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IGNITION TIMING CONTROL DEVICE

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Fig. 1

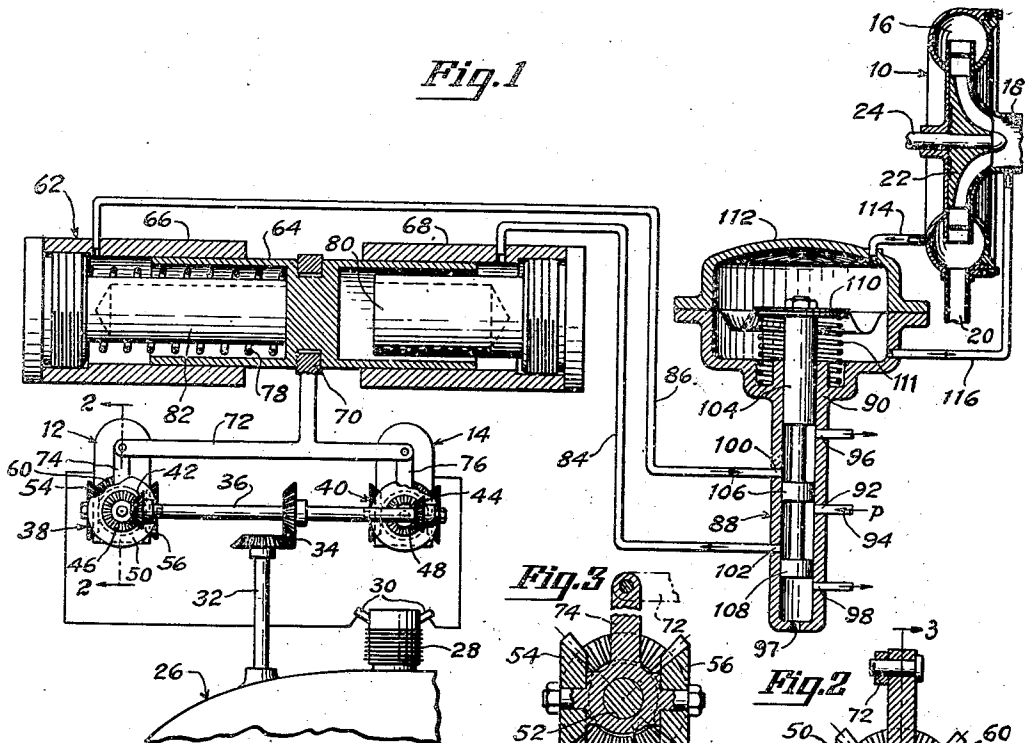
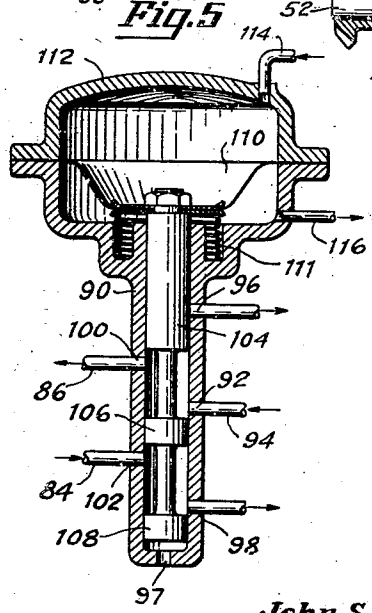
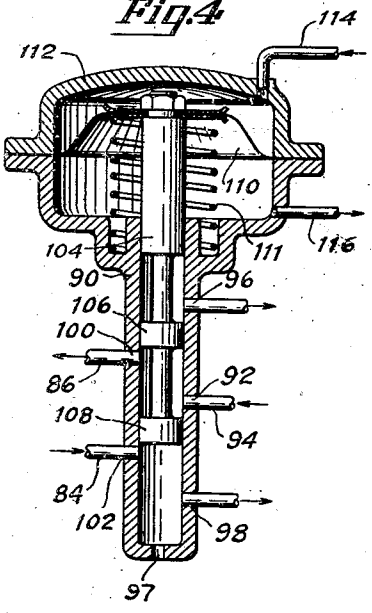


Fig. 3

Fig. 2

Fig. 5

Fig. 4



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IGNITION TIMING CONTROL DEVICE

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8 Claims. (Cl. 123-117)

This invention relates to improvements in ignition timing control devices for an engine equipped with a supercharger.

An object of the invention is the provision of an automatic ignition control mechanism actuated by the pressure drop across the engine supercharger and responsive to power operating conditions of the engine.

A further object is the provision of an ignition timing control device which is operative to advance the ignition timing during an intermediate range of engine power output and to retard the timing on both sides of that intermediate range.

A still further object is the provision of an ignition timing device utilizing a simplified form of servo-motor control for adjusting the timing according to the power output of the engine.

Other objects and advantages will be apparent from the specification and claims, and from the drawing, which illustrates what is now considered to be a preferred embodiment of the invention.

