Jan. 31, 1967 C. R. WOODBURN 3,301,245

FUEL CONTROL MEANS

Filed June 25, 1964 2 Sheets-Sheet 1

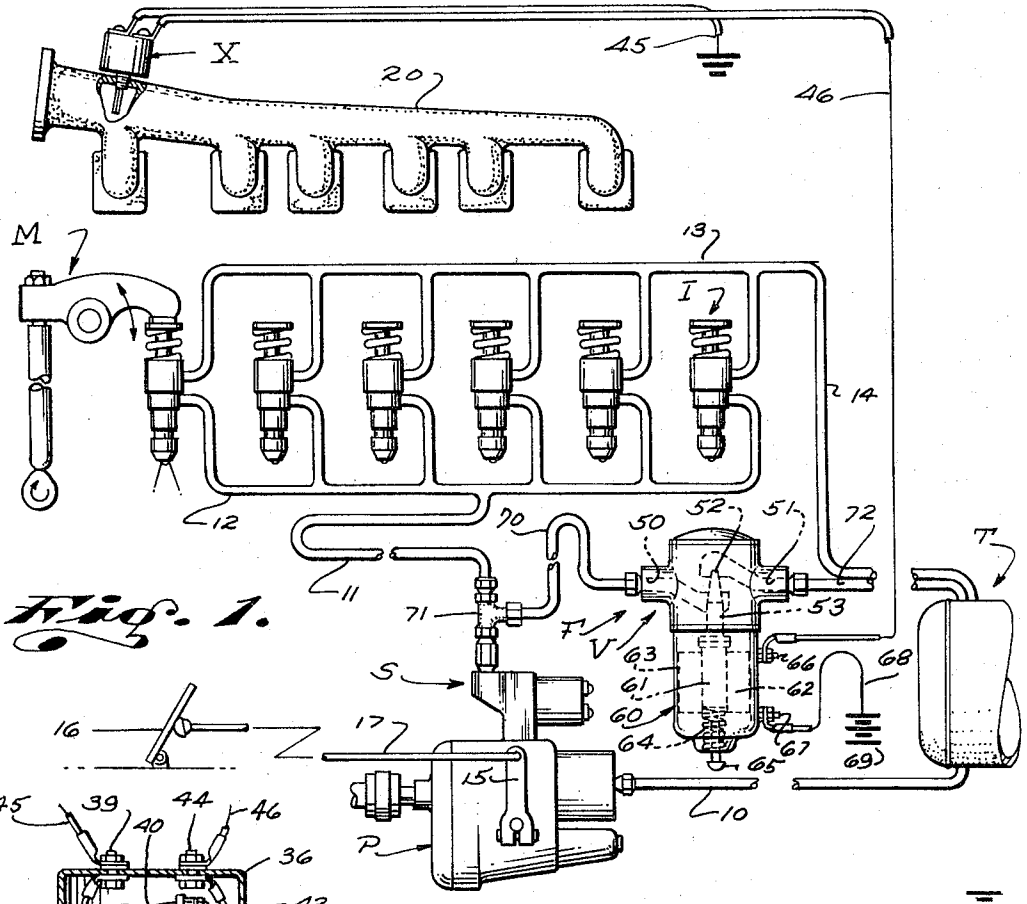


Fig. 1.

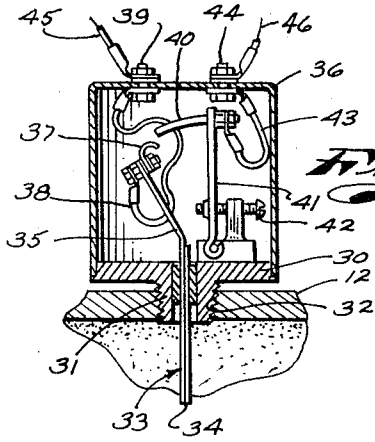


Fig. 2.

