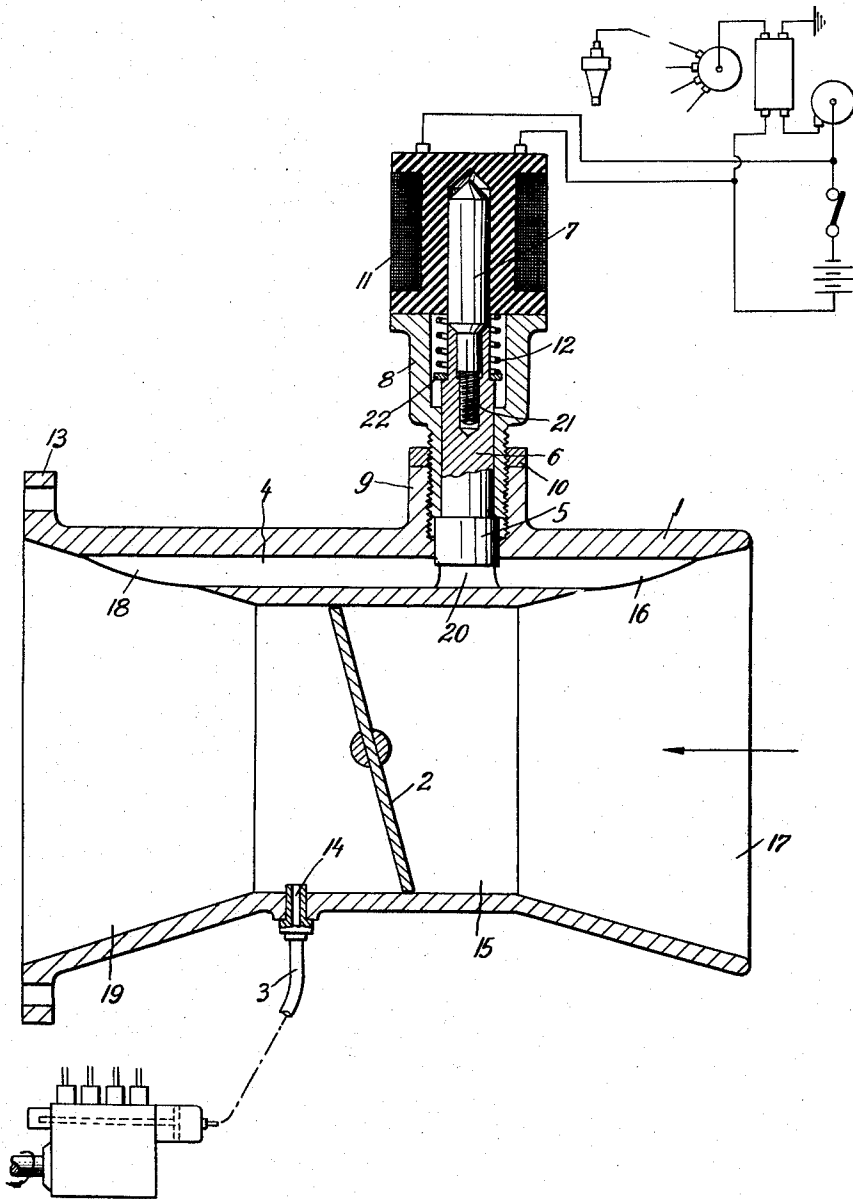


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AIR INLET CONTROL MECHANISM FOR AN INTERNAL COMBUSTION ENGINE

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My invention relates to an air inlet control mechanism for an internal combustion engine of the type in which fuel is injected into the air charge and is ignited upon subsequent compression by a spark plug.

In the operation of such machines it is an incident of frequent occurrence that when the operator desires to stop the engine and for this purpose turns off the electric current supply to the spark plug, the engine will continue to operate. This continued operation is due to automatic ignition of the charge in the cylinder by matter having a high temperature, such as glowing deposits of oil carbon or other incandescent material, which is likely to form because of the high ratio of compression and of the consequent high temperature of the compressed air charge.

It is the object of the present invention to provide means which prevent the engine from operating automatically after the current supply to the spark plug has been cut off. More particularly, it is the object of the present invention to provide an improved air inlet mechanism which will cut off the air supply to the engine completely coincidentally to the deenergization of the electrical ignition.

