

### [54] IGNITION TIMING AND THROTTLE POSITION CONTROL

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[58] Field of Search .... 74/860, 864, 867; 123/117 R, 123/117 A

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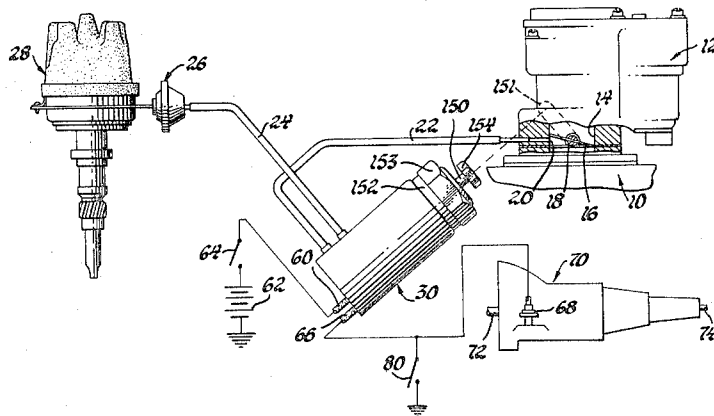
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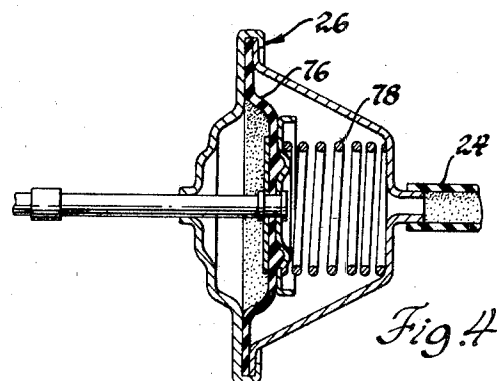
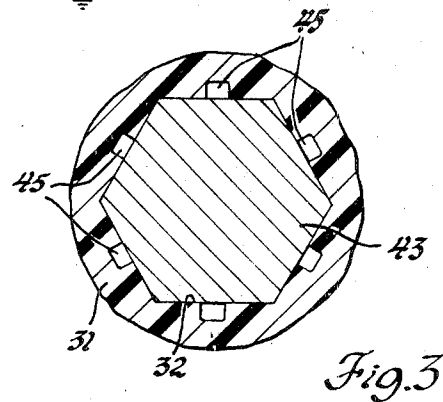
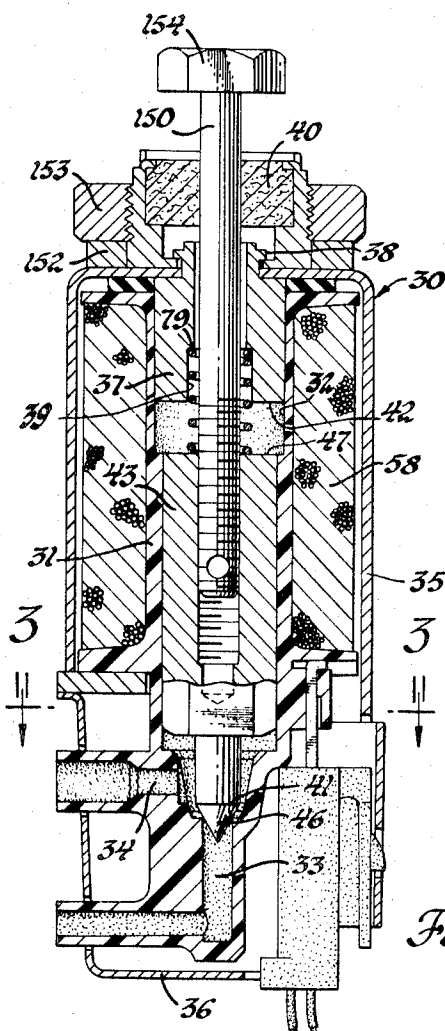
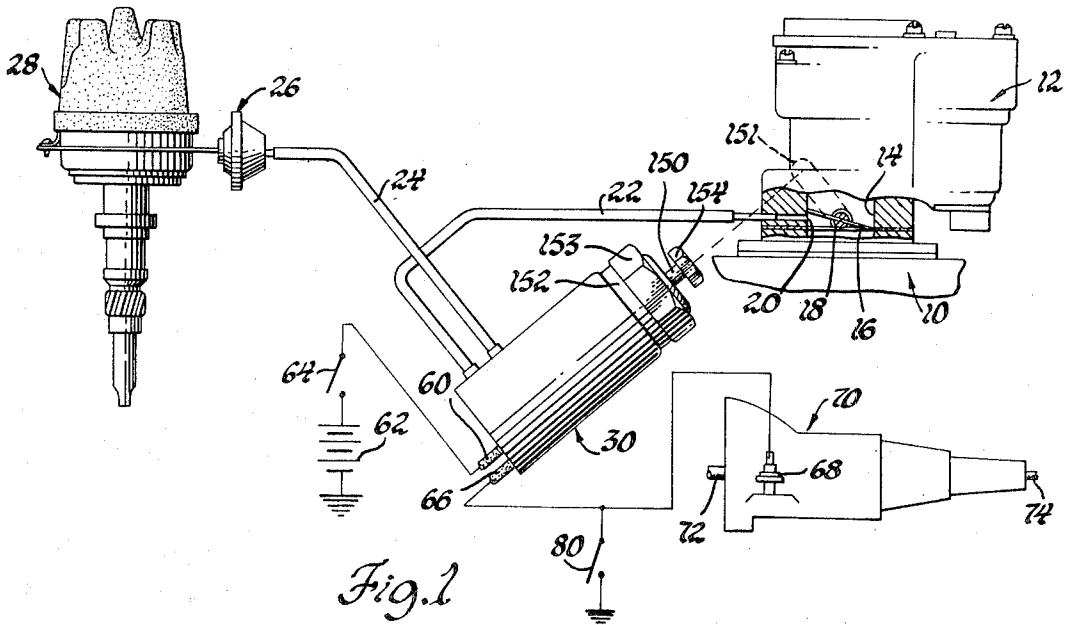
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#### ABSTRACT