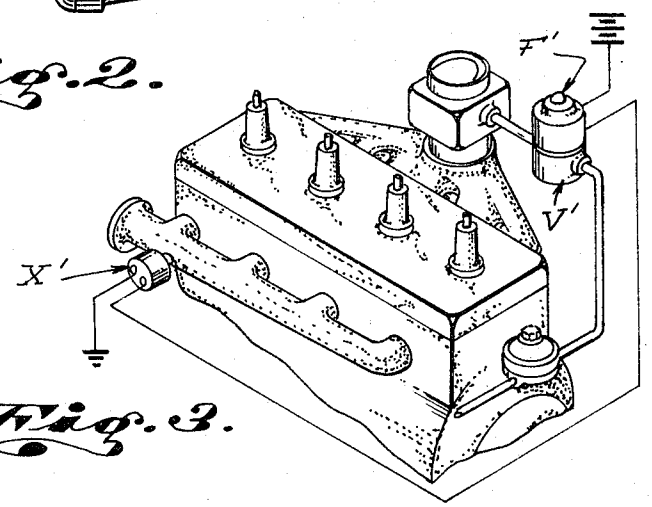


Fig. 3.

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Jan. 31, 1967 C. R. WOODBURN 3,301,245

FUEL CONTROL MEANS

Filed June 25, 1964 2 Sheets-Sheet 2

Fig. 4.

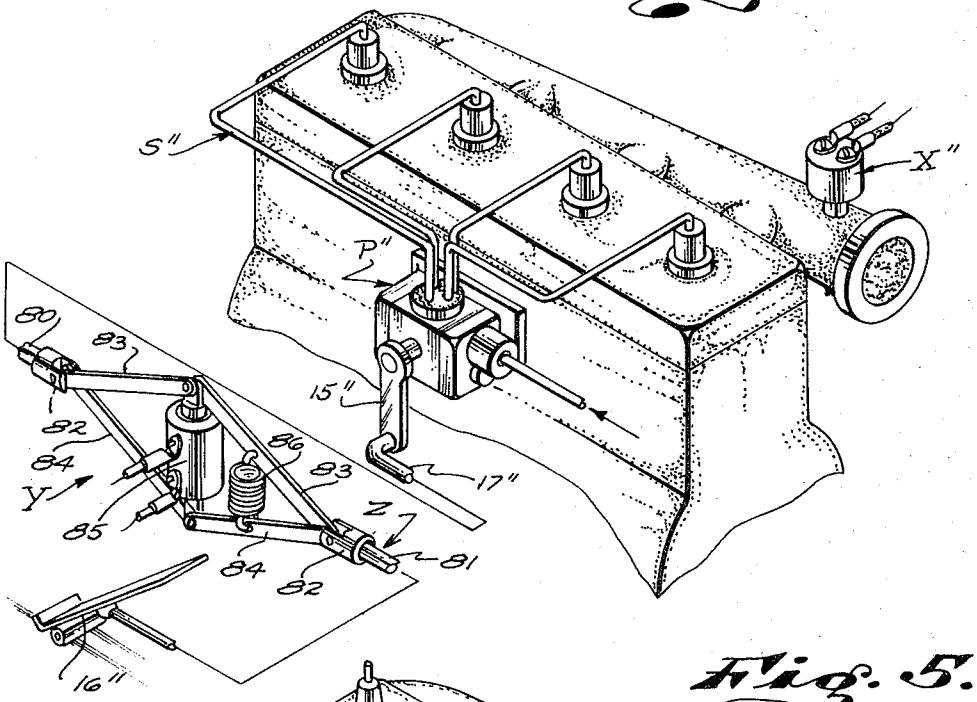
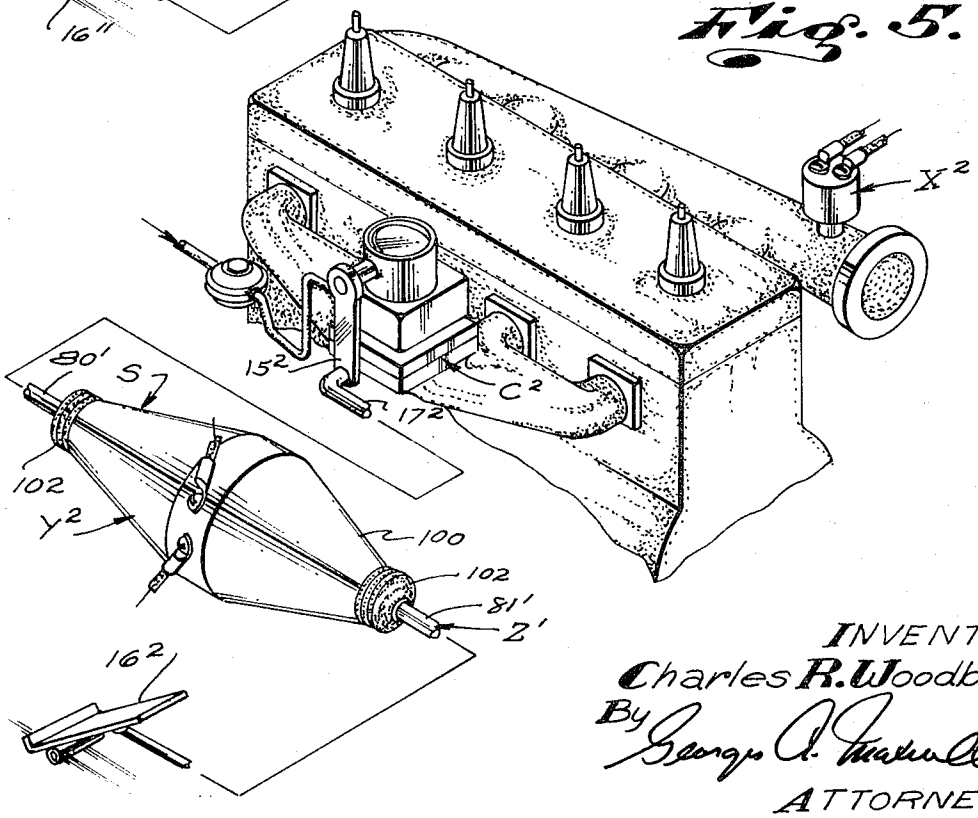


