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[54] **IGNITION TIMING CHANGE-OVER DEVICE FOR SPARK ADVANCE MECHANISM HAVING ROTATABLE GOVERNOR PLATE**

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[51] **Int. Cl.** **F02p 5/10,** F02p 5/14

[58] **Field of Search** ..... 123/179 BG, 117 A, 123/117 R

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[57] **ABSTRACT**

An ignition timing change-over device adapted for use with a spark advance mechanism having a rotatable governor plate. A plunger means is adapted to protrude and rotate the governor plate to an angular position in which an ignition advance occurs during the cold operating conditions of the engine irrespective of the intake manifold vacuum. In one embodiment, the plunger means is actuated to hold the governor plate in the advance position during closure of a starting switch. Another embodiment employs a relay and a thermostatically controlled switch to keep the plunger means in the advance position during the engine warm-up operation. A further embodiment comprises a thermostatically operated plunger which is operative to rotate the governor plate through a mechanical linkage during the engine warm-up operation.

4 Claims, 6 Drawing Figures

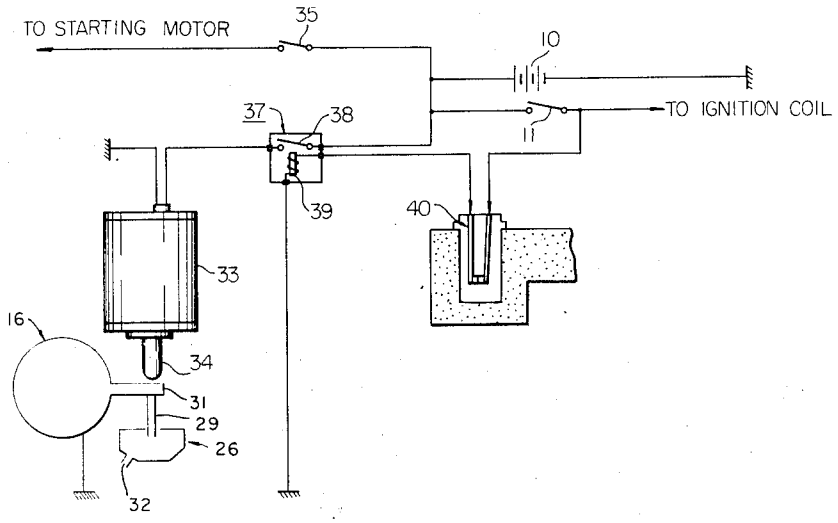

Fig. 1

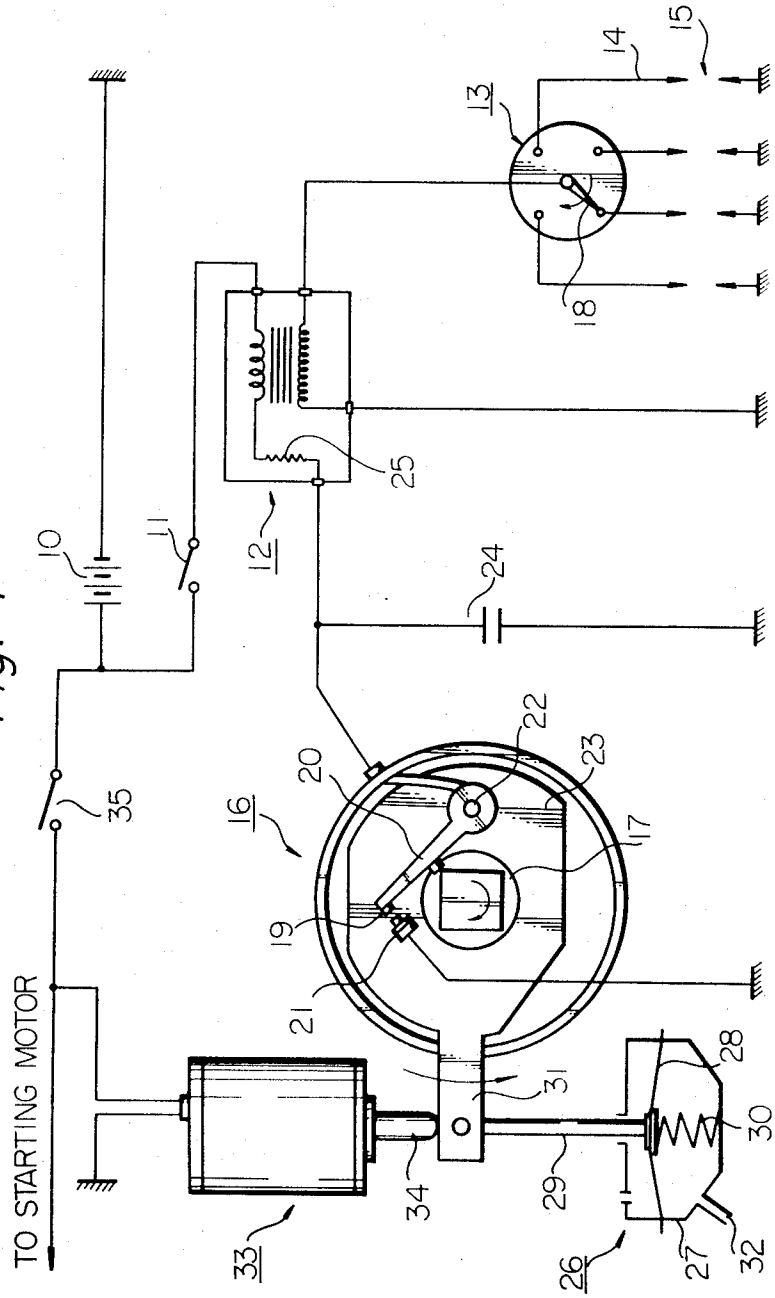

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Fig. 2

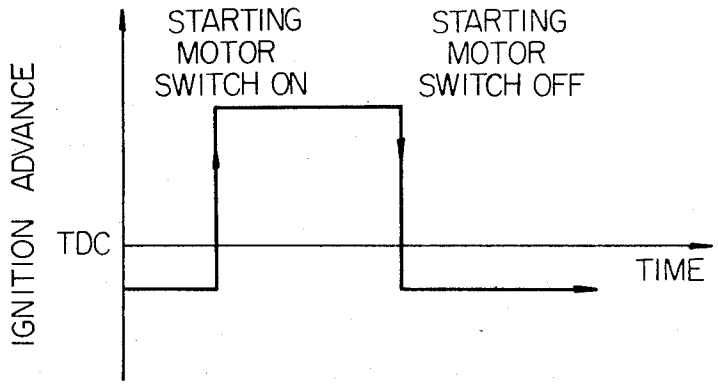

Fig. 4

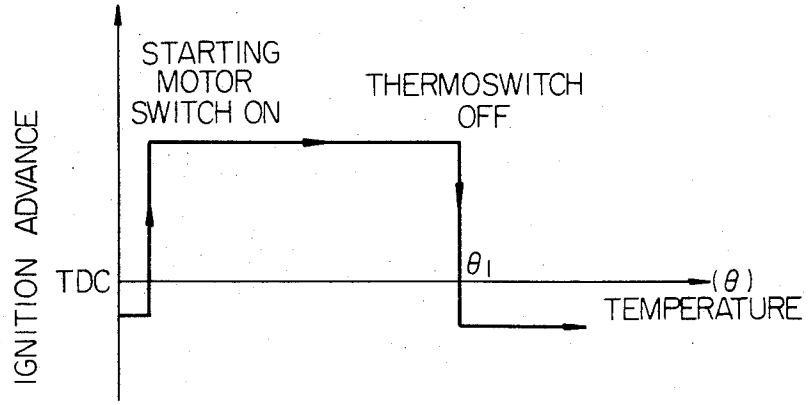

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Fig. 3

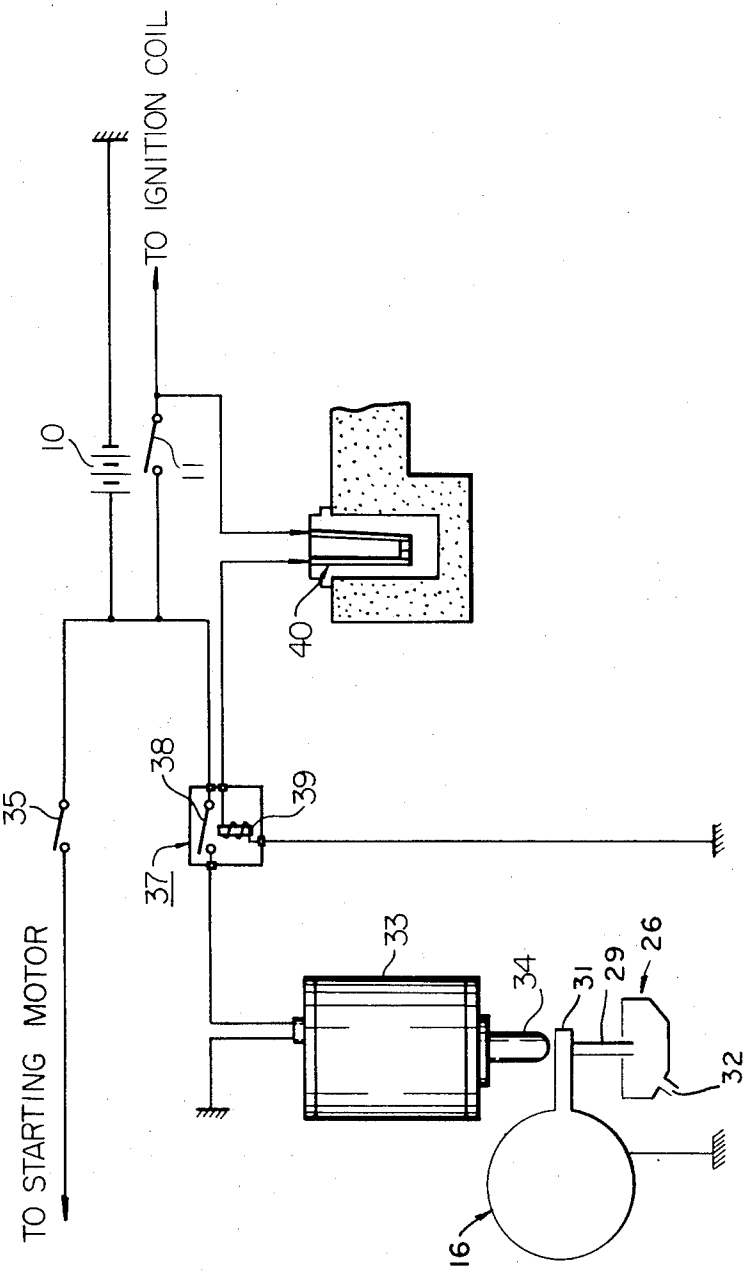

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Fig. 5

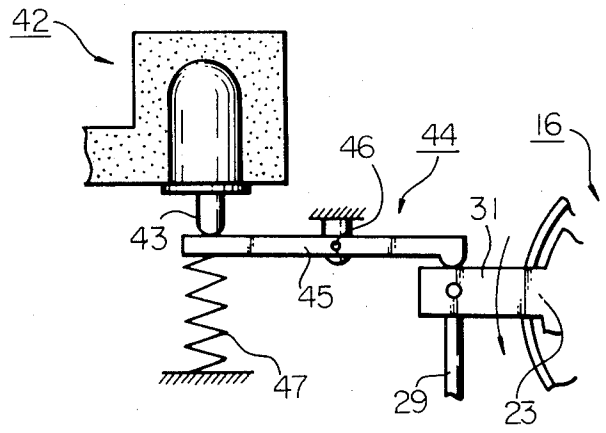
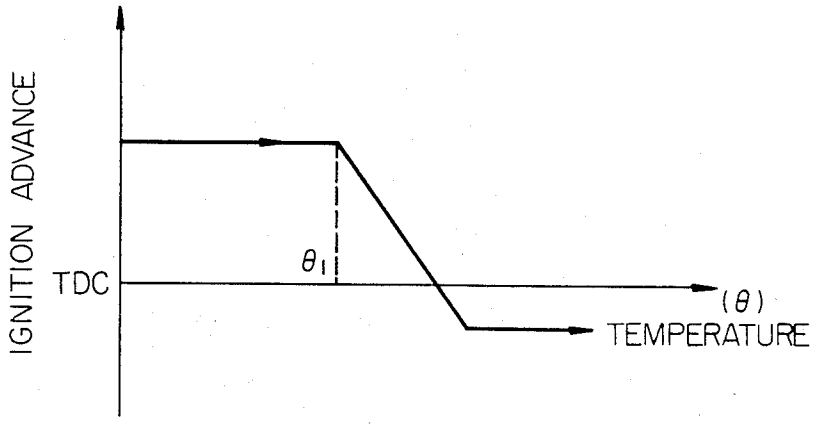