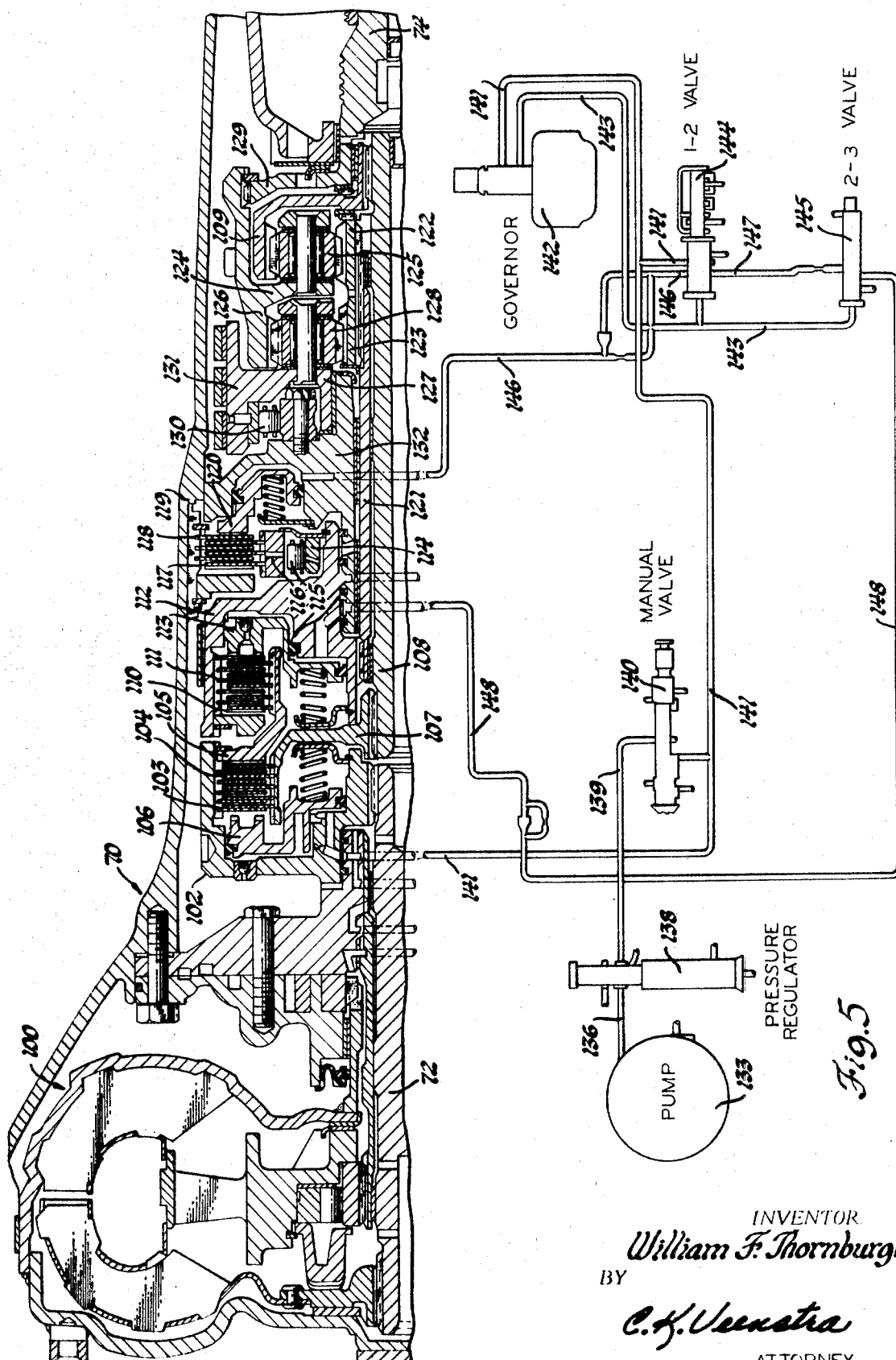
A solenoid is energized when the transmission is in high-drive ratio and is deenergized when the transmission is in the lower drive ratios or when the engine ignition system is shut off. A valve carried on the solenoid plunger closes the vacuum conduit between the induction passage and the distributor vacuum advance unit when the solenoid is deenergized to prevent vacuum advance during low-drive ratio operation and opens when the transmission is in high-drive ratio to permit vacuum advance during high-drive ratio operation. The solenoid plunger also carries a carburetor throttle stop which prevents closure of the carburetor throttle beyond a relatively fast idle position when the transmission is in high-drive ratio and which permits closure of the carburetor throttle to a relatively slow idle position when the transmission is in low-drive ratio or when the engine ignition system is shut off.