Fig. 5.



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FUEL CONTROL MEANS

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This invention relates to a fuel control means and is more particularly concerned with a thermoresponsive means for reducing the flow or supply of fuel into an internal combustion engine and to thereby slow the operation and reduce the work output of the engine when the operating temperature of said engine reaches a predetermined maximum safe operating temperature.

Throughout the automotive industry and more particularly, in the trucking industry, expensive motor damage occurs as a result of operating the vehicle motors or engines at excessive temperatures. The most common damage caused by operating an engine at excessive temperatures is burning of the valves and pistons and scarring and galling of the cylinder walls.

When such damage occurs in an engine, it must receive a major overhaul. In the case of conventional diesel engines, such as are used in trucks, such an overhaul costs between two and three thousand dollars.

Unfortunately, overheating of engines and the resulting damage thereto occurs most frequently in new or recently overhauled engines, which are tight and the parts of which have not yet broken in to operation. As a result, it often happens that an owner of a motor truck is faced with the great expense of an engine overhaul shortly after he has purchased his truck or has just had the engine thereof overhauled.

An object of my invention is to provide a means, the full purpose of which is to rob from or otherwise reduce the supply of fuel delivered to the cylinders of an engine, when the temperature in the engine reaches a predetermined maximum safe operating temperature and so that the operator thereof cannot deliberately or negligently cause overheating and resulting damage to the engine.

Another object of this invention is to provide a pressure relief or a bleeder valve in the pressure or delivery line running or extending from an engine fuel pump and means responsive to the temperature of the engine to actuate and open the valve when the temperature exceeds a predetermined value, whereby the operation or work output of the engine is slowed and reduced to an extent that said temperature is not exceeded, independent of the normal controls for the engine.

Still another object of my invention is to provide a means of the character referred to wherein said temperature responsive means includes a pyrometer in the exhaust manifold of the engine and which is responsive to the exhaust gas temperatures.

An object of this invention is to provide a means of the character referred to which is such that the valve means thereof and the pyrometer thereof can be advantageously adjusted and/or calibrated to vary the temperature at which the valve is opened and the volume of fluid or fuel robbed or bled from the fuel supply and the resulting drop in fuel pressure.

