March 18, 1969 G. W. FREITAG 3,433,209

ENGINE OVERSPEED CONTROL

Filed July 28, 1967 Sheet 1 of 4

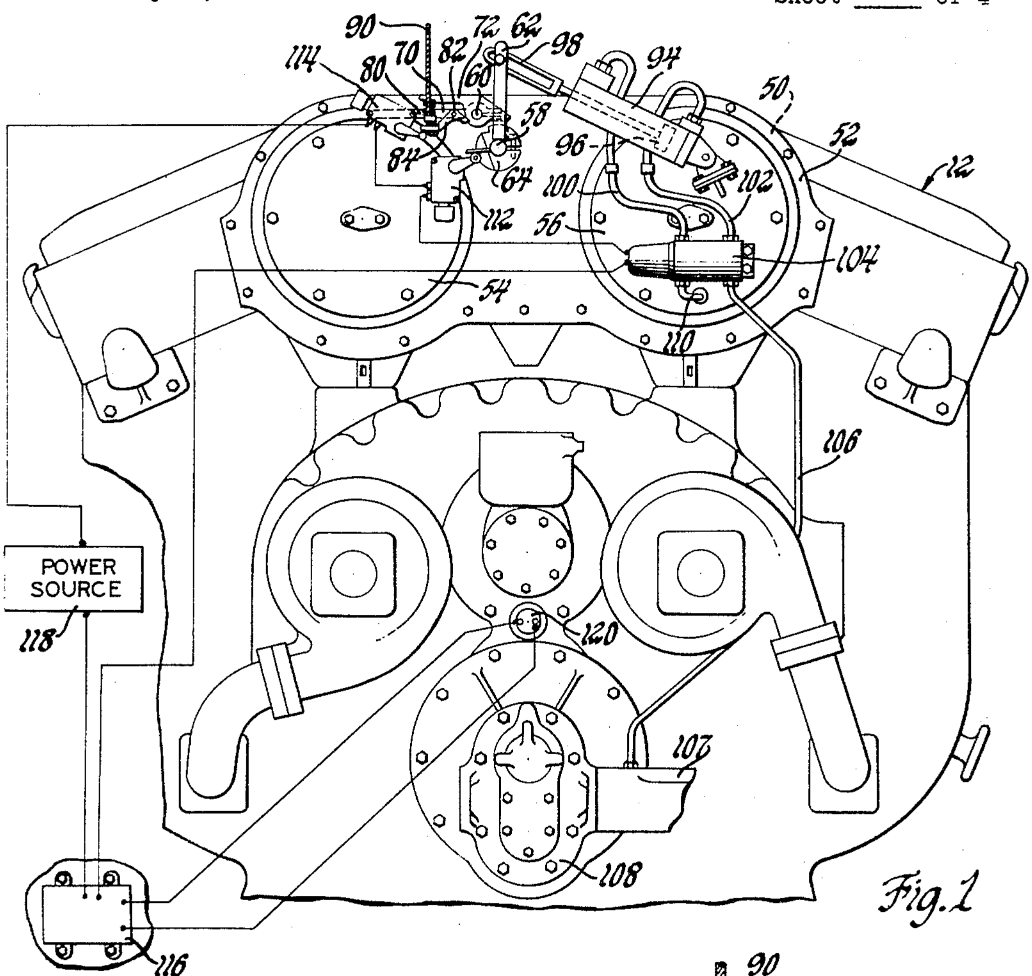

Fig. 1

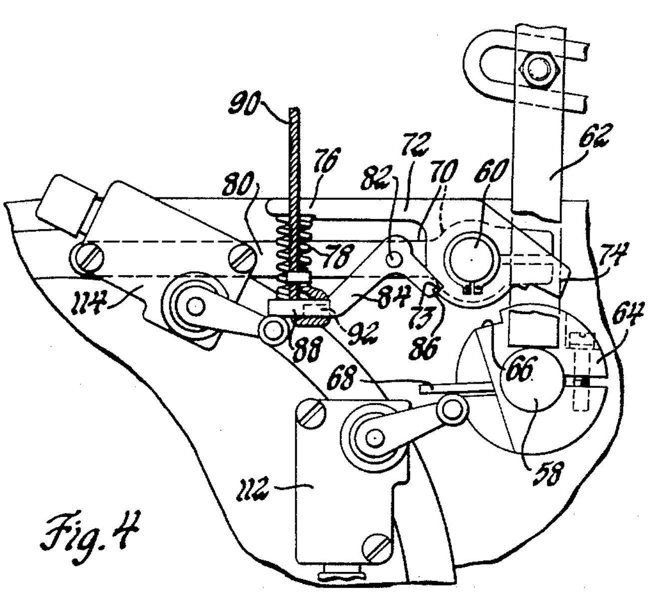