In a prior internal combustion engine of the carburetor type, it has been proposed to cut off the fuel supply within the carburetor to the auxiliary air duct bypassing the throttle valve so that the air sucked into the cylinder will no longer be carbureted (German Patent No. 905,803). This principle, however, is not readily applicable to engines of the injection type. An attempt of cutting off the fuel supply to the injection pump would not succeed in preventing the undesirable automatic operation of the engine because the injection pump would continue to inject fuel until its suction chamber would have been completely emptied. An attempt, however, to cut off the fuel supply to the injection nozzle by a valve interposed between such nozzle and the fuel injection pump would be impracticable because of the high fluid pressure of the fuel to be controlled by such valve or valves. Moreover, in a multi-cylinder engine as many of such valves would be required as cylinders are provided. While it would be possible to provide means operative upon deenergization of the electrical ignition to move the rod controlling the injection pump towards its zero feed position, such means would become rather complicated and voluminous because of the high power required to displace said rod.

Therefore, it is a further object of the present invention to provide improved means for positively stopping an internal combustion engine of the injection type upon deenergization of the electrical ignition, such means being capable of easy installation in existing engines and being simple and inexpensive to manufacture and being reliable in operation.

Further objects of my invention will appear from a detailed description of a preferred embodiment of the invention following hereinafter with reference to the draw-

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ing, it being understood that the terms and phrases used in such detailed description have been chosen for the purpose of illustrating the invention rather than that of restricting or limiting the same. The features of novelty for which patent protection is sought are pointed out in the appended claims.

In the drawing an axial section taken through the inlet pipe of an internal combustion engine having any desired number of cylinders is illustrated. The tubular valve housing 1 of a butterfly valve 2 has a flange 13 which is bolted to the inlet opening of a manifold connected to the inlet valves of an internal combustion engine of the injection type in which fuel is injected into the air charge in the cylinders and is ignited upon subsequent compression of the air charge by electrical spark plugs. The quantity of fuel injected is controlled by pressure-responsive means which act on the fuel injecting pump and are connected by a pipe 3 to a port 14 provided in the wall of the housing 1 between the butterfly valve member 2 and the flange 13. As such pressure-responsive control means are well known in the art and do not form subject matter of the present invention they are neither shown nor described. It will be understood, however, that when the butterfly valve 2 is moved to its closed position shown in the drawing, the pressure prevailing in the intake manifold will drop and the reduction of pressure will be communicated through port 14 and the pipe 3 to the pressure-responsive control means which will so adjust the fuel injecting pump as to reduce the quantity of fuel injected to the amount required for the idling operation of the engine. The air required to sustain the combustion during the idling operation is admitted to the intake manifold through an auxiliary air inlet duct 4 which bypasses the main air inlet duct 15 which is controlled and adapted to be completely closed by the butterfly valve 2. The auxiliary air inlet duct 4 extends from a bore 16 provided in the flaring mouth 17 of the main air inlet duct to the port 18 provided in the flaring discharge portion 19 of the valve housing 1.

The substantially cylindrical duct 4 is intersected by a cylindrical bore 20 of larger diameter. A cylindrical slide valve member 5 is guided in the bore 20 and is thus adapted in its lowermost position to completely close the duct 4. The bore 20 extends axially through a cylindrical boss 9 and its upper section of enlarged diameter is threaded to receive the threaded lower end of a sleeve 8 in which the reduced stem 6 of the cylindrical valve member 5 is slidably guided. A solenoid 11 is coaxially mounted on the sleeve 8 and surrounds a coaxially movable core member 7 which has a lower threaded stem 21 screwed into a threaded coaxial bore of the stem 6. Thus, the core member 7 is connected with the valve member 5 for common movement. A washer 22 seated on a shoulder of the stem 6 supports a helical spring 12 surrounding the upper portion of stem 6 and bearing against the lower face of the solenoid coil 11. A nut 10 engages the external threads of the sleeve 8 and bears upon the boss 9.

From the foregoing it will appear that the slide valve 5 is movable between a projected position in which it closes the auxiliary duct 4 and the retracted position shown in the drawing in which it opens the auxiliary duct to such an extent that the air required to sustain the combustion for the idling operation of the engine may pass therethrough. The spring 12 tends to move the slide valve 5 to the projected position in which the auxiliary duct 4 is closed but can be overcome by the attraction exerted by the solenoid coil 11 upon the core 7. The retracted position is determined by the cooperating stop faces provided at the bottom of the sleeve 8 and by the shoulder between the valve member 5 and the stem 6

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and is adjustable, after the nut 10 has been loosened, by rotation of sleeve 8. By a suitable control of its electrical circuit the electromagnetic mechanism 7, 11 which is effective to keep the auxiliary valve 5 open for operation of the engine, may be rendered ineffective for stopping the engine at the option of the operator by simple deenergization permitting the spring 12 to move the valve member 5 to projected closing position thus sealing the auxiliary duct 4. As the main air inlet duct is closed by the throttle valve 2 when the engine is set for idling operation, it will appear that by deenergization of the solenoid 11 the intake manifold of the engine will be completely sealed against the atmosphere thus stopping the engine.

