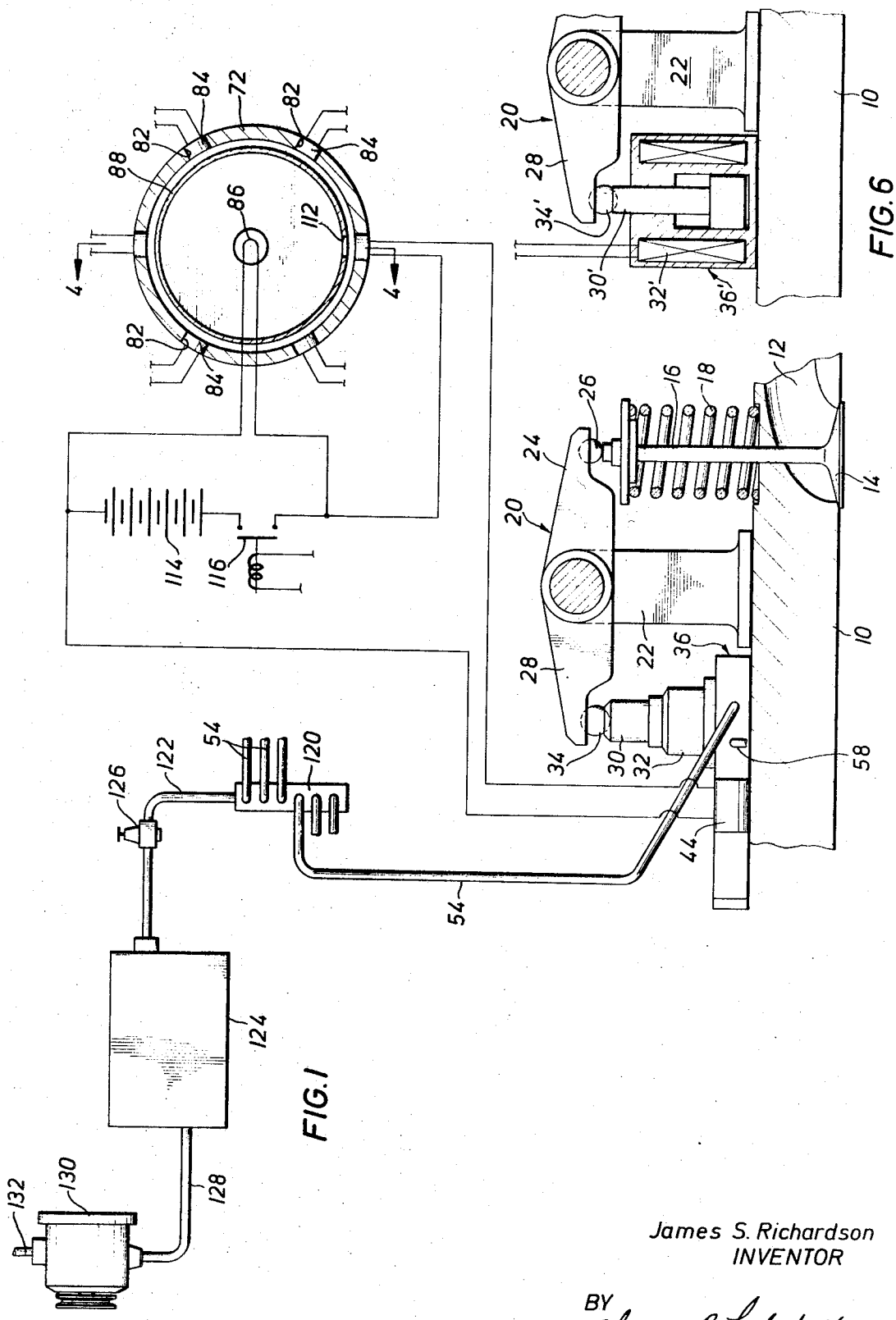


FIG. 1

FIG. 6

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FIG. 2

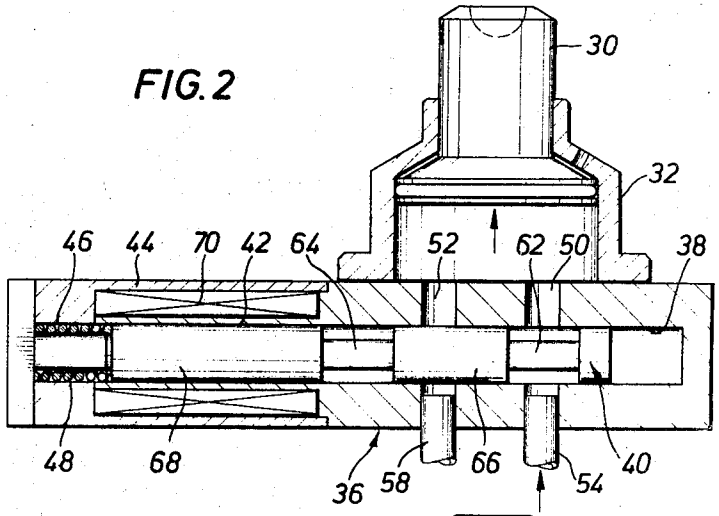


FIG. 3

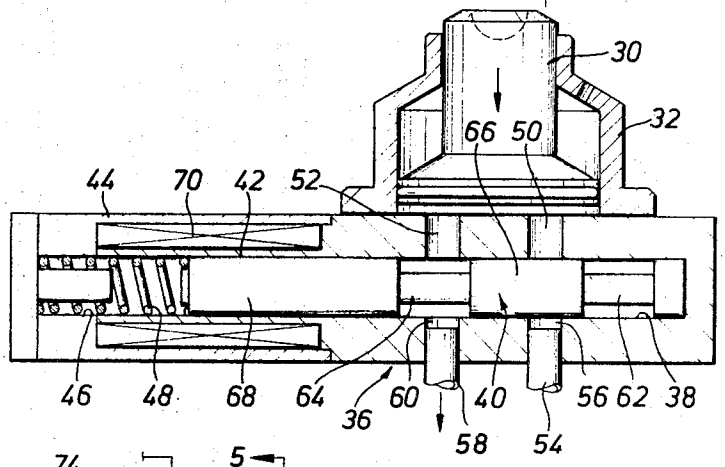
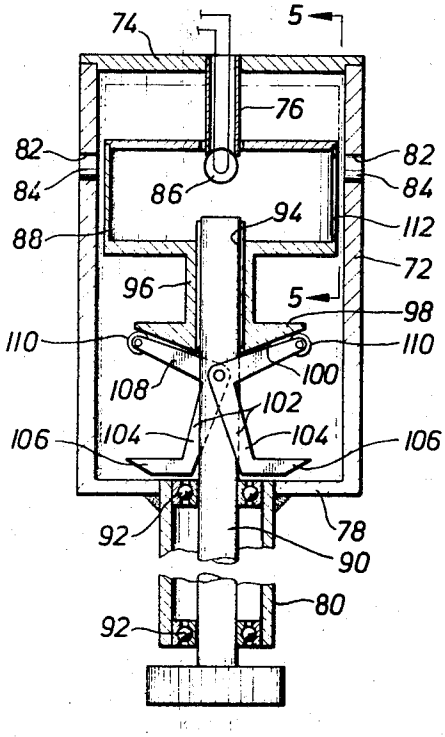


FIG. 4



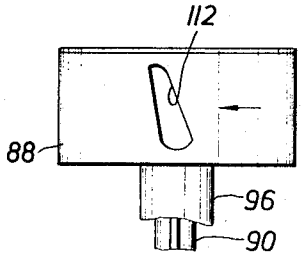


FIG. 5

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VALVE ACTUATING MECHANISM FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The invention relates to the operation of valves of internal combustion engines of the type having timing mechanism which is driven by the engine. The valves of engines of this kind are customarily opened by cam shafts rotated in response to engine speed, the cams of such shafts being positioned and shaped to accomplish the opening of the valves and the dwell or duration of such opening.

As ordinarily constructed, the cams of such cam operated valve mechanism are of a predetermined fixed shape, so that the opening of the valves always takes place when the cam shaft reaches a predetermined position of rotation which is not variable and the duration of opening of the valves is determined by the dwell portion of the cams and varies only in response to the speed of rotation of the cam shaft.

