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SAFETY CONTROL FOR AERIAL BUCKET TRUCK

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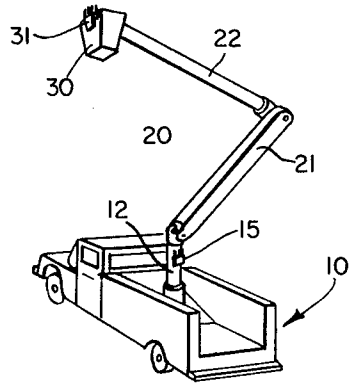



Fig. 1

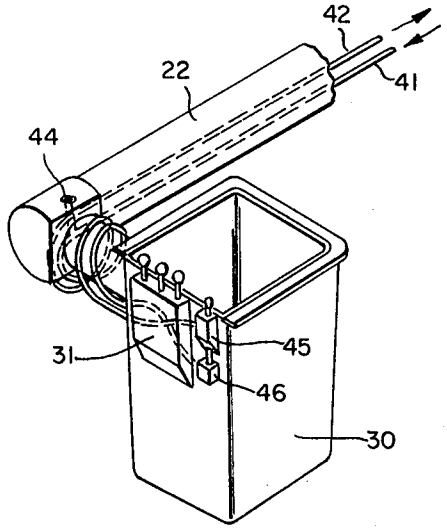



Fig. 2

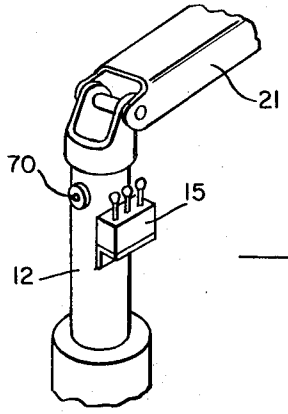
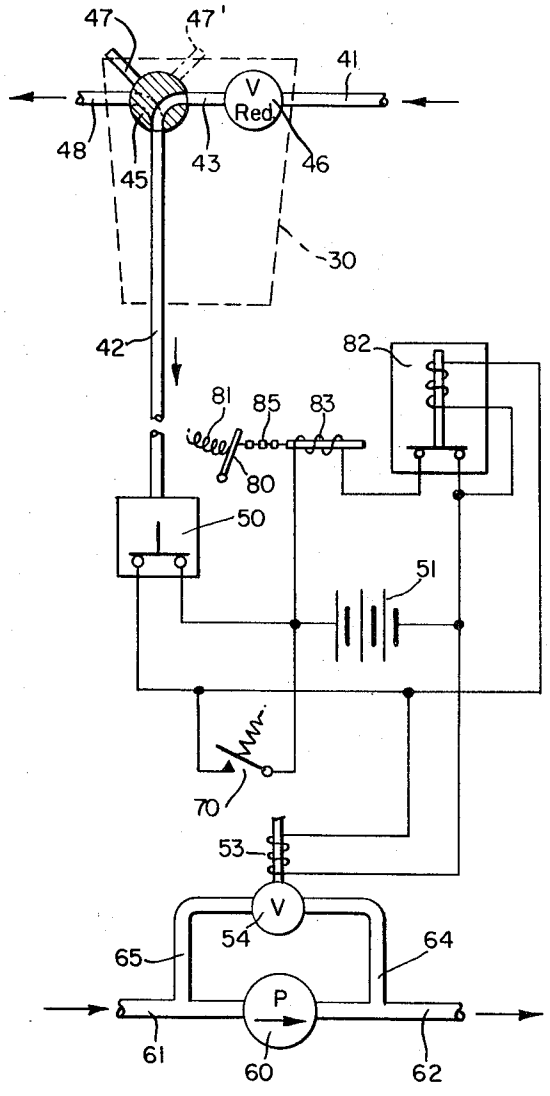



Fig. 3

Fig. 4




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3,516,514

# SAFETY CONTROL FOR AERIAL BUCKET TRUCK

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## ABSTRACT OF THE DISCLOSURE

In a hydraulically-operated aerial bucket truck, of the type used by electric utility companies for working on overhead lines and poles, a manually operable safety control is disclosed to allow the lineman, from his elevated position in the aerial bucket, to shut down the hydraulic system by utilizing the pneumatic pressure available in the bucket for driving his pneumatic tools.