4 Claims, 5 Drawing Figures





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# IGNITION TIMING AND THROTTLE POSITION CONTROL

## SUMMARY OF THE INVENTION

This invention relates to control of internal-combustion engine ignition timing and throttle position which results in reduced emission of undesirable engine exhaust gas constituents.

In the past it has been customary to provide a vacuum unit in association with the ignition distributor of the engine. The vacuum unit senses the vacuum in the engine induction passage below the throttle and, operating on the distributor breaker plate, advances the ignition timing accordingly. By advancing ignition timing in accordance with induction vacuum, fuel economy and engine performance have been maximized.

More recently, emission of undesirable engine exhaust gas constituents, such as unburned hydrocarbons and oxides of nitrogen, have been substantially reduced by preventing vacuum advance of ignition timing when the engine is driving the vehicle in the lower drive ratios, while maintaining fuel economy and engine performance without significant sacrifice by providing vacuum advance of ignition timing only when the engine is driving in the high drive ratio. That control, known commercially as the Transmission Controlled Spark system, is accomplished by a solenoid valve disposed in the vacuum conduit between the induction passage and the distributor vacuum advance unit. The solenoid is energized through a switch when the transmission is in a low drive ratio mode of operation, and the valve then closes the vacuum conduit to prevent vacuum advance of the ignition timing. When the transmission is in the high drive ratio mode of operation, the solenoid is deenergized and the valve then opens the vacuum conduit to permit vacuum advance of the ignition timing.