Various attempts have been made to provide for the advancing or retarding of the opening position of the cams and varying the dwell portion of the same, such as by moving the cam shaft longitudinally of its axis in response to changes in engine speed and contouring or shaping the cam to change the position of rotation at which lifting of the valves begins and the length of the dwell portion of the cam. Such means for varying valve actuation has not proven satisfactory, however, due to the complexity of the mechanism required, which is subject to great stresses in operation s as well as extreme conditions of wear.

SUMMARY OF THE INVENTION

Briefly described the invention comprises hydraulic valve actuating mechanism having a hydraulic pressure cylinder for each valve to be operated and including a solenoid actuated valve for controlling the admission of hydraulic fluid into and the discharge of such fluid from each cylinder, photoelectric means for controlling the energization and deenergization of the solenoids including a light source, a photoelectric cell for each solenoid and rotary shutter mechanism for controlling the exposure of the cells to the light source and cutting off such exposure in response to variations in engine speed. The rotary shutter mechanism also includes means for advancing and retarding the exposure of the photoelectric cells to the light source and for varying the duration of such exposure in response to changes in engine speed.

The hydraulic valve-actuating mechanism provides for the application of hydraulic fluid under pressure to the valve actuating cylinders to accomplish quick opening of the engine valves and for the free outflow of such fluid from the cylinders to reduce the resistance to closing movement of the valves to accomplish rapid closing of the same.

The invention includes solenoid means for operating a valve of an internal combustion engine in combination with electric photocell and shutter mechanism responsive to engine speed for controlling the valve operation.

BRIEF DESCRIPTION OF THE VIEWS OF THE DRAWINGS

FIG. 1 is a fragmentary view partly in cross section and partly diagrammatic illustrating a preferred embodiment of the valve actuating mechanism of the invention;

FIG. 2 is a vertical, central, cross-sectional view on an enlarged scale, showing details of structure of the hydraulic valve-actuating means of the mechanism, showing the same in its valve-opening position;

FIG. 3 is a view, similar to that of FIG. 2 showing the valve-actuating means in the valve-closed condition;

FIG. 4 is a cross-sectional view taken along the line 4–4 of FIG. 1, looking in the direction indicated by the arrows;

FIG. 5 is a fragmentary side elevational view of the rotary shutter of the valve-timing means of the mechanism, showing details of structure of the same; and

FIG. 6 is a fragmentary cross-sectional view similar to FIG. 1, illustrating a somewhat modified form of the engine valve-actuating mechanism of the invention.

DETAILED DESCRIPTION OF A PARTICULAR EMBODIMENT OF THE INVENTION

Referring now to the drawings in greater detail the invention is disclosed herein in connection with its application to an internal combustion engine of a usual type having a cylinder head **10** formed with the usual valve ports, such as the port **12**, which is opened and closed by a valve **14**, whose valve stem **16** is provided with a coil spring **18** positioned for coaction with the valve and head to yieldingly urge the valve toward closed position. The valve is opened in the usual manner by a rocker **20**, rotatably mounted on a post **22** on the cylinder head and having one arm **24** thereof positioned to bear at its free end on the upper end of the valve stem, as by means of a suitable bearing **26**, and its other arm **28** bearing at its free end on the upper end of a plunger **30**, of a hydraulic pressure cylinder **32**, as by means of a ball bearing **34**. The hydraulic pressure cylinder is supported on a base **36** resting on the cylinder head, which base has a bore **38** therein in which a valve **40** is slidably disposed. The bore **40** is closed at one end, and the base is formed at the other end of the bore with an externally reduced portion **42**, surrounded by an elongated, cylindrical cap or cover **44** formed with a counterbore **46**, within which a coil spring **48** extends which bears against one end of the valve **40** to yieldingly urge the valve in one direction in the bore.

The bore **38** is in communication with the interior of the pressure cylinder **32** through an inlet passageway **50** and an outlet passageway **52** and an inlet supply pipe **54** is connected in communication with the bore through a port **56** opposite the inlet passageway **50**, while an outlet pipe **58** is connected in communication with the bore through an outlet port **60** located opposite the outlet passageway **52**.