## BACKGROUND OF THE INVENTION

Electric utilities conventionally use an aerial bucket truck for work on poles and overhead wires. Because the bucket and the articulated boom which carries the bucket are necessarily moved to positions close to the electric wires which may be operating at high voltages, it is necessary from a safety point of view that at least the upper leg of the boom be not made of metal or other conducting material nor carry electric wiring in order to avoid any possibility of establishing a dangerous connection between the high voltage wires and ground. Thus, in the conventional aerial bucket truck, at least the upper leg of the articulated boom is made of insulating plastic, as for example, high strength glass filament reinforced epoxy.

The insulated boom bucket truck is ordinarily supplied with two drive systems, one a drive system for driving the boom which carries the bucket, which conventionally may be a hydraulic system, and the other a pneumatic system for driving the pneumatic tools used by the lineman.

It is conventional to provide two sets of controls for the hydraulic system. One set of controls is usually located on the mast at the base of the boom in the truck body. The other set of hydraulic controls is located at the bucket itself. Thus, the boom may be moved and positioned by the lineman in the bucket. Or the boom may be manipulated by a workman down in the truck body. In the conventional system, the hydraulic controls on the mast at the base of the boom are over-riding controls, which is to say, these lower controls, when operated, will over-ride the hydraulic controls in the bucket.

In the conventional aerial bucket truck, if the hydraulic controls in the bucket become fouled by tree branches, or if other mishap should occur, resulting in hazardous movement of the boom and bucket, the lineman in the bucket can de-activate the bucket hydraulic controls and immobilize the boom by operating a lever to place a hydraulic shunt across the bucket hydraulic controls. When he does so, the lower hydraulic controls on the mast at the base of the boom in the truck body remain operative, and the boom can be manipulated by the man in the truck to bring the bucket down safely.

If, however, in the conventional truck just described, a tree or tree branch should fall across the over-riding hydraulic controls on the mast down at the base of the boom, and if, as a result thereof, the bucket and boom are caused to move out of control, the lineman in the aerial bucket has no means for stopping the boom movement. This is, of course, a very dangerous and undesirable situation.



## SUMMARY OF THE INVENTION

In accordance with the present invention, a manually operable safety control is provided in the otherwise conventional hydraulically-operated bucket truck whereby the lineman in the bucket may depressurize and thus de-activate the hydraulic system.

In accordance with the invention, an air-operated or pneumatic switch is mounted on the truck body and connected to insulating pneumatic lines extending up through the insulating articulated boom to the aerial bucket. In the presence of pneumatic pressure, the air-operated switch closes its contacts to complete an electrical circuit which includes a solenoid operated valve. This valve is made to control a bypass hydraulic shunt across the hydraulic pump. In normal operation, pneumatic pressure is applied to the air-operated switch to energize the solenoid operated valve to hold the pump bypass closed, thereby blocking flow of hydraulic fluid through the shunt path across the hydraulic pump. If, however, the over-riding hydraulic controls on the mast at the base of the boom become disabled, as by a tree branch falling thereacross, or the like, hazardous movement of the bucket may result, which the lineman cannot control because the bucket controls have been over-ridden. In such emergency, the lineman in the aerial bucket can stop the otherwise uncontrolled movement of the boom, by manually throwing a safety lever to reduce, as by venting, the pneumatic pressure in the insulating hoses extending down through the boom to the pneumatic switch on the truck body. This reduction in air pressure opens the air-operated switch, which in turn opens the electrical circuit through the solenoid operated valve, moving the valve from shut to open position. This establishes a hydraulic shunt path across the hydraulic pump and reduces the hydraulic pressure in the rest of the hydraulic system effectively to zero, thereby de-activating the hydraulic drive and stopping movement of the boom. An advantageous feature is that the pump is still running and the hydraulic system can be instantly re-activated by the lineman in the bucket or by the truck operator. As a further feature of the invention, when the pneumatic switch is released, as just described, to de-activate the hydraulic drive, the throttle of the truck motor is automatically moved in a direcion to slow down the motor, thereby avoiding racing of the motor which would otherwise occur when the hydraulic pump load was removed.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a typical aerial bucket truck;

