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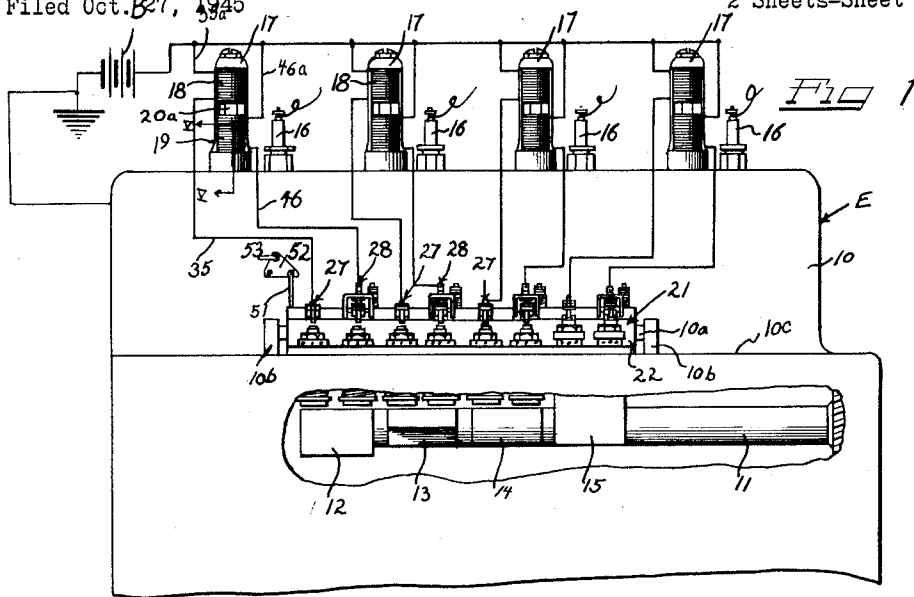
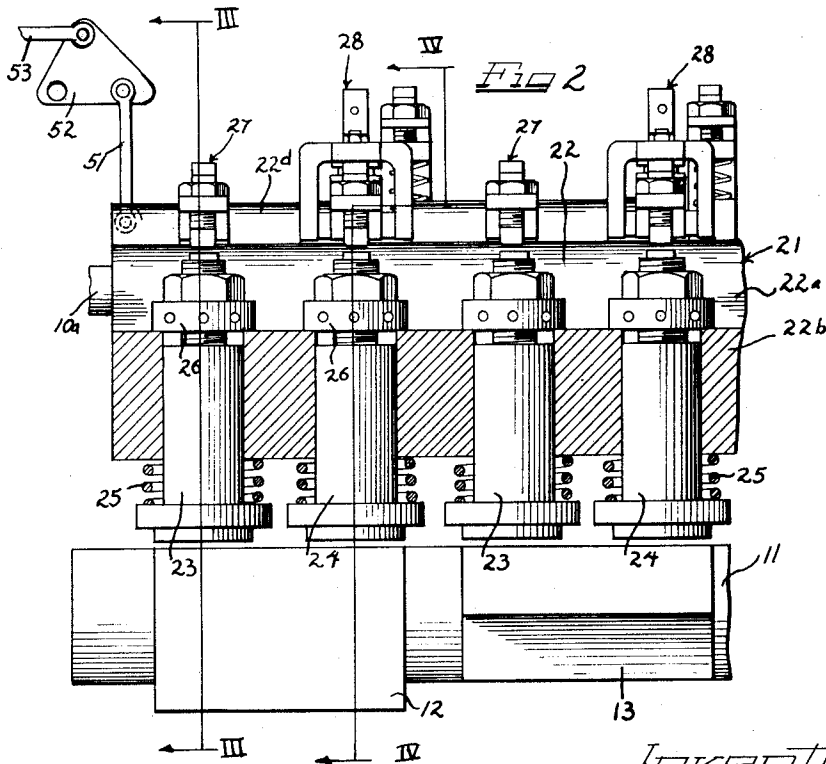
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2,569,090

