

May 14, 1957

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2,791,995

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Filed Feb. 15, 1954

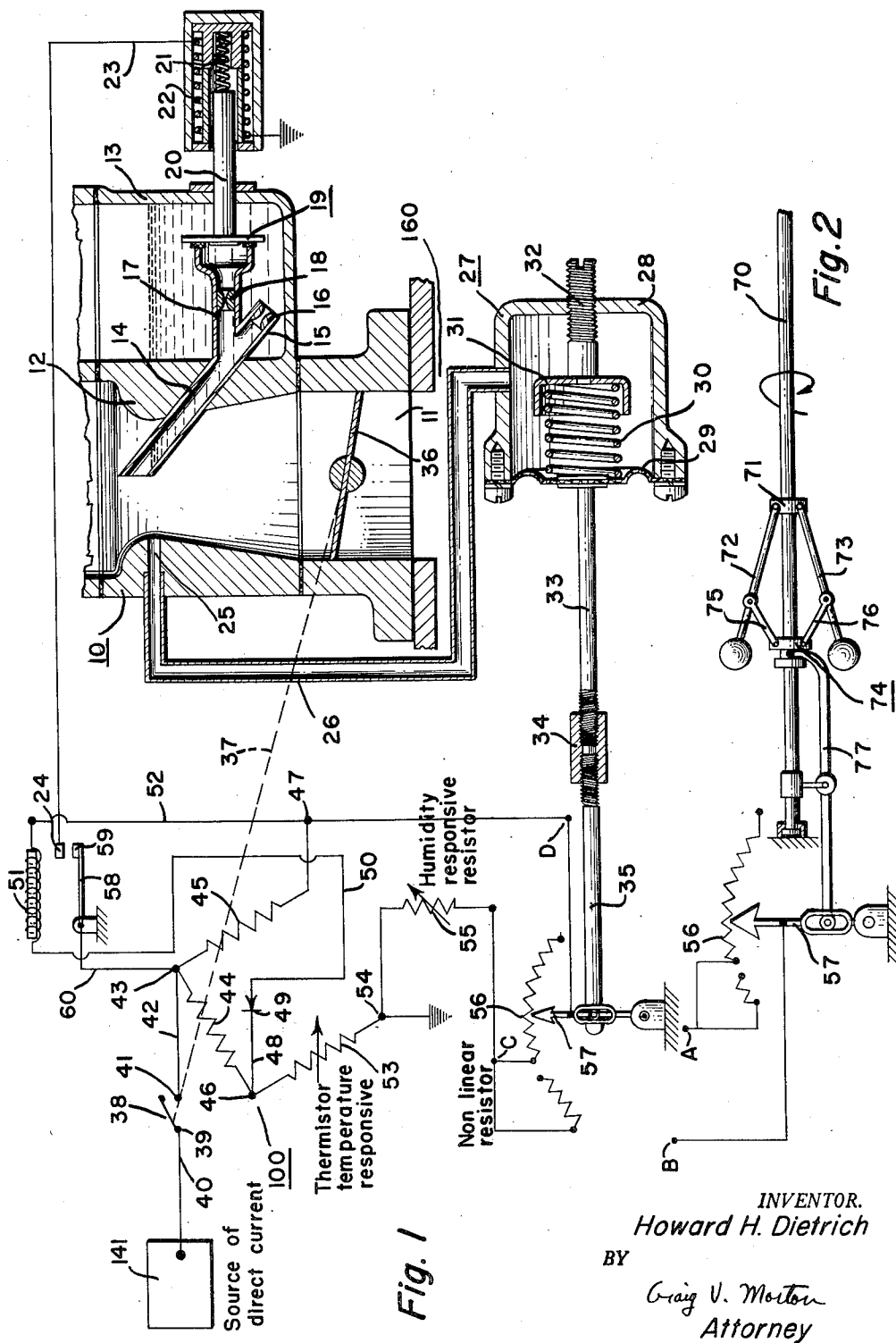


Fig. 1

Fig. 2

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ANTI-DETONATION DEVICE FOR A CARBURETOR

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Application February 15, 1954, Serial No. 410,284

16 Claims. (Cl. 123-119)

This invention pertains to means for preventing destructive detonation in internal combustion engines, and particularly to means for automatically sensing incipient detonation and, thereafter, preventing the occurrence of destructive detonation.