In the drawing,

Fig. 1 is a diagrammatic view of a control apparatus constructed according to the invention, certain elements being shown in section to better illustrate the construction thereof.

Fig. 2 is a view of a detail of one of the magneto drive gear trains, on line 2-2 of Fig. 1.

Fig. 3 is a view along the line 3-3 of Fig. 2.

Fig. 4 is a view through the control valve and valve operating mechanism shown in Fig. 1 but showing a different operating position of the valve from the position shown in Fig. 1, and

Fig. 5 is a view similar to Fig. 4 showing an operative position of the valve different from the positions shown in Figs. 1 and 4.

Referring to the drawing in detail, 10 generally indicates an engine supercharger and 12 and 14 indicate a pair of magnetos which supply electrical energy to the engine ignition system.

The supercharger has a casing 16 with an inlet 18 and outlets 20. The impeller 22 is driven by a shaft 24 extending from the engine, generally indicated at 26. Each outlet 20 is connected with the intake of an engine cylinder, in a well known manner.

Magnetos 12 and 14 are connected with the engine spark plugs 30 by suitable ignition conduits and are driven from the engine by means diagrammatically illustrated in Fig. 1 and comprising an engine driven shaft 32, gears 34, shaft 36 and adjustable gear trains, indicated at 38 and 40.

Shaft 36 has a bevel gear at each end thereof, 55

as indicated at 42 and 44, and these gears mesh with gears 46 and 48 of gear trains 38 and 40. As the two gear trains 38 and 40 are similar in all respects, a detailed description of only one of them will be sufficient for the present purpose.

Referring to Figs. 2 and 3, gear 46 is rigidly secured to an oppositely beveled gear 50 supported for free rotation on the outer end of the magneto drive shaft 52. Gear 50 meshes with a pair of idler gears 54 and 56 carried by a cage 58 supported on shaft 52 which is freely rotatable therein. Idler gears 54 and 56 mesh with a drive gear 60 secured to shaft 52 by pin 61. The drive is therefore from shaft 36 through gears 42 and 46 to gear 50 and from gear 50 through idler gears 54 and 56 to gear 60. With this arrangement, it is apparent that rotation of cage 58 about shaft 52 will angularly displace gear 60 relative to gear 50 resulting in an angular displacement of shaft 52 relative to engine driven shaft 32 and a consequent change in the timing of the magneto driven by shaft 52.

Rotational movement of the cages of both magneto gear drives, about the magneto drive shafts, is controlled by a servo-mechanism generally indicated at 62 and comprising a double ended piston 64 slidable in axially aligned cylinders 66 and 68 and connected with the cages of the magneto gear trains 38 and 40 by a yoke 70 and cross bar 72 pivotally connected at its ends to two arms 74 and 76 extending radially from the idler gear cages 58, of gear trains 38 and 40 so that movement of piston 64 will effect a change in the timing of the magnetos.

Within cylinder 66 is a compression spring 78 which urges piston 64 towards its spark-retarding position against the end of a stop 80 secured in the cylinder 68 and telescopically associated with the hollow end of the piston 64. A somewhat similar stop 82 in cylinder 66 limits the movement of piston 64 in the spark-advancing direction. Stops 80 and 82 are integral with the screw plugs which close the outer ends of cylinders 68 and 66 respectively. Either or both stops 80 and 82 may be adjusted so that a desired spark setting may be obtained for both retarded and advanced positions.

Piston 64 is moved towards spark advanced position, illustrated in Fig. 1, by the application of fluid under pressure through line 84 to the interior of cylinder 68 and is moved towards spark retarded position by spring 78 and also by fluid under pressure admitted through line 86 to the interior of cylinder 66. The application of fluid under pressure to servo-motor 62 is controlled

by a valve, generally indicated at 88, and so arranged that when fluid under pressure is being applied through one of these lines to a cylinder, the other line acts as a drain for the other cylinder.

Valve 88 comprises a cylinder 90 having an intermediate port 92 connected with a fluid pressure line 94, drain ports 96 and 98 spaced from pressure port 92 on opposite sides thereof, and ports 102 and 100 for lines 84 and 86 disposed each between the pressure port and a drain port. Within cylinder 90 is a plunger 104 provided with two pistons 106 and 108 controlling the connection between the above mentioned ports in a manner to be described. A drain is provided at 97 to a sump, which is usually the engine crankcase.

Plunger 104 is operated by a flexible diaphragm 110 mounted in a hollow casing 112 in such a manner as to provide a closed chamber at each side of the diaphragm. One of these chambers is connected through tube 114 with supercharger casing 16 and the other chamber is connected through a tube 116 with the supercharger inlet 18 so that the pressure differential between the supercharger inlet and outlet is exerted on diaphragm 110 which tends to resiliently take the position illustrated in Fig. 4. A compression spring 111 is placed beneath diaphragm 110 to give the correct rate of travel in proportion to the pressure head of the supercharger.