Another feature adopted on recent engines has been an increase in idle airflow to improve combustion under high-speed closed throttle decelerating conditions. This increase is accomplished by limiting closure of the throttle to what may be termed a "fast idle" position. On some engines, however, the increased closed throttle airflow permits afterrun or dieseling of the engine after the engine ignition system is shut off.

To prevent dieseling, a solenoid operated throttle stop has been adopted. The solenoid is energized through the engine ignition switch and positions a throttle stop to limit throttle closure to the fast idle position. When the engine ignition system is shut off, the solenoid retracts the throttle stop to permit the throttle to close to a slow idle position. With the throttle in the slow idle position, airflow to the engine is insufficient to support dieseling and this undesirable mode of operation is avoided.

This invention provides a single solenoid control for both ignition timing and throttle position which advantageously combines the functions of the separate Transmission Controlled Spark and antidieseling solenoids in a single unit. Moreover, the control provided by this invention also functions to vary the closed position of the throttle with transmission drive ratio; thus increased airflow to the engine is provided during a closed throttle deceleration while the transmission is in the high drive ratio, and the throttle is permitted to close to a slow idle position for reduced idle speed after the transmission reaches the lower drive ratios.

The details as well as other objects and advantages of this invention are set forth in the drawings and description of a preferred embodiment.

## SUMMARY OF THE DRAWINGS

FIG. 1 shows, somewhat schematically, this ignition timing and throttle position control, with the solenoid valve disposed in the vacuum conduit between the induction passage and the distributor vacuum advance unit, with the solenoid throttle stop disposed adjacent the carburetor throttle lever, and with the solenoid winding connected through a switch which senses the transmission drive ratio;

FIG. 2 is an enlarged axial sectional view of the solenoid, showing the details of its construction;

FIG. 3 is a view along line 3—3 of FIG. 2, further enlarged to show the details of the solenoid plunger and its disposition within the spool;

FIG. 4 is an enlarged axial sectional view of the vacuum advance unit, showing the details of its construction; and

FIG. 5 is a sectional view, in side elevation, of the transmission of FIG. 1, illustrating its construction and schematically showing portions of its hydraulic circuitry.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the engine 10 is illustrated as having a carburetor 12 providing an induction passage 14. A throttle 16 is rotatably disposed on a shaft 18 in induction passage 14. A vacuum port 20 opens from induction passage 14 below throttle 16. Port 20 is connected through a conduit 22-24 to a vacuum advance unit 26 mounted on distributor 28. A solenoid control 30 is disposed in conduit 22-24.

Referring to FIG. 2, control 30 includes a spool 31 defining a central passage 32 terminating at one end in an opening 33 connected to conduit 22 and having a lateral opening 34 connected to conduit 24. Spool 31 is disposed within a case 35 and has a shield 36 disposed about one end. A member 37, staked to case 36 at 38, is disposed in the open end of central passage 32. A central opening 39 in member 37 leads through a urethane foam filter 40 to the atmosphere. A pair of valve seats 41 and 42 are defined about openings 33 and 39 respectively.

A magnetically responsive plunger 43 is disposed within passage 32 and is reciprocable between valve seats 41 and 42. As shown in FIG. 3, plunger 43 and passage 32 are essentially hexagonal. A plurality of grooves 45 defined in passage 32 form channels through which air at atmospheric pressure may be supplied from opening 39 to opening 34. Plunger 43 has a conical tip 46 and a flat end 47 which respectively cooperate with valve seats 41 and 42 to close either opening 33 or opening 39.