Fig. 4

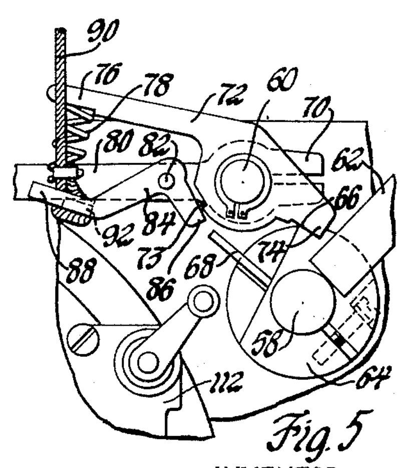

Fig. 5

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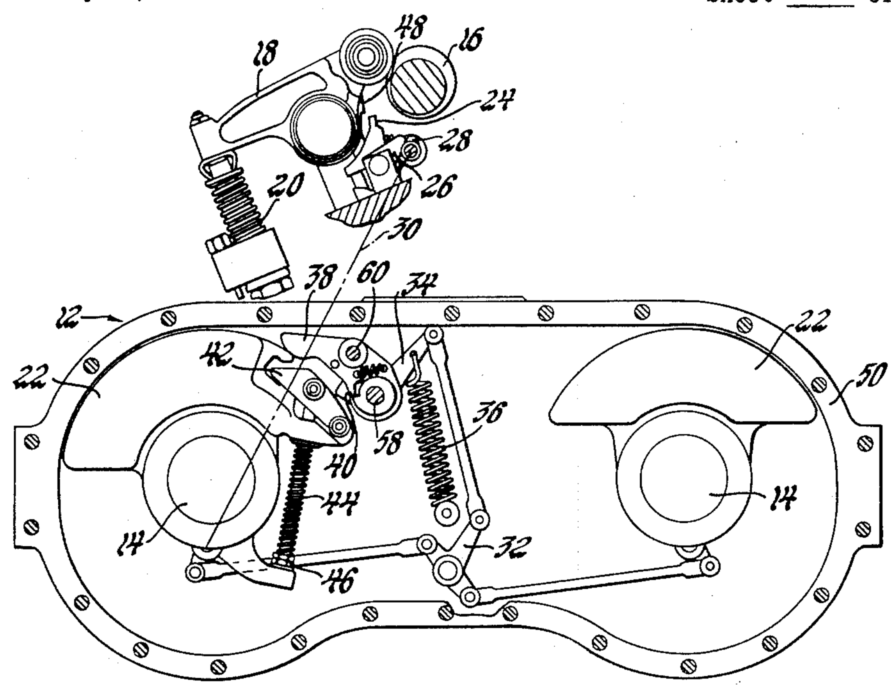