ELECTRICAL CONTROL DEVICE

Filed Oct. 27, 1945

2 Sheets-Sheet 1



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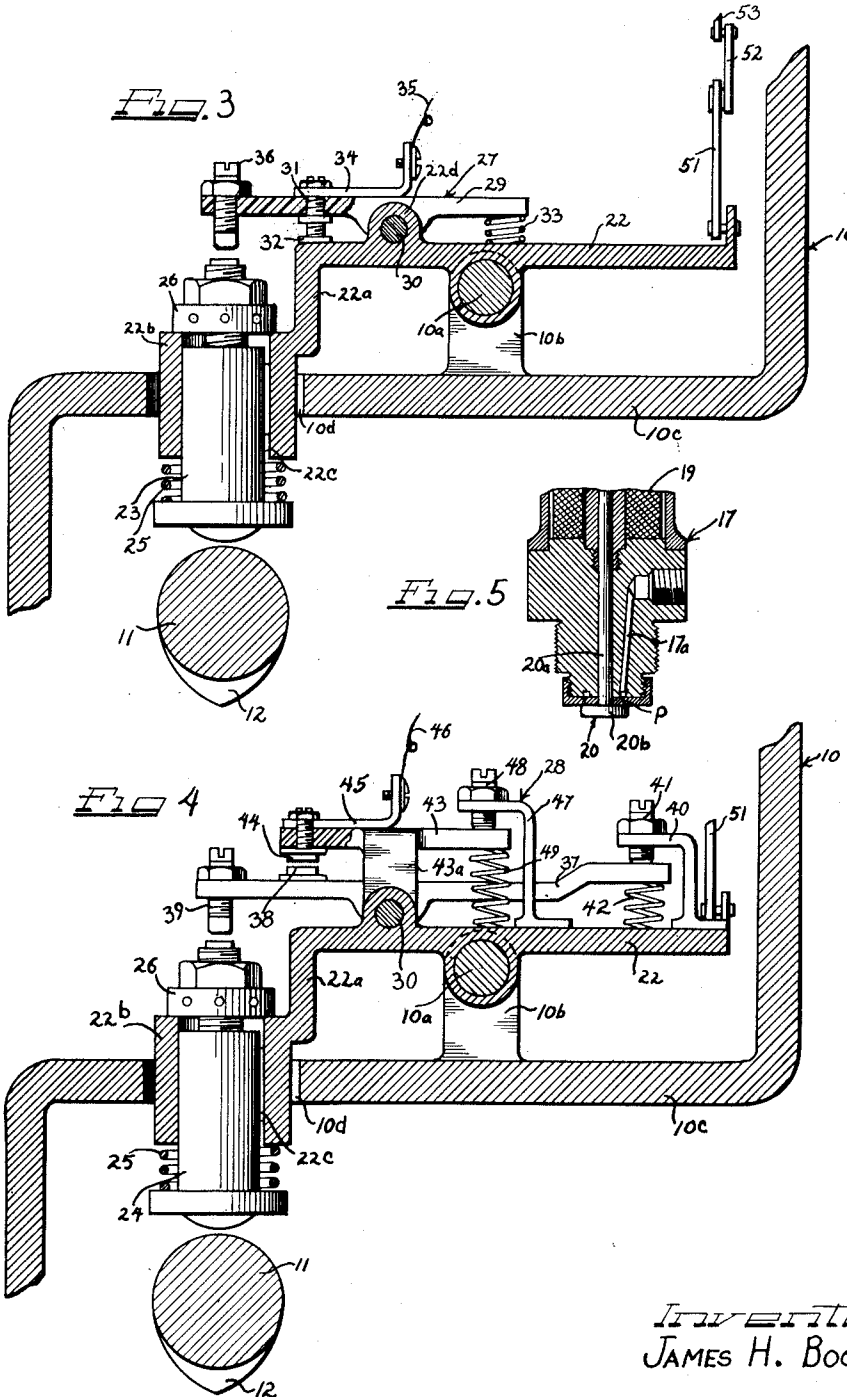
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2 Sheets-Sheet 2



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2,569,090

ELECTRICAL CONTROL DEVICE

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Application October 27, 1945, Serial No. 625,091

2 Claims. (Cl. 200—27)

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This invention relates to control devices for automatically regulating energization of electrical circuits.

Specifically, the invention deals with an electrical control unit for solenoid-operated injector valves to supply fuel to internal combustion engines.

The control device of this invention is especially useful in connection with fuel injectors of the type disclosed in my copending application Serial No. 588,630, filed April 16, 1945, now abandoned.