A solenoid coil 58 is wound about spool 31. As shown in FIG. 1, one lead 60 of coil 58 is connected to a voltage source 62 through the engine ignition switch 64. The other lead 66 for coil 58 is connected to a switch 68 which closes the circuit to ground when it senses the pressure of the hydraulic fluid used to engage the direct drive clutch in transmission 70 and which opens the circuit in the absence of such pressure. As explained in further detail below, transmission 70 includes a plurality of drive ratios which are selectively engageable between driven shaft 72 and drive shaft 74. When a lower drive ratio is engaged between driven shaft 72 and drive shaft 74, the speed of the drive shaft 74 is reduced below the speed of driven shaft 72 to a greater extent than when the high drive ratio is engaged between driven shaft 72 and drive shaft 74.

Referring to FIG. 4, vacuum advance unit 26 includes a diaphragm 76 biased in a direction to retard ignition timing by a spring 78. When vacuum signals are supplied through vacuum conduit 22-24 to vacuum advance unit 26, the vacuum signals are applied against the right-hand side of diaphragm 76 and pull it in a direction, against the bias of spring 78, to advance ignition timing.

With the solenoid 58 deenergized as shown in FIG. 2, a spring 79 pushes plunger 43 downwardly and tip 46 closes opening 33 to prevent transmission of vacuum signals from induction passage 14 to vacuum advance unit 26. Vacuum advance unit 26 is then vented to atmosphere through vacuum conduit 24, lateral opening 34, and passages 45 about plunger 43, between flat end 47 and valve seat 42, and through opening 39 and filter 40.

When transmission 70 is in high drive ratio, switch 68 will cause the solenoid coil 58 to be energized; magnetically responsive plunger 43 will then be lifted against the bias of spring 79 so that end 47 of plunger 43 engages valve seat 42 and tip 46 of plunger 43 moves away from valve seat 41. En-

gagement of end 47 with valve seat 42 closes off the atmospheric vent to vacuum advance unit 26. A vacuum signal is then transmitted from induction passage 14 through vacuum conduit 22, opening 33, valve seat 41, lateral opening 34, and vacuum conduit 24 to vacuum advance unit 26 to cause the ignition timing to be advanced.

If desired, port 20 may be located just above, rather than below, throttle 16 so that, when throttle 16 is moved to an open position, its edge traverses the port. Port 20 then would sense vacuum in induction passage 14 only when throttle 16 is open, and vacuum advance unit 26 then would advance the ignition timing only during open throttle operation in a high drive ratio; the ignition timing would not be advanced, for example, whenever throttle 16 were closed for deceleration even though transmission 70 momentarily remained in the high drive ratio mode of operation.

As shown in FIG. 1, solenoid 58 may be energized by a switch 80 independently of transmission controlled switch 68. With some engines, vacuum advance of ignition timing is desired at engine temperatures below a certain level, 82° F. for example, irrespective of the transmission drive ratio. This is achieved by closing switch 80 through a thermostat responsive to engine coolant temperature, thus energizing solenoid 58.

Similarly, with some engines vacuum advance of ignition timing is desired as engine coolant temperatures approach an upper limit, 220° F. for example. Switch 80 also may be closed under such conditions to energize solenoid 58 and permit vacuum advance of ignition timing.

Moreover, with some engines vacuum advance of ignition timing is desired for a certain time, 20 seconds for example, after the engine is started. For this purpose, switch 80 may be closed through a relay which times out after energization by a circuit, such as that responsive to engine oil pressure for example, which indicates when the engine has started to operate.

FIG. 5 illustrates certain details of transmission 70. Since transmission 70 is of well-known construction, as shown, for example, by the 1969 Oldsmobile Chassis Service Manual, and since it has been explained at length in U.S. Pat. No. 3,321,056, only certain portions are set forth and discussed here.