FIG. 2 is an enlarged view of the aerial bucket showing the controls at the bucket;

FIG. 3 is an enlarged view showing the controls on the mast which supports the articulated boom;

FIG. 4 is a schematic illustration of the pneumatic means, the electrical circuit, and the hydraulic means, provided in accordance with the present invention to allow the lineman in the aerial bucket to de-activate the hydraulic drive to stop movement of the boom.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a typical aerial bucket truck **10** having in the truck body a mast **12** which supports an articulated boom **20** comprising a lower boom **21** and an upper boom **22**. The upper boom **22** is made of high strength insulating material, such as glass filament reinforced epoxy, and carries at its upper end a lineman's bucket **30**.

FIG. 2 is an enlarged view of the bucket **30** which carries the lineman. The bucket may also be made of high strength insulating material, or for bare-hand operation

at high voltage it may be metal lined or of metal to provide a Faraday cage or electrostatic screen. As shown in FIG. 2, attached to the bucket **30** is a hydraulic control box **31** having three control levers. The hydraulic control box **31** and the connections thereto are conventional, and accordingly the connections have been omitted from the drawing, but it is to be mentioned that the hydraulic lines or conduits which extend down through the boom to connect the control box **31** to the hydraulic system in the truck body are made of insulating material such as plastic. Also extending through the insulated boom are insulating air hoses or conduits, not shown, and in accordance with the present invention, an insulating hose **41** which is a tap from the compressed air supply. A compressed-air outlet connection **44** to the air supply line **41**, for driving pneumatic tools, is disposed on the upper boom **22** adjacent the bucket and within reach of the lineman.

In accordance with the invention, compressed air is supplied through tap hose **41** to an adjustable reducing valve **46**, and then is supplied, at reduced pressure, to a lever-operated emergency valve **45**, and then, by way of an insulating hose **42** is fed back down through the boom arms **22** and **21** to the pneumatic switch **50** mounted on the truck body.

FIG. 3 is an enlarged fragmentary view of the mast **12** in the truck body and shows that the mast **12** carries the over-riding hydraulic control box **15** mounted on the mast below the pivotal connection of the lower boom **21** to the mast. The over-riding hydraulic control box **15** in FIG. 3 is indicated as having three control levers, but the connections to the control box are conventional and are not shown in the drawing.

FIG. 4 illustrates schematically the means provided by the present invention to provide an additional safety control to the lineman working in the aerial bucket. In FIG. 4, the insulated bucket **30**, shown in dotted lines, is shown as having installed thereat the reducing valve **46** and the manually operable pneumatic safety valve **45**. Manual control of the valve **45** is afforded by a lever **47** which may be moved by the lineman from the solid line position to the dotted-line position identified as **47'**. When the lever **47** is in its normal solid-line position, the two-way air valve **45** connects line **43** to hose **42**, and compressed air, reduced in pressure by the reducing valve **46**, is supplied by way of insulating hose **42** down through the insulating boom **20** to the air-operated or pneumatic switch **50** mounted on the body of the truck **10**.

When compressed air from the compressed air supply is applied at reduced pressure to the normally-open switch **50**, as during normal operation, the switch **50** is held in the contact-closing position, and current from the truck battery **51** flows through the winding **53** of a normally-open solenoid valve **54** to maintain the valve **54** closed. Thus, pump **60** pumps oil from line **61** (which is connected to an oil reservoir) out through the line **62**, and the hydraulic pressure in line **62** is carried to the over-riding hydraulic control box **15** in the truck body and then up through insulating lines in the articulated boom **20** to the bucket hydraulic control box **31** to provide control at both places for the movement of the boom **20**.

As previously indicated, in the conventional truck, and also in the truck of the present invention, the hydraulic control box **15** mounted on the mast **12** in the truck body has over-riding control relative to the hydraulic control box **31** in the bucket. Thus, so long as the control box **15** is operable, a workman in the truck has over-riding control over the movement and positioning of the boom, and, so long as the over-riding controls in the truck body are operative, they may be used by a workman stationed below to protect the lineman in the bucket in the event the hydraulic controls **31** in the bucket (which in normal operation the lineman uses to move himself around) become damaged.