The auxiliary valve 5, the spring 12 urging the auxiliary valve to its closing position, and the electromagnetic mechanism 7, 11 effective to keep the auxiliary valve open for operation of the engine and adapted to be optionally rendered ineffective for stopping the engine constitute a unit which is detachably mounted in the wall of the auxiliary air inlet duct 4 and may readily be assembled and disassembled and even applied to existing machines. Preferably, the solenoid 11 is controlled by suitable means which will energize the solenoid when the ignition is put in operation and will deenergize the solenoid 11 when the electrical ignition is cut off.

In internal combustion engines of the type in which fuel is injected into the air charge in the cylinder and is ignited upon subsequent compression of the air charge by spark plugs, it is a requirement that when the engine is set to idling operation the main throttle 2 is fully closed. Otherwise the pressure-responsive means connected to the pipe 3 and controlling the quantity of fuel injected would be adversely affected by air flowing past the main throttle valve 2. As the ignition is "on" during the idling operation of the engine, the solenoid 11 is energized. Therefore, the core 7 is attracted and the auxiliary valve 5 is in retracted position which is determined by adjustment of the sleeve 8. Depending on this adjustment, the auxiliary air inlet duct 4 is so throttled by the auxiliary valve 5 that the air admitted through the duct 4 is just sufficient to sustain the combustion required for the idling operation.

When the operator wishes to stop the engine he will turn off the ignition whereby the solenoid 11 will be deenergized at the same time permitting the spring 12 to close the valve 5 thus completely shutting off any air from the intake manifold of the engine. Where it is desired to apply the invention to existing machines the sleeve 8 and the elements carried thereby are substituted for the conventional regulating screw serving the purpose of adjusting the idling speed of the engine.

While the invention has been described in connection with a preferred embodiment thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains, and as fall within the scope of the invention or the limits of the appended claims.

What I claim is:

1. In an internal combustion engine having an electrical ignition system of the type in which fuel is injected into the air charge in the cylinder and is ignited upon subsequent compression of the air charge by a spark plug, the combination comprising a main air inlet duct provided with a throttle valve adapted to control said air charge and to completely close said main duct for idling operation, an auxiliary air inlet duct bypassing said main air inlet duct and dimensioned to admit a quantity of air sufficient to sustain combustion for idling power when said valve is closed, an auxiliary valve for restricting said auxiliary duct, means urging said auxiliary valve

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to its closing position, and means effective to keep said auxiliary valve open for operation of the engine and adapted to be optionally rendered ineffective for stopping the engine.

2. The combination claimed in claim 1 further comprising means for adjusting the open position of said auxiliary valve to thereby adjust the idling speed of the engine.

3. The combination claimed in claim 1 in which said auxiliary valve and both of said means constitute a unit detachably mounted in the wall of said auxiliary air inlet duct.

4. In an internal combustion engine of the type in which fuel is injected into the air charge in the cylinder and is ignited upon subsequent compression of the air charge by a spark plug, the combination comprising a main air inlet duct provided with a throttle valve adapted to control said air charge and to completely close said main duct for idling operation, an auxiliary air inlet duct bypassing said main air inlet duct and dimensioned to admit a quantity of air sufficient to sustain combustion for idling power when said valve is closed, a sleeve, the wall of said auxiliary air inlet duct being provided with a bore accommodating said sleeve, a slide valve having a stem guided in said sleeve and movable therein between a projected position in which it closes said auxiliary duct and a retracted position in which it opens said auxiliary duct, an electromagnet carried by said sleeve and adapted to attract said stem to thereby move said slide valve to said retracted position, a spring acting on said stem to move said slide valve to said projected position, cooperating stop faces being provided on said valve and said sleeve to determine said retracted position, and means for adjusting said sleeve relative to said auxiliary duct.