Transmission 70 has an input shaft 72 driven by the engine through a torque converter 100. A clutch housing 102 is splined to shaft 72 for rotation therewith. A series of clutch discs 103 and 104 are adapted to be engaged when forced against a backing member 105 by a piston 106. Clutch discs 103 are splined for axial movement on clutch housing 102, and clutch discs 104 are splined for axial movement on a clutch hub 107. Clutch hub 107 is splined to an intermediate shaft 108 for driving shaft 108 when discs 103 and 104 are engaged. A ring gear 109 is splined to shaft 108 for rotation therewith. A series of clutch discs 110 are splined for axial movement on an extension of clutch backing member 105. Clutch discs 110 are adapted to engage with a series of clutch discs 111, splined for axial movement on a clutch drum 112, when forced by a piston 113. Clutch drum 112 carries a race 114 adapted to be gripped by a one-way brake 115. A second race 116 is held against rotation upon engagement of a series of brake discs 117 with a series of brake discs 118. Brake discs 117 are splined for axial movement on race 116, and brake discs 118 are splined for axial movement on the transmission housing 119. Brake discs 117 and 118 may be engaged by a piston 120. Clutch drum 112 is splined to a sleeve shaft 121 which in turn is splined to a pair of sun gears 122 and 123. A planet carrier 124 supports a planet gear 125 in mesh with sun gear 122 and ring gear 109 and also supports a ring gear 126. A second planet carrier 127 supports a planet gear 128 in mesh with sun gear 123 and ring gear 126. Planet gear 124 and ring gear 126 rotate as a unit, with output shaft 74 connected to planet carrier 124 by a flange 129. A one-way brake 130 is disposed between a brake drum 131 and a fixed support 132.

In operation, low gear is obtained by engaging clutch discs 103 and 104. Power from input shaft 72 is delivered to ring gear 109 through clutch discs 103 and 104 and shaft 108 to

drive ring gear 109 forwardly. Due to the load of output shaft 74 on planet carrier 124, planet carrier 124 tends to remain stationary so that sun gears 122 and 123 are driven reversely. Power input to planet gear 128 from sun gear 123 tends to cause planet carrier 127 to spin but such rotation of planet carrier 127 is prevented by one-way brake 130. Planet gear 128 therefore drives ring gear 126 forwardly. In low gear, drive is at the compound reduction of both planetary gearing units.

Second gear is obtained by retaining clutch discs 103 and 104 in engagement and engaging brake discs 117 and 118. Through action of brake discs 117 and 118, one-way brake 115 is rendered effective to prevent reverse rotation of clutch drum 112 and sun gears 122 and 123. Power is applied to ring gear 109, sun gears 122 and 123 are held against rotation, and planet carrier 124 is driven forwardly at the reduction ratio of the gear unit 109, 125, 122. One-way brake 130 on planet carrier 127 releases to permit planet carrier 127 to spin freely.

Direct drive or high gear is obtained by retaining clutch discs 103 and 104 in engagement, retaining brake discs 117 and 118 in engagement, and engaging clutch discs 110 and 111. One-way brake 115 permits forward rotation of clutch drum 112 and drive of sun gears 122 and 123. Since both ring gear 109 and sun gear 122 are driven at the same speed, the gear unit 109, 125, 122 is locked up and drives planet carrier 124 in direct drive. Since planet carrier 124 and sun gear 123 are driven at the same speed, the gear unit 123, 128, 126 is locked up and drive of output shaft 74 is direct drive without gear reduction.

Fluid pressure for the control system is supplied by an engine driven pump 133. Oil is discharged under pressure from pump 133 through a passage 136 to a pressure regulator 138. A main line supply passage 139 extends from pressure regulator 138 to a manually operable drive range selector valve 140. With manual valve 140 in "drive" position, pressure is conducted from main line supply passage 139 to a drive passage 141. Drive passage 141 conducts pressure to clutch piston 106 which engages clutch discs 103 and 104; this places transmission 70 in low-gear operation.

A governor 142, driven by transmission output shaft 74 receives pressure from drive passage 141 and delivers variable pressure to a governor pressure delivery passage 143. The pressure in governor passage 143, which increases as vehicle speed increases, is conducted to a low gear to second gear (1-2) shift valve 144 and to a second gear to high gear (2-3) shift valve 145. At a predetermined vehicle speed, governor pressure causes 1-2 shift valve 144 to move to its upshift position and transmit pressure from drive passage 141 through a passage 146 to brake piston 120 which engages brake discs 117 and 118; this places transmission 70 in second gear operation. Upon a further increase in vehicle speed, governor pressure causes 2-3 shift valve 145 to move to its upshift position and transmit pressure, received through a passage 147 from 1-2 shift valve 144, through a passage 148 to clutch piston 113 which engages clutch discs 110 and 111; this places transmission 70 in direct drive or high gear operation.