If the present trend of increasing the compression ratios of automobile engines continues, the problem of destructive detonation will become of major importance. Detonation, as referred to hereinafter, is defined as the conditions attendant with uncontrolled flame propagation after ignition, i. e. self-ignition. It has been determined that heavy detonation for as long as five seconds could conceivably destroy an engine. Accordingly, it would seem that the provision of some means for preventing destructive detonation is necessary. Heretofore, it has been suggested that detonation could be prevented by manually enriching the mixture ratio during times of maximum engine output. This invention relates to means for automatically sensing incipient detonation, and, thereafter, automatically enriching the mixture ratio so as to preclude destructive detonation. Accordingly, among my objects are the provision of means for sensing incipient detonation; the further provision of means for automatically enriching the mixture ratio when the conditions are such that detonation is likely to occur; and the still further provision of a carburetor including the aforementioned anti-detonation means.

The aforementioned and other objects are accomplished in the present invention by providing means responsive to engine speed, or air flow, through the carburetor, for controlling the operation of the enrichment means at predetermined throttle positions. Specifically, the device incorporates means within the carburetor for enriching the air fuel mixture, which means are controlled by four parameters, namely: throttle position; intake passage mixture temperature; humidity of intake mixture; and either engine speed or airflow through the carburetor. It has been determined that detonation is a function of the aforementioned parameters in any given engine.

The specific mechanism includes a solenoid controlled fuel valve which is disposed in the float chamber of a carburetor. The valve controls an orifice for admitting fuel to the carburetor venturi so as to enrich the air fuel mixture passing therethrough. The electric circuit for controlling energization of the solenoid valve includes a bridge circuit, a throttle position controlled switch, and a relay, having electrical connection with the bridge circuit, responsive to unidirectional unbalanced current flows therethrough.

Two legs of the bridge circuit are comprised by resistors of fixed ohmic value. A third leg includes a thermistor, the ohmic value of which varies with the temperature of intake manifold air-fuel mixture. The fourth leg of the bridge includes a non-linear variable resistor, the ohmic value of which is controlled by either engine speed or the carburetor venturi pressure, and a variable resistor, the ohmic value of which changes with the moisture content of the intake mixture. The throttle controlled

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switch energizes the bridge from a power source whenever the throttle valve is moved to, or past, a predetermined position. Accordingly, when the bridge circuit is unbalanced in one direction, i. e. sensing incipient detonation, the relay and solenoid will be energized, thereby enriching the air fuel mixture.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

Fig. 1 is a schematic illustration of the anti-detonating device of this invention with the variable non-linear resistor being controlled by venturi depression.

Fig. 2 is a fragmentary view illustrating a modification wherein the variable non-linear resistor is controlled by a speed sensitive device.

With particular reference to Fig. 1, the invention is shown in conjunction with a carburetor 10 having a throttle controlled outlet passage 11. According to conventional practice, the carburetor includes a venturi 12 and a float controlled fuel chamber 13. The fuel chamber 13 and the throat of the venturi 12 are interconnected by a nozzle and tube 14 having a Y connection submerged within the fuel chamber. One leg 15 of the Y carries a metered main fuel orifice 16 through which fuel may be admitted from the fuel reservoir to the venturi throat, in the conventional manner. The other leg 17 contains a metered auxiliary orifice 18. However, communication between the orifice 18 and the fuel chamber is controlled by a solenoid operated valve 19.

The solenoid operated valve 19 includes a plunger 20 which is biased by means of a spring 21 so that the valve is normally closed. A portion of the plunger 20 is encompassed by a solenoid winding 22, which is connected by a wire 23 to a relay contact 24. The other end of the solenoid winding 22 is connected to ground, as shown in Fig. 1. It will be appreciated that whenever the solenoid winding 22 is energized, the plunger 20 will move to the right, as viewed in Fig. 1, whereupon metered orifice 18 will be connected to the fuel chamber so that air flowing through the venturi 12 may pick up fuel from the nozzle through both orifices 16 and 18. In this manner, the mixture ratio passing through the carburetor outlet 11 to the engine intake passage 160 will be enriched.

The carburetor 10 is also formed with a passage 25 having connection with the throat of the venturi 12. Accordingly, this passage 25 will be responsive to venturi depression, or in other words, the air flow through the carburetor to the engine. As shown in Fig. 1, the passage 25 is connected by a tube 26 to a suction motor 27. The suction motor 27 comprises a housing 28, the open end of which is closed by a flexible diaphragm 29. The diaphragm constitutes a one seat for a coiled spring 30, the other end of the spring 30 being seated in a cup-shaped member 31, which is carried by a stud 32 having threaded connection with the housing 28. The spring 30 exerts its force on the diaphragm 29 in a manner tending to move the diaphragm to the left, as viewed in Fig. 1. The stud 32 may be rotated so as to regulate the amount of force which spring 30 exerts upon the diaphragm 29. The tube 26 communicates with the interior of housing 28, thereby subjecting the inner surface of diaphragm 29 to venturi depression, while the outer surface of the diaphragm 29 is subjected to atmospheric air pressure. The diaphragm 29 is connected to a rod 33, which is, in turn, connected through an adjustable coupling 34 to a rod 35.