Another object of this invention is to provide a means of the character referred to wherein a means under control of the pyrometer is arranged in the linkage of the manually operable actuating means for the throttle valve of a gasoline engine carburetor or the metering valve of a diesel engine distributing pump, which means effects a shortening of the linkage or its effective movement and reduces the flow of fuel, independently of the action of the operator, when the temperature of the engine exceeds a safe operating temperature.

It is an object of this invention to provide a means of the character referred to involving but a few, inexpensive, simple, durable and dependable components and a means which is such that it can be easily and conveniently installed in and/or removed from existing engine fuel systems with a minimum of time and effort and without requiring the alteration and/or modification of such systems.

It will be apparent that it is to be understood that means provided by this invention does not and is not intended to control the mixture or ratio of fuel and air delivered to the engine, the speed of the engine, the intake exhaust or oil pressures of the engine or the normal variations in the operating temperature of the engine, but rather, simply slows or reduces the work output of the engine when the operating temperature thereof exceeds a safe operating temperature.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of my invention, throughout which description reference is made to the accompanying drawings, in which:

FIGURE 1 is a diagrammatic view of my new fuel control means applied to one form of diesel engine fuel system;

FIGURE 2 is a sectional view of the pyrometer that I provide;

FIGURE 3 is a diagrammatic view of my new means applied to the fuel system of a gasoline operated internal combustion engine;

FIGURE 4 is an isometric, diagrammatic view of another form of my invention applied to the fuel system of a diesel engine; and

FIGURE 5 is a diagrammatic view similar to FIGURE 4 and showing my second form of fuel control means related to a gasoline operated internal combustion engine.

The fuel system S diagrammatically illustrated in FIGURE 1 of the drawings is that system provided on diesel engines manufactured by Cummins and designated and sold under the trademark "P–T" fuel system. In this system a fuel pump P driven by the engine with which the system is related draws fuel from a fuel tank T through a suitable suction line **10** and delivers the fuel through a suitable delivery line **11**, connected with and extending between the outlet side of the pump P and a manifold **12**. The manifold **12** is connected with and delivers fuel to the inlet sides or ports of the fuel injectors I of the engine.

A suitable outlet manifold **13** is connected with the outlet side or ports of the injectors I, which manifold connects with a return line **14** extending back to the fuel tank T.

The pump P is such that it delivers a constant flow of fuel to and through the injectors I and is provided with a suitable metering valve means (not shown) which valve means varies the pressure and/or volume of said flow of fuel. The metering valve means of the pump P is operated by a crank **15** operatively connected with a foot operated pedal or so-called throttle pedal **16**, by suitable linkage **17**.

The injectors I are intermittently operated by a suitable cam operated rocker arm mechanism M, within the engine, in accordance with common practice or diesel engine construction. The injectors I are such that after they are operated by the rocker arm mechanism M, they are recharged with fuel for subsequent operation.

In this system, the amount of fuel delivered or injected into the cylinders of the engine by the injectors I is determined by the size of the charge they receive, which charge is determined by the pressure and resulting volume, or vice versa, of fuel flowing therethrough and delivered by the manually controllable pump P.

It will be apparent that if the supply of fuel between the outlet side of the pump P and the manifold **12** extending to the injectors I is reduced in volume and/or in pressure, the engine with which the system is related will be slowed and its work output reduced.

The fuel control means F that I provide includes generally a pyrometer X carried by and projecting into an exhaust gas manifold **20** of the engine with which the fuel system S and the fuel control means F is related, and a valve means V connected in the delivery line **11** and under control of the pyrometer.

The valve means V is normally closed and the pyrometer X is such that it does not open or otherwise activate the valve means V until the exhaust gas temperature reaches a predetermined set temperature, whereupon the valve means V is opened.

When the valve means V opens, fuel in the line **11** is bled off, reducing the volume and the pressure of the fuel delivered to the injectors I and thereby slows the engine and reduces its work output. When the work output is reduced in the above manner, the temperature of the exhaust gases drops immediately.