The valve **40** has a reduced portion **62** positioned to establish communication between the inlet pipe **54** and inlet passageway **50** to supply hydraulic fluid under pressure to the pressure cylinder **32** beneath the plunger **30** to lift the plunger when the valve is in the position of FIG. **2**, and a reduced portion **64** positioned to establish communication between the outlet pipe **58** and outlet passageway **52** to allow an outflow of liquid from the cylinder **32** to permit the plunger **30** to move downwardly when the valve is in the position illustrated in FIG. **3**. The valve also has a portion **66** located between the reduced portions **62** and **64** which is positioned to close the outlet passageway **52** when the inlet passageway **50** is open and to close the inlet passageway when the outlet passageway is open.

The valve **40** also has an elongated portion **68** which is slidably extended into the externally reduced portion **42** of the base, upon which reduced portion an electric wire is wound to form a solenoid coil **70** surrounding the bore and which may be energized from any suitable source of electrical current to cause the valve to move from the position of FIG. **3** to the position of FIG. **2** and to allow the valve to be returned to the position of FIG. **3** by the spring **48** when the coil is deenergized.

It will be apparent that upon energization of the solenoid **70**, valve **40** will be moved from the position of FIG. **3** to the position of FIG. **2**, to open the inlet passageway **50** and close the outlet passageway **52**, whereupon liquid under pressure is supplied to the cylinder **32** to lift the plunger **30**, thus actuating the rocker **20** to move the valve **14** to open position and upon deenergization of coil **70** the valve **40** will be moved by spring **46** to the position of FIG. **3** to close inlet passageway **50** and open outlet passageway **52** to allow an outflow of liquid from cylinder **32**, whereupon valve **14** will be closed by spring **18** and the rocker **20** will be actuated to move plunger **30** downwardly.

For the purpose of timing the valve-actuating mechanism to open the valves of the engine, the invention includes electri-

cal-timing mechanism comprising a stationary cylindrical casing or housing 72, mounted at some convenient location and having a closure 74 at its upper end provided with a central opening from which a tube 76 extends downwardly in the casing, and also having a lower end wall 78 formed with a central opening from which a tubular extension 80 extends downwardly exteriorly of the casing.

The casing 72 is provided with peripherally spaced openings 82 in its sidewall, one for each of the valves of the engine which are to be operated, and within each of which a photocell 84 is positioned to be exposed to light from an electric lamp 86 located centrally in the casing at the lower end of the tube 76.

Within the casing a rotary shutter device 88 in the form of a cylinder is mounted on a shaft 90 for rotation therewith which shaft is rotatably extended through the tubular extension 80, as by means of suitable bearings 92 located therein, the shaft being adapted to be rotated in accordance with engine speed, by any suitable means, not shown, such as by timing gear mechanism of a well-known type, or by a belt drive powered by the engine or otherwise. The shaft 90 is extended into a central bore 94 of a downwardly extending lower end portion 96 of the rotary shutter upon whose free end a tapered annular flange 98 is formed having a downwardly facing beveled face 100.

The shaft 90 carries a pair of bellcrank levers 102, pivotally mounted thereon at diametrically opposite locations, each of which has at the free end of one arm 104 thereof a weight 106, and at the free end of the other arm 108 thereof a roller 110 positioned for engagement with the beveled face 100. It will be apparent that, as the speed of rotation of the shaft increases the weights 106 will tend to move outwardly and the arms 108 will be elevated correspondingly to lift the rotary shutter, and when the speed of the shaft is reduced the weights will move inwardly to swing the arms 108 downwardly to allow the shutter to move downwardly.

The rotary shutter 88 has a vertically elongated slot 112 through its sidewall which may slope upwardly somewhat in the direction of rotation of the shutter and which may also increase somewhat in width from top to bottom. The slot 112 is positioned to allow light from the lamp to pass therethrough to expose each of the photocells 84 successively to light for a predetermined time, which will vary in accordance with changes in speed of the engine.

Each photocell 84 is connected into an electrical circuit, shown in FIG. 1 provided with current from any suitable source, such as a battery 114 and into which one of the solenoid coils 70 is also connected. Thus, each of the photocells 84 is connected into circuit with one of the solenoid coils 70 to cause energization of the solenoid when the photocell is exposed to light from the lamp 86.

The lamp 86 is also connected into a circuit with the battery 114 under the control of a switch 116, which may be the ignition switch of the engine. The switch 116 may also be connected in circuit with the photocells 84 and battery 114, so that the cells will receive current only when the ignition system of the engine is on.