The carburetor 10, in the usual manner, carries a pivotally supported throttle valve 36. The throttle valve 36 either actuates directly, or is connected by mechanical linkage 37 to a switch 38, the arrangement being such

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that the contacts of switch 38 are moved to the closed position and retained therein whenever the throttle valve 36 is moved to and beyond a predetermined angular position. The particular angular position, at which the throttle valve 36 will close the switch 38 will, of course, vary with different engines. In the present invention, it will be assumed that the throttle valve 36 will close the switch 38 whenever the throttle is opened 70°, or more.

One contact 39 of the switch 38 is connected by a wire 40 to a direct current source 141, which may be constituted by an automobile storage battery. The other contact 41 of the switch 38 is connected by a wire 42 to a terminal 43. The terminal 43 forms part of a bridge circuit indicated generally by the numeral 100. The bridge 100 includes four legs, two of the legs including resistors of fixed equal, ohmic value 44 and 45, respectively. The resistor 44 is connected between bridge terminals 43 and 46, while the resistor 45 is connected between bridge terminals 43 and 47. The bridge terminal 46 is connected by a wire 48 through a rectifier 49, which may be either of the copper oxide or germanium diode type, to a wire 50, which is connected with one end of a relay winding 51. The rectifier only permits current flow from bridge terminal 47 to bridge terminal 46. The other end of the relay winding 51 is connected by a wire 52 to bridge terminal 47.

The third leg of the bridge 100 includes a thermistor 53. The ohmic value of the thermistor 53 varies with the temperature of the mixture in the intake passage of the engine 160. Moreover, the thermistor is preferably of the type having a negative temperature coefficient, i. e. the ohmic value decreases as the temperature increases. One end of the thermistor 53 is connected to the bridge terminal 54 which is connected to ground.

The fourth leg of the bridge 100 includes a resistor 55, the ohmic value of which varies with the amount of moisture in the intake passage mixture. Specifically, the resistor 55 may be considered as being humidity responsive, in that its resistance decreases with an increase in the humidity of the intake air fuel mixture. The fourth leg of the bridge also includes a non-linear variable resistor 56, the movable contact 57 of which is controlled by rod 35. The resistor 56 is shown divided and with an open circuit to illustrate its non-linear characteristic. The component resistors of the fourth bridge leg are connected between bridge terminals 54 and 47, as shown in Fig. 1.

As those skilled in the art will be cognizant of, current will only flow between bridge terminals 46 and 47 when the bridge is unbalanced. That is, current will only flow when a potential difference exists between terminals 46 and 47. The non-linear variable resistor 56 permits mixture enrichment in various ranges of air flow and prevents enrichment between the aforementioned ranges. Thus, in conformity with engine knock characteristics, mixture enrichment is permitted between 1200 to 2400 R. P. M., prevented during intermediate engine speeds and permitted at higher engine speeds. The relay 51 includes a movable armature 58 having a contact 59 adapted to be moved into engagement with contact 24, whenever the relay coil 51 is energized. The armature 58 is electrically connected by a wire 60 to bridge terminal 43, and, thence, through the switch 38 to the D. C. power supply 141.

It has been determined that detonation in any given internal combustion engine is a function of four variables, namely: intake passage mixture temperature; intake passage mixture humidity; throttle position; and either engine speed, or air flow, through the carburetor or engine. The present invention utilizes all four parameters for sensing incipient detonation. Moreover, by employing a bridge 100, it will be appreciated that the operation of the sensing system will not change with variation in the electrical potential of the source 141.

With reference to Fig. 2, a modified embodiment of the present invention is disclosed wherein engine speed,

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as a parameter, has been substituted for venturi depression. In the embodiment of Fig. 2, the shaft 70 is rotated by the engine, not shown. The shaft has attached thereto an annular member 71 having pivotally attached thereto flyweights 72 and 73. The flyweights 72 and 73 are also pivotally interconnected with a yoke 74 by means of arms 75 and 76. The yoke 74 is adapted for sliding movement along shaft 70, in response to pivotal movement of the flyweights 72 and 73 about the member 71. The yoke 74 receives a sliding rod 77, which, as shown, is connected to the movable contacts 57 of the variable non-linear resistor 56, which would be connected at points A and B to points C and D, respectively, in the bridge circuit of Fig. 1.