In accordance with this invention, fuel injector valves are mounted on an internal combustion engine such as an automobile engine to supply fuel to each cylinder of the engine. Each of these valves has solenoids for opening the valve and for holding the valve closed. These solenoids are electrically energized in the desired timed relation and for the desired length of time by means of cam shaft-controlled tappet-actuated switches. The tappets and switches are conveniently mounted on a tiltable carriage which is supported on the engine. Manual tilting of the carriage will vary the spacial relationship between the tappets and the cam shafts for regulating the amount of dwell of the tappets on the cams of the cam shaft. The dwell of the tappets on the cams determines the time increments of actuation of the switches so that engine speed is increased when the dwell is increased, and vice versa. One cam on the cam shaft preferably actuates a pair of tappets, with one tappet of the pair controlling a switch for the injector closing solenoid and the other tappet of the pair controlling the switch for the injector opening solenoid.

The switch for the injector closing solenoid is normally biased to closed position so that the closing solenoid is energized for holding the injector in closed position until the tappet opens the switch. The other switch is normally biased to open position so that the injector opening solenoid will only be energized when the tappet closes this switch.

Because de-energization of the injector closing solenoid should occur about the time the injector opening solenoid is energized, one cam can operate a pair of tappets which control the respective switches for the opening and closing solenoids of each injector. Since the time of energization of the injector opening solenoid may vary through a wide range for producing a wide range of engine operating speeds, and since the injector opening solenoid is energized when its control switch is closed by the tappets, this switch is equipped with a yieldable contact point adapted

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to move with the tappet actuated contact point after initial contact has been established. This arrangement permits closing of the switch by the tappet and continued closing movement of the tappet whenever the amount of dwell of the tappet on the cam is increased beyond that amount just sufficient to move the tappet for closing the switch.

It is, then, an object of this invention to provide an electrical control unit for solenoid actuated valves.

A further object of the invention is to provide a cam actuated electrical control unit for solenoid-operated valves such as injector valves, which unit can be easily shifted to vary its spacial relationship with the actuating cams therefor to automatically bring about a change in the timing of operation of the valves.

A further object of this invention is to provide an injector control for engines which is actuated by a cam shaft and manually moved relative to the cam shaft by an accelerator to thereby control the speed of operation of the engine.

A still further object of the invention is to provide a simplified electric control unit for solenoid operated injector valves that regulates fuel feed to internal combustion engines.

A specific object of the invention is to provide an injector control device for internal combustion engines that is actuated by the cam shaft of the engine and includes cam controlled injector opening and closing switches for each injector.

Other and further objects of the invention will be apparent to those skilled in the art from the following specific description of the annexed sheets of drawings which, by way of a preferred example only, illustrate one embodiment of the invention.

On the drawings:

Figure 1 is a side elevational view, with parts broken away to show underlying parts, and with parts somewhat diagrammatically illustrated, of an internal combustion engine equipped with a fuel injector control unit of this invention.

Figure 2 is a fragmentary vertical longitudinal cross-sectional view, with parts in elevation, of the control device of this invention.

Figure 3 is a transverse vertical cross-sectional view, with parts in elevation, of the control device taken along the line III—III of Figure 2.

Figure 4 is a transverse vertical cross-sectional view of the control device taken along the line IV—IV of Figure 2.

Figure 5 is a fragmentary vertical cross-sectional

tional view of a fuel injector taken along the line V—V of Figure 1.

As shown on the drawings:

In Figure 1 a four-cylinder engine E has a conventional block or engine body 10 with a cam shaft 11 therein carrying cams 12, 13, 14 and 15. The cam shaft 11 can be driven by the engine E and located in the same position as the conventional valve-actuating cam shaft of an internal combustion engine.

Spark plugs 16 are mounted on the engine body E above each cylinder (not shown) therein. Instead of supplying a mixture of fuel and air from a carburetor through intake valves to the engine E, in accordance with this invention the cylinders of the engine are each supplied with fuel from a separate injector valve 17 mounted on the engine body. Each injector valve 17 has a valve-closing solenoid 18 and a valve-opening solenoid 19. These solenoids 18 and 19 are selectively energized to shift a valve 20 having a stem 20a slidably mounted through the solenoids. As shown in Figure 5, the valve 20 has a head 20b on the end of the stem 20a thereof arranged to open and close ports P in the bottom of the unit 17. As illustrated, the bottom of the unit is adapted to be threaded into the engine body 10 and fuel is supplied thereto through a passage-way 17a thereof which supplies the ports P. The fuel is under pressure and, whenever the valve head 20b is spaced from the ports P, fuel will be injected into the cylinder of the engine. On the other hand, when the valve 20 closes the ports P, fuel flow to the engine ceases. The speed of operation of the engine and the power delivered by the engine are controlled by the length of time that the ports P remain open. Of course, as in internal combustion engines, the valves 17 supplying fuel to the respective cylinders of the engine must be sequentially operated in the proper timed relationship.