5. In an internal combustion engine as set forth in claim 1, wherein said means effective to keep said auxiliary valve open for operation of the engine comprises an electromagnetic mechanism which includes a solenoid directly connected to and controlled by said electrical ignition system in such a manner that said solenoid is energized when said electrical ignition is put in operation and is deenergized when said electrical ignition is cut off.

6. In an internal combustion engine having an igniting means for igniting a combustible charge during normal operation of the engine, in combination, an intake manifold, valve means in said manifold for controlling the flow of air therethrough, said valve means having an idling position providing a flow of air from the upstream to the downstream side of said valve means sufficient for idling of the engine, control means communicating with said intake manifold downstream of said valve means for controlling the supply of fuel in accordance with the pressure is said manifold downstream of said valve means, and means for cutting off the supply of air to the downstream side of said valve means when the ignition of the engine is turned off.

7. In an internal combustion engine having an igniting means for igniting a combustible charge during normal operation of the engine, in combination, an intake manifold, valve means in said manifold for controlling the flow of air therethrough, said valve means having an idling position providing a flow of air from the upstream to the downstream side of said valve means sufficient for idling of the engine, control means communicating with said manifold downstream of said valve means for controlling the supply of fuel in direct proportion to the pressure in said manifold downstream of said valve means, and means for cutting off the supply of air downstream of said valve means when the igniting means of the engine is turned off to reduce the pressure in the manifold downstream of said valve means suddenly and to cut off the supply of fuel when the igniting means is turned off as a result of the reduction in pressure downstream of said valve means.

8. In an internal combustion engine having an igniting

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means for igniting a combustible charge during normal operation of the engine, in combination, an intake manifold, valve means in said manifold for controlling the flow of air therethrough, said valve means having an idling position providing a passage for flow of air from the upstream to the downstream side of said valve means sufficient for idling of the engine, control means communicating with said manifold downstream of said valve means for controlling the supply of fuel in direct proportion to the pressure in said manifold downstream of said valve means, and means actuating said valve means for cutting off the supply of air downstream of said valve means when the igniting means of the engine is turned off to reduce the pressure in the manifold downstream of said valve means suddenly and to cut off the supply of fuel when the igniting means is turned off as a result of the reduction in pressure downstream of said valve means, said valve means closing said passage for the flow of air to the downstream side of said valve means when the ignition is turned off and only while the engine continues to operate.

9. In an internal combustion engine having an igniting means for igniting a combustible charge during normal operation of the engine, in combination, an intake manifold, a valve in said intake manifold for controlling the flow of air therethrough, said valve having a position completely closing said manifold during idling of the engine, bypass means bypassing said valve for providing a flow of air from the upstream to the downstream side of said valve when the latter is in its idling position sufficient for idling purposes; control means communicating with said manifold downstream of said valve for supplying fuel in direct proportion to the pressure in the manifold downstream of said valve; a second valve movable to and from a closing position extending across and closing said bypass means to cut off the supply of air to the downstream side of said first valve, and means for locating said second valve in said closing position thereof when the igniting means is turned off so as to cut off the supply of fuel due to the great reduction in pressure in the manifold downstream of said first valve therein, said means for locating said second valve in said closing position thereof when the igniting means is turned off locating said second valve out of the closing position thereof when the igniting

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means is turned on to open the bypass means during normal operation of the engine.

10. In an internal combustion engine having an igniting means for igniting a combustible charge during normal operation of the engine, in combination, an intake manifold, a valve in said intake manifold for controlling the flow of air therethrough, said valve having a position completely closing said manifold during idling of the engine, bypass means bypassing said valve for providing a flow of air from the upstream to the downstream side of said valve when the latter is in its idling position sufficient for idling purposes, control means communicating with said manifold downstream of said valve for supplying fuel in direct proportion to the pressure in the manifold downstream of said valve, a second valve movable to and from a closing position extending across and closing said bypass means to cut off the supply of air to the downstream side of said first valve, and means for locating said second valve in said closing position thereof when the igniting means is turned off so as to cut off the supply of fuel due to the great reduction in pressure in the manifold downstream of said first valve therein, said means for locating said second valve in said closing position thereof when the igniting means is turned off locating said second valve out of the closing position thereof when the igniting means is turned on to open the bypass means during normal operation of the engine, said second valve being in the form of an armature of a solenoid which is spring loaded to move to its closing position when the solenoid is unenergized and said means for moving said second valve being in the form of the coil of the solenoid and an electrical circuit for energizing the coil when the igniting means is energized and for de-energizing the coil when the igniting means is unenergized.

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