Operation

The anti-detonation device operates as follows. When the engine, not shown, is operating with the throttle valve 36 at a position less than the predetermined position, i. e. 70° opening, the contacts 39 and 41 of the switch 38 will be separated, and, accordingly, the bridge sensing circuit will be deenergized. However, as soon as the throttle valve 36 is moved to an open position of 70° or greater, the switch 38 will be closed, thereby energizing the bridge 100. When the bridge is energized, it may be either in a balanced or an unbalanced condition depending upon engine conditions. Thus, the ohmic value of non-linear resistor 56 is controlled by the suction motor 27 in Fig. 1 and by the flyweights 72 and 73 in Fig. 2. Moreover, in either embodiment, the ohmic values of the thermistor 53 and the humidity responsive resistor 55 are determined by the semi-instantaneous condition of the fuel mixture in the intake passage. If the bridge 100 is unbalanced with terminal 47 having a greater positive potential than terminal 46, current will flow through the rectifier 49 and through the relay winding 51 to the terminal 46. In this manner, the relay winding 51 will be energized whereupon contact 59 will be moved into engagement with contact 24, and solenoid 22 will be energized. Thus, the valve 19 will be moved to an open position, whereupon the mixture ratio passing through the carburetor is enriched. These conditions prevail when the electrical bridge 100 senses incipient detonation. The enriched fuel mixture will have an anti-knocking effect and tend to prevent excessive pressures in the cylinders.

It should be noted that if the bridge 100 is unbalanced so that if point 46 is at a greater positive potential than point 47, the relay winding 51 will not be energized, inasmuch as the rectifier 49 only permits current flow in the opposite direction between terminals 47 and 46.

The bridge circuit will sense incipient engine detonation in the following manner, if the several parameters are considered individually. The thermistor 53, which is responsive to the temperature of the intake passage mixture, will sense incipient detonation, or knock, and as the temperature increases, the ohmic value of the thermistor decreases. Thus, the bridge circuit 100 will be affected by a temperature increase since the potential of terminal 46 will approach ground potential. In this manner, current will flow from terminal 47 to terminal 46, which current flow is permitted by the rectifier 49, and the relay 51 will be energized. Similarly, as venturi pressure decreases with increased engine speed, the diaphragm 29 will move to the right, in Fig. 1, and the yoke 74 will move to the right, in Fig. 2, with an increase in engine speed. Accordingly, additional resistance 56 will be introduced into the bridge leg between terminals 47 and 54 as engine speed increases. This will have the desired effect of increasing the potential of terminal 47 thereby causing current flow in the same direction as that of an increase in temperature on the thermistor 53.

The arm 57 of the resistor 56 will be in the open circuit position of the non-linear resistor 56 between engine speeds of 1200 to 2400 R. P. M., thereby introducing an infinite resistance in the bridge leg between termi-

nals 47 and 54 to cause a current flow between terminals 47 and 46 irrespective of the other parameters of detonation. Thus, when the arm 57 is in the open circuit position, the relay 51 will be energized and the mixture will be enriched if the throttle is in a position where switch 38 is closed.

The humidity responsive resistor 55 decreases in ohmic value as the humidity of the intake passage mixture increases. Thus, if the humidity of the intake passage mixture is high, the resistor 55 may prevent an unbalanced bridge condition even though the mixture temperature or engine speed is in the critical range, since high humidity tends to prevent detonation or engine knocking. Moreover, at engine speeds above 2400 R. P. M., the ohmic value of the resistance 56 introduced into bridge leg between terminals 47 and 54 increases proportionally.

From the foregoing it is manifest that the present invention provides automatic means for sensing incipient detonation, which means are automatically operable to effect enrichment of the combustible mixture.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. The combination with an internal combustion engine having an intake passage and a carburetor, said carburetor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through said mixture passage, an energizing circuit for said solenoid responsive to incipient engine detonation, and means conditioning the energizing circuit for operation when said throttle valve is at a predetermined position.

2. The combination with an internal combustion engine having an intake passage and a carburetor, said carburetor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through said mixture passage, an energizing circuit for said solenoid including a relay, an electrical circuit responsive to incipient engine detonation and controlling the energization of said relay, and means for conditioning said electrical circuit for operation when said throttle valve is at a predetermined open position.