Fig. 6



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IGNITION TIMING CHANGE-OVER DEVICE FOR SPARK ADVANCE MECHANISM HAVING ROTATABLE GOVERNOR PLATE

This invention relates to automotive ignition systems and more particularly to an ignition timing change-over device which is incorporated in the ignition system to electrically or mechanically control the ignition timing so as to improve engine performance during cold starting of the engine.

In order to solve the vehicular air pollution problems, various measures have been taken including retarding of the ignition timing in a spark ignited internal combustion engine. The retarding of the ignition timing is found most effective during warm-up operation of the engine, to reduce the content of harmful pollutants such as hydrocarbons and nitrogen oxides in automobile exhaust gases. And, it is a usual practice to hold the ignition timing in the neighbourhood of or about five degrees behind top dead center on the compression stroke at idle speed during warm-up operation of the engine although it is most desirable to provide **10** to **18** degrees of ignition advance to give the maximum engine performance or thermal efficiency at that speed unless considerations is given to the reduction of content of the harmful exhaust gases. However, the method of retarding the ignition timing is disadvantageous in that it adversely affects the engine performance during cold starting of the engine. That is, with the ignition timing initially set 0° to 5° behind the top dead center, great difficulties are experienced in starting the engine at the atmospheric temperatures below −15° C.

It is, therefore, an object of this invention to provide an ignition timing change-over device which is incorporated in the ignition advance unit, whether it may be of pneumatic or centrifugal type, to improve the engine performance during the engine starting.

It is another object of this invention to provide a plunger means which is capable of advancing the ignition timing 10° to 18° of the crank angle ahead of the top dead center during cold starting of the engine.

In the drawings:

FIG. **1** is a circuit diagram showing, partly diagrammatically, an ignition system according to one embodiment of this invention;

FIG. **2** is a diagrammatical illustration of the ignition advance accomplished by the system of FIG. **1** during the time when the starting switch is closed;

FIG. **3** is view similar to FIG. **1**, showing a modification of this invention;

FIG. **4** is a diagrammatical illustration of the ignition advance attained by the system of FIG. **3** during the engine warm-up operation;

FIG. **5** is a fragmentary diagrammatic view showing another modification of this invention; and

FIG. **6** is a view similar to FIG. **4**, but shows a gradual change in the ignition timing to the retarded side effected by the unit shown in FIG. **5**.

Referring now to FIG. **1**, the ignition system as depicted comprises a d.c. voltage source or battery **10**, an ignition switch **11**, an ignition coil **12**, a distributor **13**, spark plug wires **14** and spark plugs **15**. Also included in the system is a single point breaker **16** having a breaker cam **17** which rotates with the distributed rotor **18** of the distributor **13**. The breaker **16** has a set of contact points, one being a movable contact point **19** attached to a contact arm **20** and the other being a stationary contact point **21** connected to ground. The arm **20** is mounted for pivotal movement about a pin **22** in a governor plate **23** to open and close the breaker contact points **19** and **21** by the rotating action of the breaker cam **17**. The stationary contact point **21** is also mounted on the governor plate **23**. The movable contact arm **20** is shunted by a condenser **24** to ground and connected to the primary side of the ignition coil **12** by way of a resistor **25**.

