July 21, 1959 W. E. McCOLLOUGH 2,895,561

TORQUE RESPONSIVE FUEL CUT-OFF MEANS

Filed Jan. 17, 1957

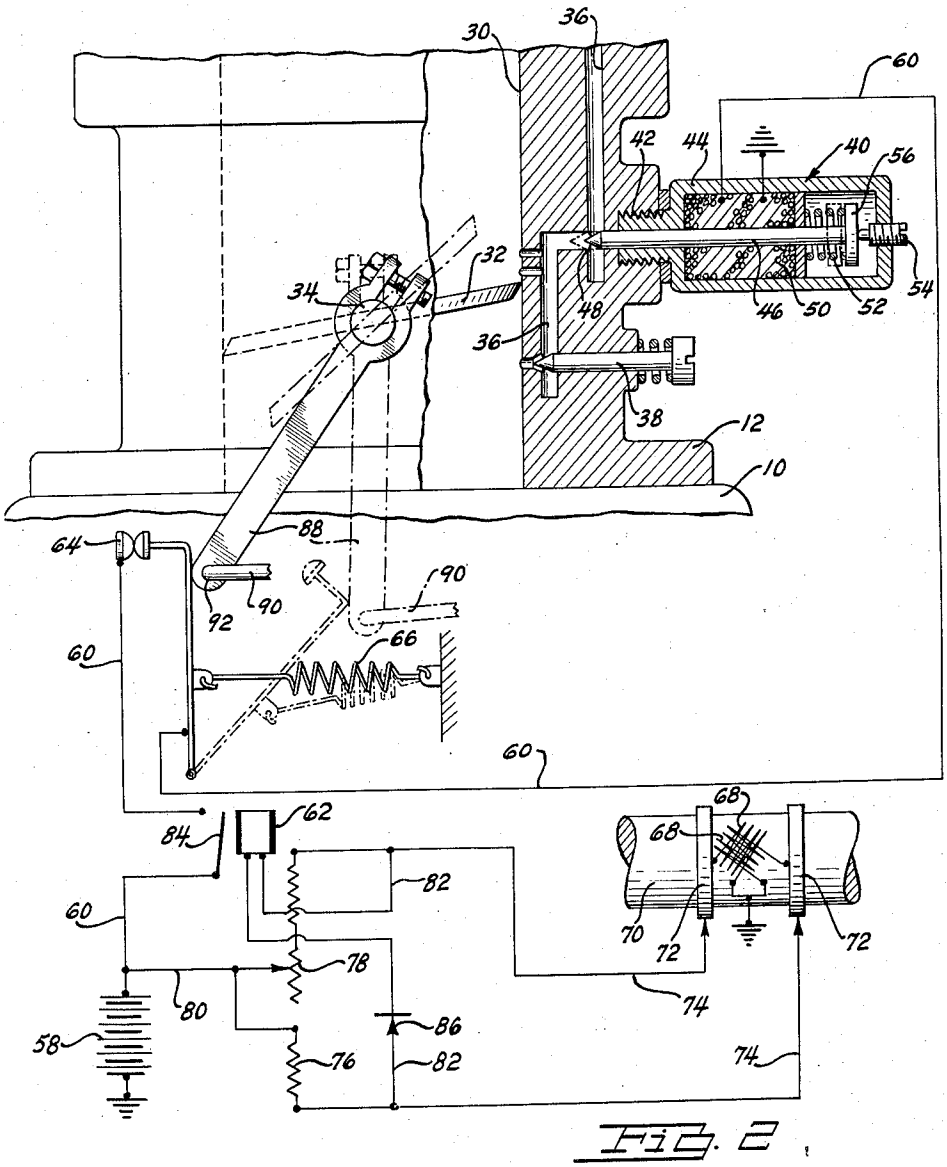


Fig. 2

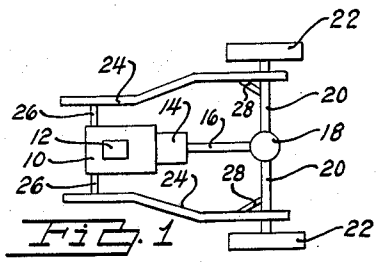


Fig. 1

INVENTOR.
WILLIAM E. McCOLLOUGH
BY
Walter Patorwho, Sr.
ATTORNEY

United States Patent Office 2,895,561 Patented July 21, 1959

2,895,561

TORQUE RESPONSIVE FUEL CUT-OFF MEANS

William E. McCollough, Detroit, Mich., assignor to Holley Carburetor Company, Van Dyke, Mich., a corporation of Michigan

Application January 17, 1957, Serial No. 634,701

14 Claims. (Cl. 180—82)

This invention relates to fuel cut-off devices for internal combustion engines, and more particularly to means for actuating such devices.

It is known that back-firing in the exhaust system of an internal combustion engine driven vehicle such as a truck is caused by the igniting in the exhaust system of unburned fuel vapors leaving the engine, particularly during overrun or deceleration periods on descending a long hill or coasting with the transmission engaged so that the vehicle drives the engine. To eliminate this back-firing, various valves and other fuel cut-off devices have been proposed to prevent the supply of fuel to the engine during such periods. More recently, it has been observed with some concern by various groups that such unburned fuel is also a major contributing factor to the unhealthy smog conditions existing in metropolitan areas where great numbers of such vehicles are concentrated, and they too have proposed the use of similar devices for this additional reason to cut-off the fuel from the engine during deceleration periods.

Most of these devices, whatever their particular construction, have been actuated by the increase in engine manifold vacuum during such overrun periods. As a consequence of this use of manifold vacuum, these valves or other devices have necessarily had to be constructed and adjusted in such a manner that their operating point is sufficiently above any manifold vacuum value which may occur during any other engine operating condition; this is necessary to insure that they do not operate when accelerating the free engine and so that they cannot possibly interfere with normal idling operation. Because of this, a considerable portion of the desirable operating range of such devices is lost.