3. The combination set forth in claim 2 wherein the last recited means comprises a throttle valve controlled switch.

4. The combination set forth in claim 2 wherein the sensing means comprises a bridge circuit.

5. The combination set forth in claim 2 wherein said sensing circuit comprises a bridge circuit, and wherein said relay is electrically connected across said bridge so as to be energized by a certain unbalanced condition thereof.

6. The combination set forth in claim 5 wherein said bridge circuit includes a variable resistance element, the ohmic value of which is controlled by venturi depression.

7. The combination with an internal combustion engine having an intake passage and a carburetor, said car-

buretor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through said mixture passage, an energizing circuit for said solenoid including a relay, an electrical circuit responsive to incipient engine detonation for controlling the energization of said relay, said circuit comprising a bridge circuit, said relay being electrically connected across said bridge so as to be energized by a certain unbalanced condition thereof, and means for conditioning said bridge circuit for operation when said throttle valve is at a predetermined open position, said bridge circuit including a variable resistance element, the ohmic value of which is controlled by engine speed.

8. The combination with an internal combustion engine having an intake passage and a carburetor, said carburetor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through said mixture passage, an energizing circuit for said solenoid including a relay, an electrical circuit responsive to incipient engine detonation for controlling the energization of said relay, said circuit comprising a bridge circuit, said relay being electrically connected across said bridge so as to be energized by a certain unbalanced condition thereof, and means for conditioning said bridge circuit for operation when said throttle valve is at a predetermined open position, said bridge circuit including a plurality of resistors, the ohmic value of one resistor varying with the temperature of the mixture in the intake passage of said engine, the ohmic value of another resistor being dependent upon the humidity of the mixture in said intake passage.

9. The combination with an internal combustion engine having an intake passage and a carburetor, said carburetor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through said mixture passage, an energizing circuit for said solenoid including a relay, an electrical circuit responsive to incipient engine detonation for controlling the energization of said relay, said circuit comprising a bridge circuit, said relay being electrically connected across said bridge so as to be energized by a certain unbalanced condition thereof, and means for conditioning said bridge circuit for operation when said throttle valve is at a predetermined open position, said bridge circuit including a plurality of resistors, the ohmic value of one resistor being controlled by engine speed, the ohmic value of another resistor varying with the temperature of the mixture in the engine intake passage.

12. The combination with an internal combustion engine having an intake passage and a carburetor, said carburetor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through said mixture passage, an energizing circuit for said solenoid including a relay, an electrical circuit responsive to incipient engine detonation for controlling the energization of said relay, said circuit comprising a bridge circuit, said relay being electrically connected across said bridge so as to be energized by a certain unbalanced condition thereof, and means for conditioning said bridge circuit for operation when said throttle valve is at a predetermined open position, said

15. The combination with an internal combustion engine having an intake passage and a carburetor, said carburetor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through

said mixture passage, an energizing circuit for said solenoid including a relay, an electrical circuit responsive to incipient engine detonation for controlling the energization of said relay, said circuit comprising a bridge circuit, said relay being electrically connected across said bridge so as to be energized by a certain unbalanced condition thereof, and means for conditioning said bridge circuit for operation when said throttle valve is at a predetermined open position, said bridge circuit including a variable resistance element, the ohmic value of which is dependent upon the humidity of the mixture in said engine intake passage.

16. The combination with an internal combustion engine having an intake passage and a carburetor, said carburetor having a mixture passage formed with a venturi, a throttle valve in said mixture passage for controlling communication between the mixture passage and the intake passage, a fuel reservoir, a fuel nozzle disposed in said venturi and a main fuel orifice for admitting fuel from said reservoir to said nozzle; of means for preventing destructive detonation in said engine comprising, an auxiliary fuel orifice for admitting fuel to said nozzle, a valve for controlling communication between said fuel reservoir and said auxiliary orifice, a solenoid for opening said valve so as to enrich the mixture flowing through said mixture passage, an energizing circuit for said solenoid including a relay, an electrical circuit responsive to incipient engine detonation for controlling the energization of said relay, said circuit comprising a bridge circuit, said relay being electrically connected across said bridge

so as to be energized by a certain unbalanced condition thereof, and means for conditioning said bridge circuit for operation when said throttle valve is at a predetermined open position, said bridge including a variable resistance element, the ohmic value of which is dependent upon the temperature of the mixture in said engine intake passage.

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