The means F is such that as the temperature of the exhaust gases increases above the set, predetermined safe operating temperature of the engine, the valve means V is opened to a proportionate and greater extent and will continue to so open until such time as the volume and pressure of the fuel to the injectors I is only sufficient to operate the engine at idling speed, in an unloaded condition. It is highly important that the means F that I provide does not completely shut off the fuel supply to the engine but assures sufficient flow of fuel to permit the engine to idle, as an overheated engine may be badly damaged if stopped and let to cool in a standing or stationary condition.

This last mentioned condition is controlled by the maximum extent to which the valve means V can be opened, which factor can be easily adjusted for and controlled, as will hereinafter be described.

In light of the above, it will be apparent that when the means F is set into operation, the effect will be immediately experienced or noticed by the operator of the engine and he can manually reduce the load on the engine and continue accordingly. It will also be apparent that should the operator seek or attempt to compensate for and overcome the effect of the means F, as by advancing the throttle pedal, the temperature of the exhaust gases will increase and the means F will immediately and automatically overcome such efforts. Accordingly, the operator is effectively prevented from abusing and burning up the engine.

It will be noted that the temperature of exhaust gases in internal combustion engines varies or changes very rapidly, in response to the work output of the engine and that there are many commercially available pyrometers and the like which operate extremely rapidly in response to changes in temperatures. Accordingly, the means F that I provide can be made to operate extremely rapidly and is not such that it must wait and function slowly in response to changes in temperature of a mass, such as the cylinder head of the engine or the water in the cooling system of the engine.

Accordingly, the means F that I provide is such that it will not unduly impede or interfere with the safe and serviceable operation of the engine with which it is related. That is, the operator, if he does not attempt to deliberately abuse the engine, will not find himself without the necessary power output from the engine to continue with the work the engine is intended to perform in a satisfactory manner.

In the form of the invention illustrated in FIGURES 1 and 2 of the drawings, the pyrometer X involves a base **30** with an externally threaded tubular stem **31** depending therefrom and threadedly engaged in a drilled and tapped opening or hole **32** provided in the exhaust manifold **12** of

the engine. An elongate thermoresponsive by-metal coupler **33** is carried by the base and has a lower, depending probe portion **34** extending through the stem and into the manifold and an elongate upwardly projecting swinging arm portion **35** extending upwardly from the base. A suitable case **36** is removably secured to the base to overlie and house the top of the base and the upper arm portion **35** of the coupler **33**.

The upper end of the arm portion **35** of the coupler carries a suitable insulated contact brush **37**, which brush has a suitable lead line **38** extending to and connected with a ground terminal post **39** at one side of the case.

Arranged within the case is an elongate resistance bar **40**, which bar is adapted to be slideably engaged by the brush **37**. The bar **40** is an elongate arcuate member carried by an elongate substantially vertically extending arm **41** pivotally mounted on the base. A suitable adjusting screw **42**, carried by a boss on the base, within the confines of the case and coupled with said arm, is provided to vary and adjust the position of the bar with respect to the brush.

A suitable lead line **43** is connected to the end of the bar adjacent the carrier arm **41**, which lead extends to and is connected with a terminal post **44** at said one side of the case.

The bar **40** is, by means of the screw **42**, positioned to normally occur in spaced out of contact position with the brush **37** and such that when the lower portion **34** of the coupler is subjected to the maximum safe operating temperature of the engine, the arm portion **35** of the coupler shifts or swings sufficiently towards the bar **40** to establish contact between the bar and the brush **37**. As the temperature increases, the brush moves longitudinally along the resistance bar **40** and the resistance afforded thereby is effectively lowered.

In accordance with the above, it will be apparent that the temperature at which the means F is set into operation, can be advantageously varied and controlled.

It will be further apparent that the adjusting screw **42** occurs within the case and that the case can be suitably sealed with or to the base to prevent unauthorized tampering with the adjustment of the pyrometer.

The post **39** of the pyrometer is connected to a ground line **45** and the post **44** is connected with a power line **46** extending from the valve means V, as will hereinafter be described.