It is now proposed to provide a means for actuating such fuel cut-off valves or other devices, not in response to engine vacuum but in response to the reversal of the direction of power flow in the vehicle drive train. In other words, under normal accelerating and driving conditions power is flowing from the engine to the rear wheels. At idle no power may be flowing. Under deceleration or overrun conditions the rear wheels are supplying power to the engine, and it is under the entire range of this condition that it is desirable to prevent the flow of fuel to the engine. The above proposed means of actuating fuel shut-off devices constitutes what is believed to be a theoretically ideal solution to the basic problem of when to shut off the fuel for the purposes described.

In the drawings:

Figure 1 is a diagrammatic view of a typical vehicle drive train.

Figure 2 is a diagrammatic view of a system embodying the invention for cutting off the fuel during coasting or overrun periods of a vehicle drive train such as that shown by Figure 1.

Referring to Figure 1, the usual vehicle drive train includes an engine **10** having a carburetor or other fuel control device **12** and an associated transmission **14**, a

drive shaft **16**, a differential assembly **18**, drive axles **20** and drive wheels **22**. This drive train is resiliently connected to the vehicle frame members **24** by means of engine mounts **26** and rear spring **28**.

Referring now to Figure 2, the carburetor **12**, like most carburetors, includes an air intake passage **30** having a throttle valve **32** pivoted on the shaft **34** for controlling the flow of motive fluid to the engine. In addition, the wall of the carburetor has a suitable idle passage **36** extending from the usual fuel bowl (not shown) to the air intake passage below the throttle plate when it is in the idle position shown in solid lines. The flow of idle fuel through the passage **36** is controlled by the usual adjustable needle valve **38**.

With the above structure, it is apparent to those skilled in the art that when the vehicle is at a standstill with the engine running at idle speed, the throttle valve **32** is closed as shown in solid lines in Figure 2. Under these circumstances, the idling manifold vacuum in the engine below the throttle valve **32** will cause fuel to flow from the fuel bowl, which is at pressure approaching atmospheric, through the passage **36** past the needle valve **38** and into the air intake passage **30**. In other words, to operate an engine at so-called "curb idle," the engine is fed a rich mixture.