If, however, as previously indicated, the over-riding hydraulic controls **15** in the truck should malfunction or be damaged, as by tree or tree branches falling thereacross, neither the workman in the truck nor the lineman in the bucket has thereafter any control over the hydraulic pressure drive and the boom and bucket may be driven toward and into a high tension line, or other dangerous situation, before a workman in the truck can rush into the truck cab to shut off the truck motor. Furthermore, should the truck motor be shut down to de-activate the hydraulic system and stop the movement of the bucket, the lineman, who may perhaps be injured and/or unconscious, could be in a precarious position from which it would be desirable that he be extracted with all possible dispatch. This would generally require restarting the truck motor, which could introduce an appreciable delay.

The dangerous condition just postulated is remedied by the present invention for, in the emergency situation just described wherein the hydraulic controls **15** in the truck are damaged and can no longer control the hydraulic system, the lineman in the aerial bucket can merely throw the lever **47** from the solid line position to the dotted line position indicated in FIG. 4. This disconnects the input pressure line **43** from the hose **42**, and connects the hose **42** to the atmospheric vent line **48**. Thus, the air pressure in hose **42** is very rapidly reduced and the pneumatic switch **50** releases, opening the electrical circuit, and de-energizing the winding **53** of the solenoid valve **54**. Valve **54** opens and the hydraulic pressure in line **62** immediately drops to zero, or substantially zero, since pump **60** now only drives the oil through the bypass lines **64** and **65**. With no hydraulic pressure in the hydraulic line **62**, the boom **20** immediately stops moving and thus the danger that the uncontrolled boom and bucket would have moved into a high tension line or other dangerous position, is avoided.

The use of a pneumatic switch **50** which can be held closed by a reduced value of pneumatic pressure allows the hydraulic drive to the boom to be de-activated in a minimum of time, for when the lineman throws the lever **47** to the vent position **47'**, the pressure in hose **42** is very quickly reduced to a value equal to the release value of the air-operated switch **50**. To assure maximum speed of opening of the pneumatic switch **50**, the reducing valve **46** is adjusted for an operative pressure in the hose **42** slightly above the minimum necessary to hold the switch **50** in contact-closing position.

The lineman may immediately restore the operative condition of the pneumatic controls, as for example when the emergency is over, by restoring the lever **47** from the dotted line vent position **47'** to the solid line operating position. This action pressurizes the pneumatic switch **50** which energizes the solenoid valve **54** to close the pump bypass and restore pressure in the hydraulic system.

To allow the workman in the truck to re-activate the hydraulic pressure system after the lineman in the bucket has thrown the safety lever to the vent position, a spring-loaded push-button switch **70** is provided for the electrical circuit to short out the contacts of the air-operated switch **50**. Such push-button switch **70** may conveniently be mounted on the mast **12** in the truck body.

The push-button switch **70** is preferably spring-loaded to open position. After, or during an emergency, the truck operator may re-activate the hydraulic system regardless of the position of the emergency valve **45** by holding the switch **70** closed with one hand and he can then operate the adjacent over-riding hydraulic controls **15** with his free hand, regardless of the positioning or condition of the bucket controls.

It is apparent from the description that the present invention provides, in an aerial bucket truck, an electrically safe pneumatic-electro-hydraulic system with provides the lineman with an additional measure of safety and which is itself fail-safe so far as loss of air pressure

or loss of electric power is concerned. For, in the case of loss of air pressure and/or electric power, the hydraulic pressure is removed from the boom drive and the boom and bucket remain motionless until the defect is remedied.