The ignition system includes a conventional vacuum advance unit **26** and governor advance unit (not shown). The vacuum advance unit **26** comprises a housing **27** including a diaphragm **28**, a diaphragm connecting link bar **29**, and a spring **30** held against the diaphragm **28**. One end of the diaphragm connecting link bar **29** is operatively connected to a radially extending end **31** of the governor plate **23** of the breaker **16**. A conduit **32** connects the vacuum unit **26** to the intake manifold (not shown).

Positioned adjacent to the breaker **16** is a solenoid means **33** having a plunger member **34** engaged at its tip with the extending end of the governor plate **23** and adapted to rotate the governor plate **23** in a direction to advance the ignition timing 10° to 18° before the top dead center. When the plunger member **34** is projected by energization of the solenoid means **33** during starting of the engine. The solenoid means **33**, along with a starting motor (not shown), is electrically connected to the battery **10** by way of a starting switch **35**.

Operation of the system is such that when the starting switch **35** is closed to start the engine the plunger member **34** is projected to rotate the governor plate **23** counterclockwise to the angular position which is proper for the engine starting, so that a proper ignition advance is accomplished relative to the normal retarded condition as shown in FIG. **2**. Once the engine is started the starting switch **35** is opened to deenergize the solenoid means **33**, causing the plunger member **34** to retract thereby rotating the governor plate **23** clockwise to the angular position dependent upon the intake manifold vacuum. With the governor plate **23** in the position an ignition retarding is obtained as shown is FIG. **2**. It is to be understood that when the plunger member **34** is actuated the governor plate **23** is rotated thereby irrespective of the intake manifold vacuum.

FIG. **3** illustrates a modification of the system shown in FIG. **1** although the ignition coil and distributor are not shown for the sake of clarity of illustration. In FIG. **3**, like parts and components are indicated by the same reference numerals as those shown in FIG. **1**.

In the embodiment shown, also, a solenoid means **33** is provided that is adapted to rotate the governor plate **23** of the breaker **16** by a plunger member **34** operatively connected thereto. However, the solenoid means **33** of this arrangement is electrically connected to the battery **10** by way of a relay **37**. The relay **37** includes a switch **38** which is normally kept open by spring pressure and a solenoid coil **39** having one end connected to ground and the other to a thermostatically controlled switch **40** which in turn is connected to the battery **10** by way of the ignition switch **11**. The thermostatically controlled switch includes a pair of contact members, one of which is of a bimetal plate adapted to warp toward the other contact member, thus coming into contact therewith. The thermostatically controlled switch **40** is so located as to sense the engine tempera-

ture, for example, cooling liquid, engine oil, exhaust gases or engine body itself so as to open the relay solenoid circuit when the engine temperature exceeds a predetermined level θ_1° C. In case of cooling liquid, for example, the switch **40** may be so set as to open when the temperature of the liquid increases to 10° C.

In operation, the ignition switch **11** is closed simultaneously with the closure of the starting switch **35.** The solenoid coil **39** of the relay **37** is energized so that the switch **38** connects the solenoid means **33** to the battery **10,** causing the plunger **34** to protrude and rotate the governor plate **23** of the breaker **16.** Thus, the ignition timing is advanced relative to the normal retarded condition during cold starting of the engine. When the cooling liquid temperature is raised by the engine operation to the value θ_1 the thermostatically controlled switch **40** opens to de-energize the solenoid coil **39** of the relay **37.** As a result, the relay switch **38** opens and the solenoid means **33** is deenergized causing the plunger **34** to be retracted. Thus, the ignition timing is retarded under this normal operating condition of the engine. FIG. **4** diagrammatically shows the relationship between the ignition timing and cooling liquid temperature θ.

FIG.**5** shows another modification of the invention comprising a thermostat **42** of the type in which the plunger **43** gradually protrudes as the temperature sensed thereby increases above θ_1° C. The of the plunger member **43** is transferred to the governor plate **23** of the breaker **16** through a connecting linkage **44.** As shown, the connecting linkage **44** comprises an arm member **45** mounted for pivotal movement about a stationary fulcrum **46** and a spring member **47** mounted desirably on the wall of the engine for urging the arm member **45** to rotate in a clockwise direction as viewed in FIG. **5.** When the cooling liquid temperature, for example, is below θ_1° C during the engine warm-up, the plunger member **43** of the thermostat **42** is kept in the retracted position and the spring member **47** urges the arm **45** to be rotated clockwise, rotating the governor plate **23** counterclockwise so that the ignition timing is switched to 10° to 18° ahead of the top dead center of the piston. As described above, when the liquid temperature is increased to θ_1° C the plunger member **43** is caused gradually to protrude and rotate the arm member **45** counterclockwise against the action of the spring member **47.** As a result, the governor plate **23** is rotated clockwise to the angular position dependent upon the intake manifold vacuum, thereby retarding the ignition timing as shown in FIG. **6.**