As indicated above, switch 68 is responsive to pressure in passage 148. It will be appreciated, however, that switch 68 also could be responsive to a predetermined pressure in governor pressure delivery passage 143, or as another alternative, switch 68 could be mechanically operated by 2-3 shift valve 145.

It also will be appreciated that in a transmission where the drive ratio is changed manually rather than through the use of hydraulic pressure, switch 68 may be arranged to be operated by the transmission shift linkage rather than by hydraulic pressure.

As indicated, with the illustrated three-speed automatic transmission it has been found most advantageous to advance the ignition timing when the transmission is in the high gear—direct drive mode of operation and to prevent ignition timing when the transmission is in first and second gear—low and intermediate drive ratio modes of operation. With a two-speed

automatic transmission, it has been found advantageous to permit advanced ignition timing in the high drive ratio and to prevent advanced ignition timing in the low drive ratio. With a three-speed manual transmission, it has been found advantageous to permit advanced ignition timing in high gear and to prevent advanced ignition timing in first and second gear and when the clutch is disengaged. With a four-speed manual transmission, it has been found advantageous with some engines to limit advanced ignition timing to third and fourth gear operation and with other engines to limit advanced ignition timing to fourth gear operation. In some instances vacuum advance during reverse operation is also desirable.

Referring again to FIGS. 1 and 2, a carburetor throttle stop member 150 is threadedly received in plunger 43 and extends through central opening 39 adjacent a throttle lever 151 connected to throttle shaft 18. When solenoid 58 is energized during the high drive ratio mode of operation, stop member 150 is extended to engage throttle lever 151 and prevent throttle 16 from closing beyond a fast idle position. This permits the flow of air to the engine necessary for proper combustion when throttle 16 is initially closed to decelerate the engine. After transmission 70 downshifts to a lower drive ratio, solenoid 58 is deenergized and stop member 150 is retracted. Throttle 16 is then permitted to close to the slow idle position determined by the usual curb idle adjustment screw (not shown). In this position, airflow is limited to that required for proper idle operation.

Control unit 30 is mounted on a bracket 152 secured relative to carburetor 12 and is retained on bracket 152 by a nut 153. The head 154 of stop member 150 is formed to receive a wrench so that stop member 150 may be threadedly adjusted within plunger 43, the complementary hexagonal configurations of plunger 43 and passage 32 preventing plunger 43 from turning as stop member 150 is adjusted. Movement of stop member 150 relative to plunger 43 permits adjustment of the fast idle position of throttle 16 which is established by stop member 150.

Thus this control provides a fast idle carburetor throttle setting for high gear closed throttle deceleration with a slow idle carburetor throttle setting for engine operation at idle speed. Proper combustion is thereby enhanced during high-gear closed throttle deceleration while avoiding the increased fuel consumption and tendency toward dieseling attendant upon a fast idle throttle position for operation at idle speed. This novel control over throttle position is combined with control over ignition timing in a single control unit, thus reducing the complexity of assembly on an engine and assuring a reduction in emission of undesirable exhaust gas constituents.

It is possible that, with some engines, dieseling may occur even with throttle 16 in the slow idle position required for engine operation at idle speed. It is contemplated that control 30 may include an additional solenoid winding, energized through ignition switch 64, which will establish an intermediate position between full extension of stop member 150 and full retraction of stop member 150. Such a control would provide a fast idle throttle position for high-gear closed throttle deceleration, an intermediate throttle position for engine operation at idle speed, and a nearly closed throttle position to prevent sufficient airflow to support dieseling when the engine ignition system is shut off. It is further contemplated that such a control would include the valve structure necessary to control ignition timing in accordance with transmission drive ratio.

It also should be recognized that with some engines it may be desirable to energize switch 68 at a selected engine or vehicle speed instead of with a selected transmission drive ratio. The operation of control 30 would remain unchanged under such circumstances.