While the spark plugs keep firing and the engine continues to run, the combustion is incomplete, which means that unburned hydrocarbons are discharged through the exhaust system.

When the vehicle is coasting or descending a hill with the transmission engaged and the throttle valve closed, the above condition occurs to a greater extent because the engine, like a pump, is being driven by the vehicle at greater than normal idling speed. With the consequent increase in engine manifold vacuum, even more idle fuel is forced through the passage **36** and an even richer mixture is produced. Combustion is still incomplete and even more hydrocarbons are discharged into the exhaust system than at curb idle.

When this even greater amount of unburned fuel mixes with air in a hot exhaust system, backfiring may occur. That which is not burned by backfiring is discharged to atmosphere and contributes to smog conditions.

In order to eliminate the above backfiring and discharge of unburned fuel, fuel cut-off devices have been proposed to stop the flow of idle fuel to the engine during overrun or deceleration periods.

While the particular constructions of the proposed devices may vary considerably, they all seem to have a common feature; that is, they are actuated to shut-off the fuel when the engine manifold vacuum reaches a given value, which must be sufficiently greater than normal engine vacuum so that engine operation will not be jeopardized.

For instance, if normal free engine vacuum is 17–22 inches of mercury, these devices may be set to operate at 22 or more inches of mercury. However, during any particular period of coasting, when the engine is not needed and is being driven by the vehicle, the engine vacuum may exceed 17 inches of mercury but never attain 22 inches of mercury. Thus, during such a period the objectionable conditions still exist.

The invention contemplates a novel approach to the problem of shutting the fuel off as soon as possible and resuming its flow as late as possible.

It is known that the entire drive train of a vehicle, from the engine to the drive wheels, undergoes a reversal of torque when the engine stops driving the wheels and the wheels begin to drive the engine, and vice versa. This phenomena is the true indication of overrun, and it is when the wheels first begin to drive the engine

that it would be desirable to cut off the flow of idle fuel. This can be accomplished in a number of ways by sensing such reversal of torque in the drive train and transmitting the signal to a suitable fuel shut-off device; Figure 2 illustrates diagrammatically one embodiment of such a fuel cut-off device.

The actual fuel cut-off valve is a solenoid-operated needle valve 40 similar to stationary needle valve 38. The threaded portion 42 of casing 44 screws into the carburetor 12 so that the needle valve 46 which extends axially thereof will not engage the seat 48 when the coil 50 is not energized because the spring 52 urges the needle 46 to the right. The tension of the spring 52, and thus the initial position of the needle 46, may be adjusted by rotating the set screw 54, which engages the spring retaining head 56 of the needle. When the coil 50 is energized the needle valve 46 is drawn to the left against the tension of the spring 52 so that the needle valve 46 engages the seat 48 and completely closes off the idle fuel passage 36.

The method of energizing the coil 50 will now be described.

A direct current power source 58 such as a vehicle battery is connected to the solenoid operated valve 40 by the line 60 having connected in series a suitable relay 62 and a lock-out switch 64, the latter having a spring 66 tending to hold the switch 64 in the open position shown by broken lines. The D.C. power supply 58 and the solenoid operated valve 40 are grounded in the usual manner to provide a complete electrical circuit.