In Fig. 1 the diaphragm is in an intermediate position corresponding to an intermediate power output of the engine. In this position pistons 106 and 108 connect pressure port 92 with port 102 of line 84 thus applying pressure to the interior of cylinder 66 to move piston 64 to the left against spring 78 to a position against the end of the stop 82, thus moving arms 74 and 76 to the position at which the timing of the magnetos is advanced. At the same time, line 86 is connected with drain port 98 to vent any fluid trapped in cylinder 66.

Fig. 4 shows diaphragm 110 in the position which it occupies during idling operation of the engine when the pressure head across the supercharger is substantially negligible. In this position the diaphragm has raised pistons 106 and 108 to connect pressure port 92 with port 100 of channel 86 thus applying fluid under pressure to the interior of cylinder 66 to force piston 64 to its limiting position against stop 80 which corresponds to the spark retarding position of the servo mechanism. At the same time, line 84 is drained through port 98.

Fig. 5 shows the position of diaphragm 110 when the engine is operating in the upper portion of its power range. Under this condition pistons 106 and 108 connect the line 86 with the pressure line 94 through ports 100 and 92 to apply fluid under pressure to the interior of the cylinder 66 thus again retarding the spark by moving piston 64 against stop 80. At the same time the line 84 is connected with the drain port 98 thus venting fluid from the cylinder 66 as indicated above in connection with Fig. 4.

Since the engine power output is accurately indicated by the pressure head across the supercharger, it will be apparent that the apparatus above described serves to maintain the engine ignition timing retarded during idling and full power operation of the engine, and to advance the timing only during the intermediate, or cruising, range of engine output. Thus is provided a highly sensitive and accurate automatic

control for regulating the timing of the engine ignition to avoid detonation while at the same time providing the maximum efficiency and economy of engine operation.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. In combination with an engine having a supercharger and an adjustable electric ignition system, a servomotor for adjusting said ignition system to change the timing thereof, and means for controlling said servomotor including a casing, a diaphragm dividing said casing into two separate chambers, means connecting one of said chambers with the outlet side of said supercharger, means connecting the other chamber with the inlet side of said supercharger, and a device actuated by said diaphragm for controlling said servomotor.

2. In combination with an engine having a supercharger and an adjustable electric ignition system, a servomotor for adjusting said ignition system to change the timing thereof, and means for controlling said servomotor including a casing, a diaphragm dividing said casing into two separate chambers, means connecting one of said chambers with the outlet side of said supercharger, means connecting the other chamber with the inlet side of said supercharger, and a device actuated by said diaphragm for controlling said servomotor, said device having three operative positions corresponding to three consecutive pressure ranges between the inlet and outlet of said supercharger and operative in the first and third of said positions to maintain said servomotor in its spark retarding position, and in the second of said positions to maintain said servomotor to its spark advancing position.

3. In combination with an engine having a supercharger and an adjustable electric ignition system, a servomotor for adjusting said ignition system to change the timing thereof, and means for controlling said servomotor including a casing, a diaphragm dividing said casing into two separate chambers, means connecting one of said chambers with the outlet side of said compressor, means connecting the other chamber with the inlet side of said compressor, and a valve actuated by said diaphragm and hydraulically connected with said servomotor for maintaining said servomotor in its spark retarding position during the high and low ranges of engine power operation and maintaining said servomotor to a spark advanced position during engine operation within a predetermined intermediate power range.

4. In combination with an aircraft engine, an engine driven supercharger, an electrical ignition mechanism, an adjustable timing device for said mechanism, and means responsive to variations in the pressure rise across said supercharger for adjusting said timing device including means for retarding the ignition timing at relatively low and high values of said pressure rise and advancing the ignition timing at intermediate values of said pressure rise.

5. In a method of operating an aircraft engine having an adjustable electric ignition system and an engine driven supercharger, the steps of varying the ignition timing in accordance with variations in the pressure rise across said supercharger, comprising, automatically advancing the ignition timing in response to an increase in the pressure

rise across said supercharger to an intermediate value and automatically retarding the ignition timing in response to a further increase in said pressure rise to a higher value thereof.

6. In ignition timing apparatus for an engine having an induction system and a supercharger therefor, means responsive to the pressure rise directly across said supercharger, and means controlled by said pressure responsive means for adjusting the ignition timing.

7. In ignition timing apparatus for an engine having an induction system and a supercharger therefor, a source of fluid pressure, valve means for controlling the application of said pressure

for advancing or retarding the ignition timing, and means responsive to the pressure rise directly across the engine supercharger for adjusting the valve means to retard the ignition timing when said pressure rise is above or below an intermediate range and to advance the ignition timing when said pressure rise is within said range.

8. In an engine having an ignition system, an induction system and a supercharger in said induction system, means for adjusting the ignition timing, and means actuated by the pressure rise directly across said supercharger for operating said adjusting means.

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