I claim:

1. In combination with an internal-combustion engine having an induction passage for airflow to the engine, a throttle in said induction passage for controlling airflow therethrough, said throttle having fast and slow idle positions, a throttle lever

connected to said throttle for controlling the position thereof, a vacuum unit for advancing the timing of ignition in said engine when vacuum signals are applied thereto, a vacuum conduit connected between said vacuum unit and said induction passage for transmitting vacuum signals from said induction passage to said vacuum unit, and an associated transmission with an input connected to said engine and an output connected to a load and with variable ratio drive means driving said output from said input, said variable ratio drive means providing high and low drive ratios wherein said low drive ratio reduces the speed of the output from the speed of the input to a greater extent than said high drive ratio:

an ignition timing and throttle position control comprising a hollow elongated housing having first and second openings respectively located in opposite ends thereof and having a lateral opening located intermediate the ends thereof, said first opening forming a portion of said vacuum conduit for receiving vacuum signals from said induction passage, said lateral opening forming a portion of said vacuum conduit for supplying vacuum signals to said vacuum unit, said second opening being connected to atmosphere for venting said vacuum unit thereto, said first and second openings defining valve seats, a magnetically responsive plunger disposed within said housing and reciprocable between said valve seats, a solenoid coil surrounding said housing, switch means energizing said coil when said high drive ratio is operative, energization of said coil causing said magnetically responsive plunger to disengage the valve seat defined by said first opening and to engage the valve seat defined by said second opening to thereby permit advance of ignition timing by said vacuum unit, said switch means deenergizing said coil when said low drive ratio is operative, a spring which upon deenergization of said coil moves said plunger to disengage the valve seat defined by said second opening and to engage the valve seat defined by said first opening to prevent advance of ignition timing by said vacuum unit, and a stop member carried by said plunger and extending through said second opening adjacent said throttle lever, energization of said coil causing extension of said stop member into engagement with said throttle lever to thereby prevent closure of said throttle beyond a certain position, said certain position defining said fast idle position, deenergization of said coil permitting said spring to cause retraction of said stop member out of engagement with said throttle lever to thereby permit closure of said throttle to said slow idle position.

2. The control of claim 1 wherein said stop member is adjustable with respect to said plunger whereby said fast idle position of said throttle may be varied.

3. In combination with an internal-combustion engine having an induction passage for airflow to the engine, a throttle in said induction passage for controlling airflow therethrough, said throttle having fast and slow idle positions, a throttle lever connected to said throttle for controlling the position thereof, an ignition system, and an associated transmission with an input connected to said engine and an output connected to a load and with variable ratio drive means driving said output from said input, said variable ratio drive means providing high and low drive ratios wherein said low drive ratio reduces the speed of the output from the speed of the input to a greater extent than said high drive ratio:

a solenoid operated throttle position control until comprising  
a magnetically responsive actuator,  
a stop member carried by said actuator and engageable with said throttle lever for controlling the idle position of said throttle,  
a coil surrounding said actuator,  
switch means energizing said coil when said ignition system is operating and said high drive ratio is operative to cause movement of said actuator and said stop member toward said throttle lever to thereby prevent closure of said throt-

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tle beyond said fast idle position, said switch means deenergizing said coil when said ignition system is not operating, or when said low drive ratio is operative, and a spring which is effective upon deenergization of said coil to move said actuator and said stop member away from said throttle lever to thereby permit closure of said throttle to said slow idle position.

4. In an internal-combustion engine having an induction passage for airflow to the engine, a throttle in said induction passage for controlling airflow therethrough, said throttle having fast and slow idle positions, an ignition system, and an associated transmission with an input connected to said engine and an output connected to a load and with variable ratio

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drive means driving said output from said input, said variable ratio drive means providing high and low drive ratios wherein said low drive ratio reduces the speed of the output from the speed of the input to a greater extent than said high drive ratio: the method of controlling said throttle which comprises the steps of

preventing closure of said throttle beyond said fast idle position when said ignition system and said high drive ratio are operating,

and permitting closure of said throttle to said slow idle position when wither said ignition system or said high drive ratio is not operating.

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