The particular pyrometer construction illustrated and described above can be varied widely in form and construction without affecting the novelty of the present invention.

It is to be noted that all that is required to mount and relate the pyrometer X to the engine with which the means F is related is to drill and tap the hole or opening **32** in the manifold **12**. It is also to be noted that should the means F that I provide be removed from the engine, the hole or opening **32** can be easily and conveniently plugged and affords no adverse effects.

The valve means V that I provide includes an elongate body having inlet and outlet ports **50** and **51** at its opposite sides, communicating with axially spaced inlet and outlet chambers within the body. An axially extending tapered needle valve seat is provided in the body to extend between and communicate with the said axially spaced inlet and outlet chambers and an elongate gate needle valve member **52** is arranged in seated sealing engagement in said seat. The valve member **52** is provided with an elongate stem **53** which stem projects axially from one end of the body.

The valve means V further includes a solenoid operating means **60**, which means includes an iron core **61** fixed to and extending axially outwardly from the outer or free end of the stem and a coil **62** carried by a case **63** fixed to said one end of the body and surrounding the core.

A suitable compression spring **64** is carried by the case in axial alignment with the core to engage the free end of

the core and to normally yieldingly urge the core, stem and valve member inwardly into the body and to hold the valve member in closed, sealing engagement in the valve seat.

An idle adjustment screw **65** is carried by the case to oppose the outer free end of the core and serves to limit the longitudinal outward movement of the core and the resulting outward movement of the valve member relative to the valve seat.

The ends of the coil are connected with a pair of terminal posts **66** and **67** accessible at the side of the case.

The post **66** is connected with the power line **46** extending to and connected with the post **44** on the pyrometer X and the post **67** is connected with a suitable power supply line **68** extending from a suitable power source, such as a battery **69**.

The outlet port **50** of the valve is connected with a fuel line **70** which line extends to and is connected with a T fitting **71** engaged in and between the outlet port of the engine fuel pump P and the inlet end of the delivery line **11**. Accordingly, the installation of my new system requires no rebuilding or modification of the engine fuel system.

The outlet port **51** of the valve is connected with a discharge line **72** which line can be connected with the suction line **10**, the return line **14**, or, as illustrated, extend back to the fuel tank T.

With the structure set forth above, it will be apparent that the valve means V is normally closed and that the electrical circuit provided is open. When the pyrometer X is heated to a predetermined point, contact is made between the bar **40** and the brush **37**. When such contact is established, the circuit is closed and, due to the resistance afforded by the bar **40**, a small amount of current flows through the coil, shifting the core against the resistance of the compression spring. Accordingly, the valve opens to a limited extent and a small amount of fuel is bled from the fuel system. If the temperature of the exhaust gases increases, the resistance is automatically reduced and the solenoid opens the valve further and until such time as the core is stopped by the screw **42**, whereupon so much fuel is bled from the fuel system of the engine that only sufficient fuel is provided to operate the engine in an unloaded idling condition.

It will be apparent that my novel means F can be advantageously applied to any diesel engine fuel system.

In the case of a diesel fuel injection system where a distributor type pump is employed and a separate delivery line extends from the pipe to each injector, a separate tap line with a spring-loaded check valve therein must be provided to extend from each delivery line to the single, common valve means V of my control system.

In the form of the invention illustrated in FIGURE 3 of the drawings, I have illustrated, diagrammatically, my new system F' related to a gasoline operated internal combustion engine.

In this application of my system, the valve means V' is connected with or to the fuel delivery line extending from the fuel pump P' to the carburetor C.

It may be asserted that the means F' in this installation will cause the engine to run lean and to therefore overheat. This, however, is not the case, as the means F' responds very rapidly to the changes in the work load or output of the engine and the resulting changes in the temperature of the exhaust gases. Accordingly, the means F will, in reality, prevent the engine from running too lean and hot and will force the operator thereof to operate the engine in a manner which will not overload and therefore overheat the engine.