As previously indicated, when the air-operated switch **50** is released to open-circuit position, and the electrical circuit is thereby opened, a relay may be operated to move the throttle of the truck motor to a slow-down position to avoid racing of the truck motor when the hydraulic load is removed. Such an arrangement is shown in FIG. 4 of the application. In FIG. 4, the throttle **80**, which controls the speed of the motor of truck **10**, is biased toward idling or slow-speed position by a biasing spring **81**. In normal operation, the air-operated switch **50** holds its contacts closed, thereby closing the circuit through the battery **51**. It will be seen that when the contacts of the air-operated switch **50** are closed, current flows not only through the winding of the solenoid valve **53** but also through the winding of a normallly-open throttle-control relay **82**, thereby closing the contacts of relay **82** and causing current to also flow through the coil of a plunger solenoid **83** whose plunger is connected by a flexible link **85** to the throttle **80** causing the solenoid plunger to pull the flexible link **85** toward the right, as viewed in FIG. 4, thereby holding the throttle **80** away from the idling position and causing the truck motor to run at the proper operative speed. The plunger-solenoid **83** may be of any suitable conventional type such as the series L solenoids marketed by Synchro-Start Products, Inc. of Skokie, Ill. When, at the time of an emergency, the lineman in the aerial bucket throws the lever **47** to the dotted line position **47'**, and air is vented from the air hose **42** as previously described, and the contacts of the air-operated valve **50** open, the circuit through the winding of the throttle relay **82** is opened and current flow therethrough is interrupted. The contacts of throttle relay **82** open and the flow of current through the winding of the solenoid **83** ceases. The plunger of the solenoid is thereupon pulled to the left by the action of the spring **81**, and the throttle **80** moves to idling position.

What is claimed is:

**1.** In an aerial bucket truck having a truck body; an insulating boom supported by said truck body; an insulating aerial bucket carried at the upper end of said boom; a hydraulic pressure system for driving said boom, said hydraulic pressure system including a pump, first hydraulic controls at said bucket for moving said boom; second hydraulic controls at said truck body for moving said boom in overriding relation to said first controls; and insulating hydraulic lines interconnecting said first and second controls; a pneumatic pressure system for supplying pneumatic pressure to the bucket for operating a lineman's tools, said pneumatic system including a source of compressed air and an insulating hose connecting system; the improvement which is characterized by the provision of:

(a) a hydraulic bypass at said truck body shunting said pump,

(b) said bypass including a solenoid valve which is open when said solenoid is not energized;

(c) an electrical circuit including a power supply, at said truck body for energizing said solenoid valve to close said valve, thereby to shut off said bypass;

(d) an air-operated switch at said truck body, said switch being coupled to said pneumatic pressure system and having contacts in said electrical circuit which are closed when air pressure is applied to said switch:

(e) a manually-operable two-position pneumatic safety valve at said aerial bucket and connected to said pneumatic pressure system and by insulating hose to said air- operated switch for controlling the supply of air pressure to said air-operated switch at said truck body;

(f) said safety valve in one position allowing air pressure from said pneumatic system to be supplied to said air-operated switch to hold the contacts of said switch in electrical-contact-closing position, said safety valve in the other position reducing the air pressure to said air-operated switch to release said switch to electrical-contact-opening position, whereby the lineman in said aerial bucket by operating the safety valve to said other position may open the electrical circuit to de-energize the solenoid valve to establish the bypass shunting said pump, thereby to remove the hydraulic pressure from the boom drive.

**2.** Apparatus according to claim **1** characterized in that:

(a) a manually-operable switch is connected in said electric circuit across the contacts of said air-operated switch for closing said electric circuit when said air-operated switch is in circuit-opening position;

(b) said manually-operable switch is disposed at said truck body in proximity to said second hydraulic controls for enabling a workman stationed at said truck body to operate said manually-operable switch simultaneously with said second hydraulic controls;

(c) whereby, while said safety valve is in said other position said workman may close said electrical circuit to close the bypass shunting the pump by operating said manually-operable switch, thus restoring hydraulic pressure to the boom drive and enabling him to operate said second hydraulic controls for causing desired movement of the boom.

**3.** Apparatus according to claim **1** characterized in that:

(a) said pump is driven by the truck motor;

(b) spring means are provided biasing the truck motor throttle toward idling position;

(c) said electrical circuit includes a throttle control relay and a throttle solenoid connected to the throttle of the truck motor, said throttle control relay being energized when said safety valve is in said one position, thereby to close an electrical circuit to energize said throttle solenoid to overcome the biasing action of said spring means and to hold said throttle at faster than idling speed, said throttle control relay being deenergized when said safety valve is in said other position, thereby to open the circuit to de-energize said throttle solenoid and allow said biasing spring means to return the throttle to idling-speed position.