The relay 62 is operated by means of a bridge circuit, one side of which includes a pair of strain gauges 68 connected in series and suitably grounded. These strain gauges 68, which are secured in the normal manner to one of the rotating members in the vehicle drive train such as the drive shaft 70 (shaft 16 in Fig. 1), are adapted to sense minute deflections in the shaft 70 resulting from the reversal of torque in the shaft. Each strain gauge 68 is connected to a suitable slip ring contact 72 adapted to rotate with the shaft 70 so that signals from the strain gauges 68 may be transmitted to the leads 74. The other side of the bridge circuit includes fixed and variable resistances 76 and 78 of suitable values and connected in series to the line 80 leading from power source 58. With this construction, the proper balancing of the bridge circuit may be accomplished, and current will flow in the intermediate line 82, which includes the relay 62, in response to deflections in the shaft 70 as sensed by the strain gauge 68. The direction of the current will be dependent upon the direction of reversal of torque in the shaft 70 and the value of the current will be dependent upon the amount of deflection of the shaft 70.

To accomplish the object of the invention, it is desired to actuate the solenoid operated valve 40 to close the idle fuel passage 36 when the positive torque in the shaft 70 existing when the engine 10 drives the wheels 22 first changes to a negative torque resulting from the wheels 22 driving the engine 10. This may be done by providing a relay 62 which is spring loaded so that the contact 84 is open during positive torque and is closed by the flow of current through the relay 62 when the torque becomes negative. Since the relay 62 would normally operate to close the contact 84 in either direction of current flow, the flow of current during positive torque can be blocked by means of any known device 86 such as a selenium or other rectifier acting as an electrical check valve. Thus, only current resulting from negative torque can flow through the relay 62, and the idle passage 36 will be blocked only under conditions of negative torque. It is apparent that other types of relays or other electrical devices may be employed for this purpose.

It may be desirable, for safety and other reasons, to open the fuel passage 36 in order to restore the engine during a deceleration or overrun period, and this is the function of the lock-out switch 64. A lever 88 actuated by linkage 90 is secured for rotation with the throttle shaft 34, and the relative position of the lever is such that the free end 92 of the lever opposes the spring 66 to close the switch 64 only when the throttle 32 is in the closed position, as it would be during an overrun or deceleration period. Thus, the solenoid operated valve 40 will be actuated only when the throttle 32 is closed to idle position. Should it become necessary to use the engine 10, the throttle 32 may be opened in the usual manner to the broken line position, in which case the spring 66 will open the switch 64, thus breaking the circuit and allowing the spring 52 to force the needle valve 46 to the right and re-establish the flow of fuel through the passage 36.

While the invention has been illustrated by a particular embodiment in which the sensing of the reversal of torque in the drive shaft is employed to actuate the fuel shut-off valve, the invention is not intended to be limited to this particular embodiment, it being apparent that the reversal of torque in any member of the drive train from the engine to the rear axle could be employed for this purpose. It is within the scope of the invention, for instance, to employ the change in relative position of the engine 10 with respect to the vehicle frame 24 during driving and overrun periods or the change in automatic transmission oil pressure to actuate the fuel cut off device. Various other modifications may be made without exceeding the scope of the invention, as defined in the following claims.

What I claim is:

1. In a vehicle having an engine, a driven axle and a drive train between said engine and said axle, a carburetor adapted to supply a motive fluid to said engine, said carburetor having a manually operated throttle for controlling the speed of said engine and an idle fuel system for supplying idle fuel to said engine when said throttle is closed, said idle fuel system including a valve adapted when closed to shut off the supply of said idle fuel, and means in addition to the inherent control of said vehicle by said manual throttle for closing said valve when said axle is driving said engine, said means including means having the sole function of sensing directly the torque in said drive train.

2. In a vehicle having an engine, an axle normally driven by said engine when said vehicle is in motion and a drive train between said engine and said axle, a carburetor adapted to supply a motive fluid to said engine, said carburetor having a manually operated throttle for controlling the operation of said engine and an idle fuel system for supplying idle fuel to said engine when said throttle is closed, said idle fuel system including a valve adapted when closed to shut off the supply of said idle fuel, and means in addition to the inherent control of said engine by said manual throttle for closing said valve when said vehicle is in motion but said engine is not driving said axle, said means including means solely for sensing directly the torque in said drive train.