In other words, while the system F' may momentarily cause a lean, hot burning, fuel mixture to be delivered to the engine, this in itself would only cause the means F' to open wider, very rapidly, and to an extent that the mixture would become so lean that the engine would deliver very little power. In such a case, in order to regain power, the operator need only let up on the throttle pedal, or close down the throttle valve, to an extent that the engine is not overloaded and excessive exhaust gas temperatures are not generated.

It is to be understood that the valve means V that I have illustrated and described above is only typical of one type or form of valve construction that can be advantageously employed in carrying out the present invention.

It is also to be understood that the solenoid type of operating means for the valve is merely illustrative of one such means that may be employed in carrying out my invention.

The fuel system S' illustrated in FIGURE 4 of the drawings is typical of the older and more conventional diesel fuel system wherein the pump P'' has a distributor within, which distributor delivers individual charges of fuel to the several injectors of the engine through separate fuel lines extending from the pump to said injectors.

The pump P'', in accordance with conventional construction, has a metering valve means within to control the volume of fuel delivered by the pump, which means is operated by a crank **15''** operatively connected with a foot operated pedal **16''**, or other suitable manually engageable mechanism. The crank **15''** and the pedal **16''** are operatively coupled or connected to each other by a suitable linkage set-up **17''**.

The linkage set-up **17''** extending between the crank **15''** and pedal **16''** can vary widely depending on the particular installation. However, the type of linkage employed in such installations has become standardized and consists of elongate rods of limited uniform cross-section, bell cranks and levers and spring loaded ball and socket type universal coupling means at and connecting the adjacent ends of the related rods, cranks and levers. Since the details of this type of linkage is substantially standardized, I have not illustrated such details and will not burden this specification therewith.

The fuel control system F'' in the form of the invention now under consideration includes a pyrometer X'', which pyrometer can and will be considered as identical with the pyrometer X illustrated and described above.

The system F'' further includes a means Y engageable in the linkage **17''** to lengthen and shorten the effective longitudinal movement of the linkage connected with the pump crank **15''**. The means Y is under control of the pyrometer X''.

In the form of the invention illustrated, the means Y includes an adapter rod Z having axially spaced sections **80** and **81**, a clevis fitting **82** threadedly engaged on the inner opposing ends of the rod sections, elongate upper and lower links **83** and **84** with outer ends pivotally secured to each clevis and extending longitudinally inwardly therefrom in divergent relationship with each other. The inner ends of the links **83** and the inner ends of the links **84** are pivotally secured together and a solenoid **85** is pivotally connected or secured to and extends between the said inner ends of the links **83** and **84**.

A tension spring **86** is engaged between the links **83** and **84** at one side of the solenoid and normally yieldingly urges the links laterally inwardly towards each other and in such a manner as to maintain the adapter rod Z at maximum length.

When the solenoid **85** is energized by operation of the pyrometer and when the temperature of the engine becomes excessive, the solenoid urges the central pivotal connections between the several links laterally outwardly and against the resistance of the spring **86**. This effectively shortens the length of the adapter rod.

As a result of the above shortening of the adapter rod Z, the fuel supply to the engine is effectively re-

duced with the same effect as in the first form of the invention, described in the preceding.

It will be apparent that the solenoid operated rod shortening device or means Y that I provide is of slight dimensions and that the sections **80** and **81** thereof are in axial alignment. Accordingly, the adapter rod can be advantageously made in substantially any desired length and can be substituted, as desired, or as circumstances require, for one of the several rods going to make up the operating linkage **17''** for the engine with which the means S'' is related.

In practice, and as illustrated in the form of the invention shown in FIGURE 5 of the drawings, the means Y in the form of the invention now under consideration, can be provided with a suitable housing.

In the form of the invention illustrated in FIGURE 5 of the drawings, I have shown the second form of fuel control means, described above, related to a gasoline operated internal combustion engine, wherein the fuel supplied to the engine is under control of butterfly type of throttle valve in a carburetor C^2.