Hydraulic fluid for the actuation of the plungers 30 is supplied to the cylinders 32 through the inlet pipes 54, best shown in FIG. 1, which are connected to a manifold 120 to which such fluid is supplied to the cylinders 32 at high pressure to actuate the plungers 30, while resistance to the outflow of return fluid from the cylinders is reduced to a minimum, thus allowing the valves 14 to close rapidly.

By constructing the cylinders 32 with their lower end portions of substantially larger diameter than the upper end portions thereof, and forming the plungers 30 with correspondingly shaped upper and lower end portions, a large area is provided against which the hydraulic fluid may act to lift the plungers, thus greatly increasing the opening force applied to the valves 14.

In the operation of the mechanism, as the speed of the engine increases the rotary shutter will be elevated to position the slot 112 so that the timing of the exposure of the photocells to light from the lamp 86 will be advanced, but reduced in duration, thereby opening the valves 14 earlier but maintaining same open for a shorter time. The slot 112 may, of course, be shaped to obtain any desired timing and duration of exposure of the photocells, whereby timing of the valves 14 may be adjusted and regulated to any desired degree.

A somewhat different form of the invention is illustrated in FIG. 6, wherein the valve rocker 20 is actuated by an electrically operated plunger 30' which operates in a solenoid housing 36' within which a solenoid coil 32' is enclosed. The outer end of the plunger 30' carries a suitable bearing 34' against which the arm 28 of rocker 20 rests. The solenoid coil 32' is connected into the electric circuit with the photocells 84 in the same manner as the solenoid coil 70 of the form of the invention illustrated in FIGS. 1, 2 and 3 to actuate the engine valve directly in response to engine speed.

The operation of this modified form of the invention is believed to be obvious, the engine valve being actuated by the solenoid in response to variations in engine speed.

The solenoid apparatus 30', 32' may, of course, be of a double-acting type, not shown, suitably connected into the timing circuit in a manner for actuation to both open and close the engine valve, should such an operation be desires.

It will thus be seen that the invention provides valve-actuating and timing mechanism which is of simple design and rugged construction and by which the opening and closing of the valves may be accomplished at high velocity while accurately timing the operation of the valves in accordance with engine speed.

The invention is disclosed herein in connection with a particular embodiment of the same, which is it intended by way of illustration only, it being evident that various changes can be made within the spirit of the invention and the scope of the appended claims.

I claim:

1. Mechanism for opening and closing a valve of an internal combustion engine comprising:

a pressure cylinder;

a plunger movably disposed in the cylinder, said cylinder having an inlet and an outlet located on one side of the plunger;

actuator means for opening the valve including means positioned for coaction with the plunger and valve to open the valve in response to movement of the plunger in one direction in the cylinder;

means for supplying fluid under pressure to said inlet;

means responsive to the running of the engine for simultaneously opening the inlet and closing the outlet to admit fluid under pressure to the cylinder to move the plunger in said one direction and for simultaneously closing the inlet and opening the outlet to allow the outflow of such fluid from the cylinder to allow movement of the plunger in the other direction in response to closing movement of the valve;

means responsive to a change in the speed of the engine for changing the time of the opening and closing of said inlet and outlet including;

a light source;

a photoelectric cell;

rotatable shutter means positioned to allow the exposure of said cell to light from said source during one portion of rotation of the shutter means and to shut off such exposure during another portion of such rotation; and

means forming a driving connection between the engine and said shutter means to rotate the shutter means in response to running of the engine.

2. The mechanism as claimed in claim 1, wherein said shutter means includes a cylindrical casing enclosing said light source and having an opening in the sidewall thereof through which light from said source may pass to said cell during one portion of the rotational movement of the shutter means.

3. The mechanism as claimed in claim 2, wherein said shutter means is movable longitudinally of its axis in response to changes in the speed of the engine, and said opening is shaped to allow an increase in the time during which light from said source may pass through the opening to said cell upon longitudinal movement of the shutter means in one direction and to cause a reduction in the time of such passage of light through the opening upon longitudinal movement of the shutter means in the other direction.

4. The mechanism as claimed in claim 3 wherein said opening is shaped to advance the time at which light from said source may begin to pass through the opening to said cell upon an increase in the speed of the engine and to retard the time at which such passage of light may begin upon a decrease in the speed of the engine.