In accordance with this invention, the sequential operation of the valves 17, and the length of time which these valves remain open, are controlled by a unit 21. The unit 21 includes a carriage or body member 22 which is rockably supported on pins or a shaft 10a carried in brackets 10b provided for the purpose on a ledge 10c of the engine body 10. The carriage 22 has a depending flange 22a along the front edge thereof carrying an integral apertured block 22b which projects through an elongated slot 10b in the ledge 10c. The slot 10d is directly above the cam shaft 11. The apertures in the block 22b are so positioned that a pair of apertures will be directly above and in aligned relation with each of the cams 12 to 15 on the cam shaft. Each aperture slidably supports a tappet and thus an injector valve closing tappet 23 and an injector valve opening tappet 24 are mounted above and in aligned relation with each cam on the cam shaft. Springs 25 bias the tappets 23 and 24 toward the cam shaft and adjustable collars 26 are threaded on the top ends of the tappets to abut the top face of the block 22b for limiting downward movement of the tappets. The tappets are thus adjustable in the bores or apertures of the block 22b relative to the cams acting on the tappets. Grooves 22c are provided in the bores or apertures of the block 22b to supply lubricant from the crank case of the engine for reducing friction between the reciprocating tappets and the block.

Each tappet 23 actuates an injector valve closing switch 27, and when the tappets engage this

switch, the switch is opened to de-energize the injector valve closing solenoid.

Each tappet 24 actuates a switch 28 controlling energization of an injector valve opening solenoid. The tappets 24 engage the switches 28 to close a circuit for energizing the injector valve opening solenoids.

As shown best in Figure 3, each switch 27 includes a rocker arm 29 composed of plastic or other insulation material, pivoted on a pin 30 carried by ears 22d on the carriage 22. The rocker arm 29 supports a contact stud 31 which cooperates with a contact button 32 on the carriage 22. The stud is adjustable in the rocker arm 29 by means of screw threads or the like so that it can depend for a desired length beneath the rocker arm. A compression spring 33 between the rocker arm 29 and carriage 22 urges the rocker arm so that the contact stud 31 will be in engagement with the contact button 32.

A connection post 34 is affixed to the contact stud 31 and a wire 35 connects this post to an injector valve closing solenoid 18.

The rocker arm 29 overhangs the tappet 23 and adjustably carries a stud 36 adapted to be engaged by the upper end of the tappet 23 whenever the tappet is raised by its actuating cam. The tappet will thereupon tilt the rocker arm 29 to separate the contact stud 31 from the contact button 32 and break a circuit from a battery B and wire 35a through the solenoid 18 and wire 35 to the ground afforded by the engine casing 10.

Thus, each switch 27 is urged to circuit closing position by the spring 33 for energizing the solenoid 18 of one of the injectors 17 and is opened by its operating tappet 23 to break the circuit and de-energize this solenoid. As explained, a separate switch 27 is provided for the solenoid 18 of each injector. The solenoid will be energized from a battery B until a tappet 23 controlling the switch 27 for that solenoid 18 opens the switch to break the circuit to the ground.

Each switch 28 includes a rocker arm 37 pivoted on the same shaft or pin 30 as the rocker arms 29 for the switches 27. The carriage 22 has a plurality of ears 22d thereon supporting the shaft or pin 30. The rocker arm 37 has a contact button 38 on its top face forwardly of the shaft or pin 30 and projects over its actuating tappet 24. The end of the arm over the tappet 24 adjustably carries a contact stud 39 which can be regulated to project a desired distance beneath the arm for varying the spacial relationship between the end of the stud and the top of the tappet. A bracket 40 is mounted on the carriage 22 and overhangs the rear end of the rocker arm 37. An adjustable stop stud 41 is carried by the bracket 40 to contact the top of the rear end portion of the rocker arm 37. A spring 42 urges the rocker arm against the stud 41. The spring 42 is compressed between the carriage 22 and the rear end of the rocker arm.