The means S^2 in this form of the invention includes a pyrometer X^2, which pyrometer can be similar to the pyrometer X in the preceding forms of the invention, and a solenoid operated rod shortening device or means Y^2, which means is the same as the means Y illustrated in FIGURE 4 of the drawings. In the form of the invention now under consideration, the means Y^2 is shown provided with a case **100**, which case surrounds and protects the working mechanism of said means. The case **100** has longitudinally outwardly convergent, conical, end portions which extend to occur about the sections **80'** and **81'** of the rod Z' and is provided with rubber bellow-type boots **102** at its opposite ends to seal between the case and the related rod sections and yet allow for relative axial shifting of the said rod sections.

In this last form of the invention, the means Y^2 is engaged in the operating linkage 17^2 extending between the throttle pedal 16^2 and the operating crank 15^2 for the butterfly or throttle valve of the carburetor C^2 of the engine.

With the above combination and relationship of parts, it will be apparent that the same results and effect are afforded by the means S^2 as in each of the preceding forms of the invention.

It is to be understood that the means Y and Y^2 that I provide and have illustrated and described in the foregoing is only illustrative of one form of rod shortening device or means that can be advantageously related to conventional operating linkage to effectively control and vary the effective movement of said linkage.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited to the specific details herein set forth, but wish to reserve to myself any modifications and variations that may appear to those skilled in the art and fall within the scope of the following claims.

Having described my invention I claim:

1. Means for limiting the exhaust gas temperatures of an internal combustion engine having a manually controlled fuel supply system and an exhaust gas manifold receiving and conducting exhaust gases from the engine, said means including a pyrometer related to the exhaust manifold and responsive to the temperatures of the exhaust gases therein, and means related to the fuel supply system and operatively connected with the pyrometer, said means related to the fuel supply system serving to reduce the supply of fuel delivered to the engine by the system when the exhaust gas temperatures exceed a predetermined point, said fuel supply system including valving means under control of a crank to control the flow of fuel into the engine and operating linkage comprising at least one axially shiftable, sectional rod connected with the crank, said means related to the fuel supply system including a solenoid operated, spring loaded rod shortening device engaged between the sections of said rod.

2. Means for limiting the exhaust gas temperatures of an internal combustion engine having a manually controlled fuel supply system and an exhaust gas manifold receiving and conducting exhaust gases from the engine, said means including a thermoresponsive switching means related to the exhaust manifold and responsive to the temperature of the exhaust gases therein, and an electrically operated means related to the fuel supply system and operatively connected with the thermoresponsive switching means, said means related to the fuel supply system serving to reduce the supply of fuel delivered to the engine by the said system when the exhaust gas temperatures exceed a predetermined point and said switching means is operated to energize said means, said fuel supply system including valving means under control of a crank to control the flow of fuel into the engine and operating linkage comprising at least one axially shiftable, sectional rod connected with the crank, said means related to the fuel supply system including a rod shortening device between the rod sections, said device including axially spaced, axially shiftable members connected with the ends of the rod sections, links having outer ends pivotally connected with the members and having inner ends pivotally connected with each other, spring means normally yieldingly urging the members axially away from each other and a solenoid engaged with the links and operable to shift the members towards each other.

3. Means for limiting the exhaust gas temperatures of an internal combustion engine having a manually controlled fuel supply system and an exhaust gas manifold receiving and conducting exhaust gases from the engine, said means including a thermoresponsive switch and variable resistance device related to the exhaust manifold and responsive to the temperature of the exhaust gases therein and a spring loaded solenoid operated means related to the fuel supply system and operatively connected with the thermoresponsive switch and variable resistance device, said means related to the fuel supply system serving to reduce the supply of fuel delivered to the engine by said system when the exhaust gas temperatures exceed a predetermined point, said fuel supply system including valving means under control of a crank to control the flow of fuel into the engine and operating linkage comprising at least one axially shiftable sectional rod connected with the crank, said means related to the fuel supply system including a rod shortening device engaged between the sections of said rod, said device including axially spaced, axially shiftable members connected with the ends of the rod sections, a pair of links having outer ends pivotally connected with the members and having inner ends pivotally connected with each other, said links related to each member diverging inwardly, spring means between one pair of links to normally, yieldingly urge the links together and the members axially away from each other and a solenoid engaged between the inner ends of the related pairs of links and operable to shift the inner ends of the links away from each other and the members towards each other.

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