3. In a power plant comprising an engine and a drive train normally driven by said engine when engaged therewith, a carburetor having a manual throttle for controlling the supply of motive fluid to said engine, said carburetor having an idle fuel system for supplying idle fuel to said engine when said throttle is closed, a valve for shutting off said idle fuel when closed, means in addition to the operation of said throttle and independent of any other engine accessory for sensing directly the torque in said drive trains, and means responsive directly to said torque sense for closing said valve when said engine and drive train are connected but said engine is not driving said drive train.

4. In a vehicle, comprising an engine, a drive train normally driven by said engine when engaged therewith, a carburetor having a manual throttle for controlling the supply of motive fluid to said engine, said carburetor having an idle fuel system for supplying idle fuel to said

engine when said throttle is closed, a valve for shutting off said idle fuel when closed, means in addition to the operation of said throttle and independent of any other engine accessory for sensing directly the torque in said drive train, and means responsive directly to said torque sense for closing said valve when said engine and drive train are connected but said drive train is driving said engine.

5. In a vehicle having an engine adapted to drive a shaft and to be supplied with fuel by a carburetor having a throttle valve to control the flow of combustion air to the engine and passages for admitting fuel to the engine, a storage battery and a device for cutting off the flow of fuel to said engine only whenever said shaft is driving said engine and said throttle valve is at engine idle position, said device including a solenoid-operated valve for closing said fuel passages against a spring normally holding said valve open when electrical current is supplied to said solenoid, an electric circuit including said solenoid-operated valve and said storage battery, a first switch operated by said throttle valve to open said circuit when said throttle valve is opened beyond idle position, a second switch to close said circuit in response to electric means sensing directly the reversal of torque in said shaft when said shaft drives said engine.

6. In a vehicle having an engine adapted to drive said vehicle and to be supplied with fuel by a fuel control having a throttle valve to control the flow of combustion air to the engine and passages for admitting fuel to the engine, an electric power source and a device for cutting off the flow of fuel to said engine only whenever said vehicle is driving said engine and said throttle valve is at engine idle position, said device including a solenoid-operated valve for closing said fuel passages against a spring normally holding said valve open when electrical current is supplied to said solenoid, an electric circuit including said solenoid-operated valve and said power source, a first switch operated by said throttle valve to open said circuit when said throttle valve is opened beyond idle position, a second switch to close said circuit in response to means sensing directly the reversal of torque in said engine when said vehicle drives said engine.

7. In a vehicle having an engine adapted to drive said vehicle and to be supplied with fuel by a fuel control having a throttle valve to control the flow of combustion air to the engine and passages for admitting fuel to the engine, an electric power source and a device for cutting off the flow of fuel to said engine only whenever said vehicle is driving said engine, said device including a solenoid valve operative when electrical current is supplied to said solenoid for closing said fuel passages against a spring normally holding said valve open, an electric circuit including said solenoid-operated valve and said power source, a first switch operated by said throttle valve to open said circuit when said throttle valve is opened beyond idle position, a second switch to open said circuit in response to bridge circuit means sensing directly the reversal of torque in said engine when said engine drives said vehicle.

8. In a vehicle having a drive train including an engine supplied with fuel by a device having a manual control and a fuel discharge passage, means for cutting off the fuel to said engine when said manual control is closed to a predetermined position and the torque in said drive train is reversed due to said engine being driven by said vehicle, said means comprising an electric circuit including a solenoid-operated valve closing said fuel passage when said solenoid is energized by the closing of said circuit, a first switch to close said circuit when said manual control is closed to said predetermined position, a second switch, electric torque sensing means associated with said drive train for producing an electric signal on reversal of torque therein and means responsive to said signal for closing said second switch.

9. In a vehicle having a drive train including an engine supplied with fuel by a carburetor having a throttle valve and an idle fuel passage, means for cutting off the fuel to said engine when said throttle valve is closed to a predetermined position and the torque in said drive train is reversed due to said engine being driven by said vehicle, said means comprising an electric circuit including a solenoid-operated valve closing said idle fuel passage when said solenoid is energized by the closing of said circuit, a first switch to close said circuit when said throttle valve is closed to said predetermined position, a second switch, electric torque sensing means associated with said drive train for producing an electric signal on reversal of torque therein, and means responsive to said signal for closing said second switch, said fuel cut-off means being rendered inoperative when said throttle valve is opened and/or said torque is again reversed by said engine driving said vehicle.