**4.** In an aerial bucket truck having a truck body; an insulating boom supported by said truck body; an insulating aerial bucket carried at the upper end of said boom; a hydraulic pressure system for driving said boom, said hydraulic pressure system including a pump driven by the truck motor, first hydraulic controls at said bucket, second over-riding hydraulic controls at said truck body and insulating lines interconnecting said first and second controls; a pneumatic pressure system for supplying pneumatic pressure to the bucket for operating the lineman's tools, said pneumatic system including a source of compressed air and an insulating hose connecting system; the improvement which is characterized by the provision of:

(a) a hydraulic bypass at said truck body shunting said pump;

(b) said bypass including a solenoid valve;

(c) an electrical circuit, including a power supply, at said truck body for controlling said bypass solenoid valve to close said valve during normal operation, thereby to shut off said bypass;

(d) an air-operated switch at said truck body, said switch being coupled to said pneumatic pressure system and having contacts in said electrical circuit which are closed or open according to the condition of said air-operated switch;

(e) a manually-operable two-position safety valve at said aerial bucket and connected through said pneumatic pressure system to said air-operated switch

for controlling the condition of said air-operated switch;

(f) whereby the workman in said aerial bucket by operating the safety valve to one of its positions may actuate said air-operated switch in said truck body thereby to actuate the solenoid valve, thereby to establish a bypass to shunt said pump, thereby to remove the hydraulic pressure from the boom drive.

**5.** Apparatus according to claim **4** characterized in that:

(a) a manually-operable spring-return switch is connected in said electric circuit across the contacts of said air-operated switch for closing said electric circuit when said air-operated switch is in circuit-opening position;

(b) said spring-return switch is disposed at said truck body in proximity to said second hydraulic controls for enabling a workman stationed at said truck body to operate said spring-return switch simultaneously with said second hydraulic controls;

(c) whereby, while said safety valve is in its position for conditioning said air-operated switch to the contact-opening condition, said workman may close said electrical circuit by operating said spring-return switch.

**6.** Apparatus according to claim **4** characterized in that:

(a) spring means are provided biasing the truck motor throttle toward idling position;

(b) said electrical circuit includes a throttle control relay and a throttle solenoid connected to the throttle of the truck motor, said throttle control relay being energized when said safety valve is in said one of its positions, thereby to close a second electrical circuit to energize said throttle solenoid to overcome the biasing action of said spring means and to hold said throttle at faster than idling speed, said throttle control relay being de-energized when said safety valve is in its other position, thereby to open said second electrical circuit to de-energize said throttle solenoid, thereby to allow said biasing spring means to return the throttle to idling-speed position.

**7.** In an aerial bucket truck having a truck body; a boom supported by said truck body; an aerial bucket carried by said boom; a hydraulic pressure system for driving said boom; said hydraulic pressure system including boom-positioning controls and a pump driven by the truck motor; a pneumatic pressure system for supplying pneumatic pressure at said bucket; the improvement which is characterized by the provision of:

(a) a hydraulic bypass shunting said pump;



(b) electromechanical bypass control means in said bypass for closing said bypass upon being energized and for opening said bypass when de-energized;

(c) an electric circuit including a source of electricity for energizing said bypass control means;

(d) pnuematic switch means in said circuit for closing said circuit when pressurized and opening said circuit when depressurized;

(e) a manually-operable two-position pneumatic safety valve in said bucket adapted to connect said pneumatic switch means to said pneumatic pressure system or to an atmospheric vent, said safety valve in one position causing said pneumatic switch means to be pressurized and in the other position to be depressurized;

(f) whereby in said one position of said safety valve said bypass is closed to render said boom-positioning controls operative and in said other position of said safety valve said bypass is open and said boom-positioning controls are inoperative and said boom is immobilized.

**8.** Apparatus according to claim **7** characterized in that:

(a) spring means are provided biasing the truck motor throttle toward idling position;

(b) said electric circuit includes a throttle control relay and a throttle solenoid connected to said throttle;

(c) said throttle control relay being energized when said safety valve is in said one position, thereby to close a second electric circuit for energizing said throttle solenoid to overcome the biasing action of said spring means and to hold said throttle at faster-than-idling-speed position;

(d) said throttle relay being de-energized when said safety valve is in said other position, thereby opening said second electric circuit to de-energize said throttle solenoid and allow said spring means to return the throttle to idling-speed position.


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