As has been described above, this invention provides an ignition timing change-over device incorporated in the ignition system to electrically or mechanically control the ignition timing so as to improve the engine performance during the engine starting and warm-up.

What is claimed is:

1. An ignition timing change-over device designed to provide a normal retarded condition during warm-up operation of an internal combustion engine, which is adapted for use with a spark advance mechanism having a rotatable governor plate, said device comprising, in combination,

A. a d.c. voltage source,

B. a relay means electrically connected to said d.c. voltage source,

C. a solenoid means elecrically connected through said relay means to said d.c. voltage source and having a plunger means provided in abutting engagement with said governor plate for mechanically rotating said governor plate to an angular position that advances the ignition timing ahead of top dead center during cold starting of said engine,

D. a starting switch which electrically connects a starting motor to:

1. said d.c. voltage source,

2. an ignition switch, and

3. said relay means, and

E. a thermostatically controlled switch electrically connected between said d.c. voltage source and said relay means for opening and closing said relay means, said thermostatically controlled switch being responsive to the engine temperature, whereby, when said engine temperature is below a predetermined value during cold starting of said engine, said thermostatically controlled switch closes said relay means thereby energizing said solinoid means to cause said plunger means to rotate said governor plate for thereby advancing said ignition timing relative to the normal retarded condition to increase engine performance efficiency during said cold starting of said engine.

2. An ignition timing change-over device as claimed in claim **1,** wherein said relay means includes a normally open switch connected in series between said solenoid means and said d.c. voltage source and a solenoid coil connected in series to said d.c. voltage source through said thermostatically controlled switch for closing said normally open switch when the engine temperature is below the predetermined value during starting condition of the engine.

3. An ignition timing change-over device as claimed in claim **1,** wherein said thermostatically controlled switch includes a pair of normally closed contact members, one of which is of a bimetal plate adapted to warp toward the other contact member when the engine temperature sensed thereby is below the predetermined value and to break contact with said other contact member when the engine temperature sensed thereby exceeds said predetermined value.

4. In an ignition system for an internal combustion engine having a spark advance mechanism provided with a rotatable governor plate, an ignition timing change-over device designed to provide a normal retarded condition when cold starting said engine and during warm-up operation thereof, which is adapted for use with said rotatable governor plate, comprising, in combination,

A. a d.c. voltage source,

B. a relay means having

1. a normally open switch connected in series to said d.c. voltage source and

2. a solenoid coil connected in series to said d.c. voltage source,

C. a solenoid means electrically connected through said relay means to said d.c. voltage source and having a plunger means in abutting engagement with said governor plate for mechanically rotating said governor plate in a direction that advances ignition timing ahead of top dead center during cold starting of said engine,

D. a starting switch which electrically connects a starting motor to:

1. said d.c. voltage source,

2. an ignition switch, and

3. said relay means, said starting switch and said ingition switch being closed simultaneously to start said engine, and

E. a thermostatically controlled switch electrically connected between said solenoid coil of said relay means and said d.c. voltage source, said thermostatically controlled switch including a pair of normally closed contact members, one of which pair is of a bimetal plate adapted to warp toward the other contact member when the engine temperature sensed thereby is below a predetermined value during engine starting and to break contact with said other contact member when the engine temperature sensed thereby exceeds the predetermined value during engine starting, said solenoid coil of said relay means being energized when said contact members of said thermostatically controlled switch are closed, whereby said normally opern switch of said relay means is closed to energize said solenoid means for causing said plunger means of said solenoid means to rotate said ignition timing relative to the normal retarded condition thereof, thereby increasing engine performance efficiency during cold starting of said engine.

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