10. In a vehicle having a drive train including an engine supplied with fuel by a device having a fuel discharge passage, means for cutting off the fuel to said engine when the torque in said drive train is reversed due to said engine being driven by said vehicle, said means comprising an electric circuit including a solenoid-operated valve closing said idle fuel passage when said solenoid is energized by the closing of said circuit, a switch to close said circuit, electric torque sensing means associated with said drive train for producing an electric signal on reversal of torque therein, and means responsive to said signal for closing said switch, said fuel cut-off means being rendered inoperative when said torque is again reversed by said engine driving said vehicle.

11. In a vehicle having a drive train including an engine supplied with fuel by a device having a manual control and a fuel discharge passage, means for cutting off the fuel to said engine when said manual control is closed to a predetermined position and the torque in said drive train is reversed due to said engine being driven by said vehicle, said means comprising an electric circuit including a solenoid-operated valve closing said fuel passage when said solenoid is energized by the closing of said circuit, a first switch to close said circuit when said manual control is closed to said predetermined position, a second switch, electric torque sensing means associated with said drive train for producing an electric signal on changes of torque therein, and means responsive to said signal for closing said second switch only when said torque is reversed.

12. In a vehicle having a drive train including an engine supplied with fuel by a carburetor having a throttle valve and an idle fuel passage, means for cutting off the fuel to said engine when said throttle valve is closed to a predetermined position and the torque in said drive train is reversed due to said engine being driven by said vehicle, said means comprising an electric circuit including a solenoid-operated valve closing said idle fuel passage when said solenoid is energized by the closing of said circuit, a first switch to close said circuit when said throttle valve is closed to said predetermined position, a second switch, electric torque sensing means associated with said drive train for producing an electric signal on changes of torque therein, and means responsive to said signal for closing said second switch only when said torque is reversed, said fuel cut-off means being rendered inoperative when said throttle valve is opened and/or said torgue is again reversed by said engine driving said vehicle.

13. In a vehicle having a drive train including an engine supplied with fuel by a device having a manual control and a fuel discharge passage, means for cutting off the fuel to said engine when said manual control is closed to a predetermined position and the torgue in said drive train at one end of said engine is reversed due to said engine being driven by said vehicle, said means compris-

ing an electric circuit including a solenoid operated valve closing said fuel passage when said soleniod is energized by the closing of said circuit, a first switch to close said circuit when said manual control is closed to said predetermined position, second switch, electric torque sensing means associated with said drive train for producing an electric signal on reversal of torque therein, and means responsive to said signal for closing said second switch, said fuel cut-off means being rendered inoperative when said manual control is opened and/or said torque is again reversed by said engine driving said vehicle.

14. In a vehicle having a drive train including an engine supplied with fuel by a device having a manual control and a fuel discharge passage, means for cutting off the fuel to said engine when said manual control is closed to a predetermined position and the torque in a portion of said drive train connected to one end of said engine is reversed due to said engine being driven by said vehicle, said means comprising an electric circuit including a solenoid operated valve closing said fuel passage when said solenoid is energized by the closing of said circuit, a first switch to close said circuit when said manual control is closed to said predetermined position, a second switch, electric torque sensing means associated with said drive train for producing an electric signal on reversal of torque therein, and means responsive to said signal for closing said second switch, said fuel cut-off means being rendered inoperative when said manual control is opened and/or said torgue is again reversed by said engine driving said vehicle.

References Cited in the file of this patent

UNITED STATES PATENTS

1,813,719	White	July 7, 1931
2,741,233	McKinley	Apr. 10, 1956
2,749,894	Sariti et al.	June 12, 1956