A yieldable contactor member 43, composed of plastic or other insulation material, has legs 43a depending from the sides thereof and pivoted on the pin or shaft 30 in straddling relation to the rocker arm 37. The yieldable contactor 43 has a contact button 44 depending from the front end thereof above the contact button 38 of the rocker arm 37. A binding post or bracket 45 is connected to the contact button 44 and overlies the top of the contactor 43. A wire 46 connects the binding post 45 with the lower or valve closing solenoid 19 of the injector actuated by the switch 28.

A second bracket 47 is mounted on the carriage 22 and overlies the rear end of the yieldable contactor 43. An adjustable stop 48 is carried by the bracket 47 to abut the top face of the contactor arm. A spring 49 is compressed between the carriage 22 and the underface of the contactor 43 at the rear end thereof to urge the contactor against the stop 48.

In operation, the tappet 24 engages the stud 39 to rock the arm 37 and thereby place the contact buttons 33 and 44 in electrical contacting relation. Current will thereupon flow from the battery B through a wire 46a to the lower or valve opening solenoid 19 and thence through the wire 46 to ground through the contactor buttons 44 and 38 and engine casing. The solenoid 19 is thereby energized. However, since the tappet 24 may have a prolonged dwell on its actuating cam and may rock the arm 37 to move the button 38 thereof upwardly beyond initial contact position with the button 44, the contactor 43 is made so that it will yield to permit this further movement. Thus the contactor 43 will be rocked on the pin or shaft 30 to compress the spring 49 and not interfere with the further upward movement.

Therefore, the switch 28 is normally biased to open position by the spring 42 and, when actuated by the tappet 24, it will close upon an initial predetermined movement of the tappet against its stud 39 but will not interfere with additional movement by the stud since the contactor 43 thereof is yieldable. When the tappet 24 recedes from the switch, the stop 48 will hold the yieldable contactor 43 at a fixed level to permit the contactor button 38 to move away from the button 44.

As indicated above, the closing solenoid for each injector 17 is energized until its switch 27 is opened by a tappet 23. Conversely, the valve opening solenoid 19 of each injector 17 is deenergized until its switch 28 is closed by a tappet 24. One cam acts on a pair of tappets respectively controlling the adjacent switches 27 and 28 and the closing solenoid for the injector is deenergized simultaneously with the energization of the opening solenoid. Of course, adjustments in the positions of the switch studs engaged by the tappets will regulate the exact timing of energization and deenergization of the opening and closing solenoids for each injector.

In order to vary the speed and power output of the engine E, the amount of dwell of the tappets on their operating cams is varied by rocking the carriage 22 on which the switches are mounted. This rocking is accomplished by mechanism controlled, for example, from the accelerator pedal of an automotive vehicle. This mechanism includes a link 51 pivoted on the carriage 22 and carried by a cam plate or rocker member 52 pivoted to the engine casing 10 and rocked by a link rod 53 extending to the control station (not shown) for the engine. Thus, when an accelerator or other operating mechanism is depressed to pull the link 53, the cam plate 52 will be

rocked to raise the link 51. This will tilt the carriage 22 to lower the tappet carrying block portion 22b thereof toward the cam shaft and thereupon cause an increased amount of dwell of the tappets on the cams. The injector opening solenoids will thereupon be energized for increased periods and additional fuel will be fed to the engine for speeding up the engine.

From the above descriptions it will be understood that this invention provides an electrical control device actuated by cams for automatically regulating the energization of electrical parts. The device is manually controlled to vary the time of energization of the parts for maintaining desired conditions.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A device for use to actuate a fuel valve of an engine which comprises a tiltably mounted carriage, a pair of cam-actuated tappets slidably mounted on said carriage, a switch biased to closed position on said carriage, tappet contact means on said switch arranged to be engaged by one of the tappets for opening the switch, a second switch on said carriage biased to open position and having a cam-actuated tappet contact means for closing the switch, a yieldable contactor on said second switch accommodating movement of the switch by its actuating tappet even after the switch is closed, and means for tilting the carriage to vary the amount of dwell of the tappets.

2. A device for use to actuate a fuel valve of an engine which comprises a tiltably mounted carriage, a first switch biased to closed position on said carriage, a second switch on said carriage biased to open position, a pair of cam actuated tappet means slidably mounted on said carriage and arranged to engage the same cam for opening said first switch and closing said second switch, and means for tilting the carriage to vary the amount of dwell of the tappet means on the cam.

JAMES H. BOOTH.

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