Fig. 2

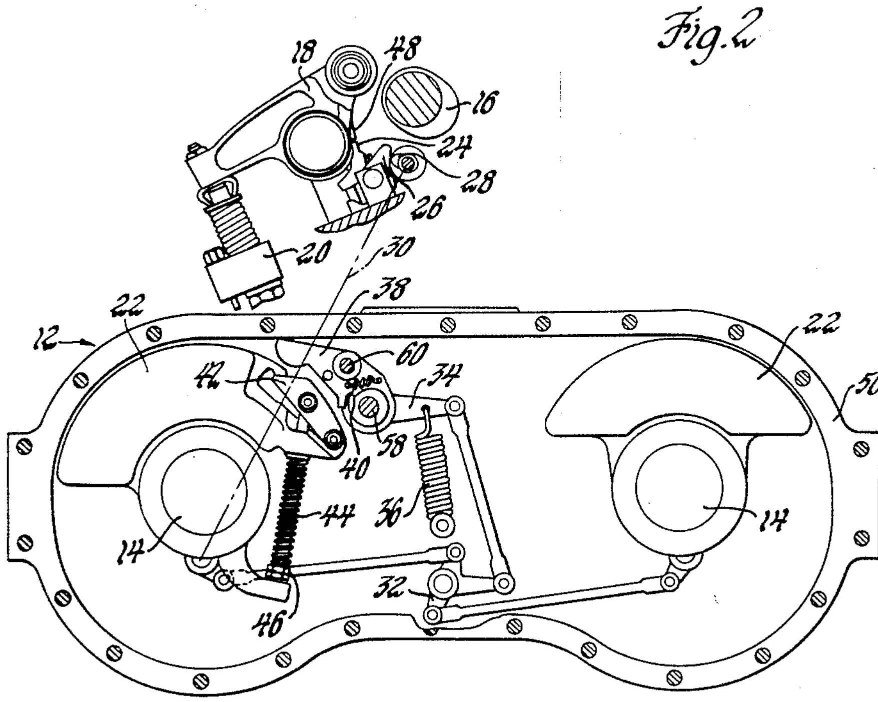

Fig. 3

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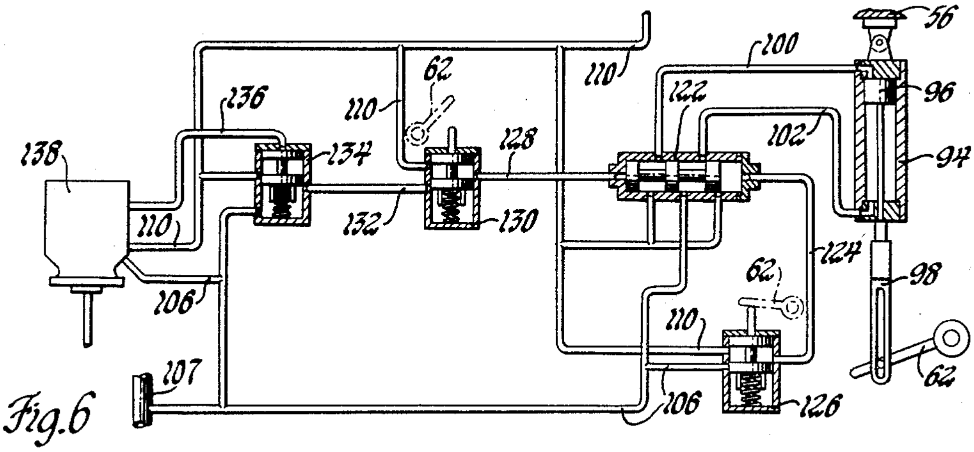

Fig.6

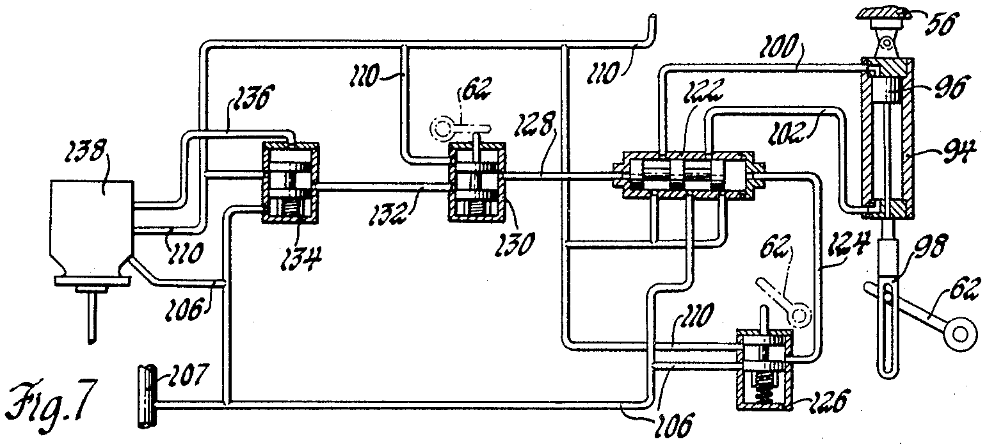

Fig.7

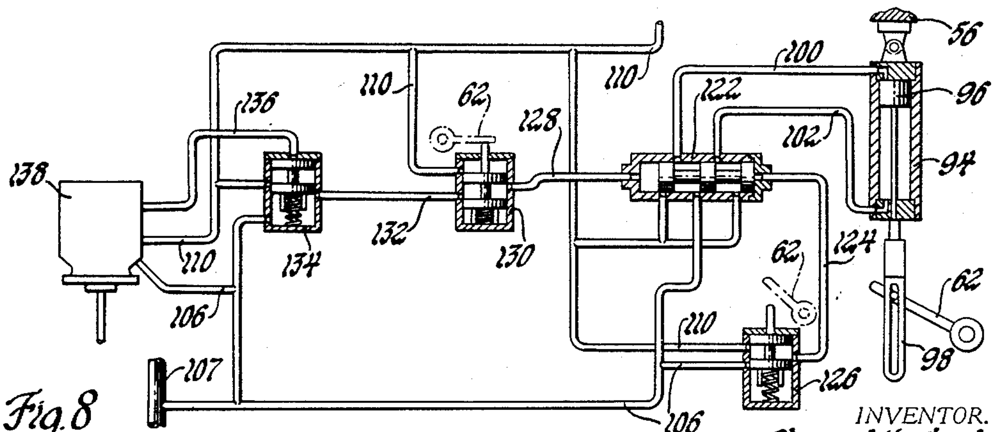

Fig.8

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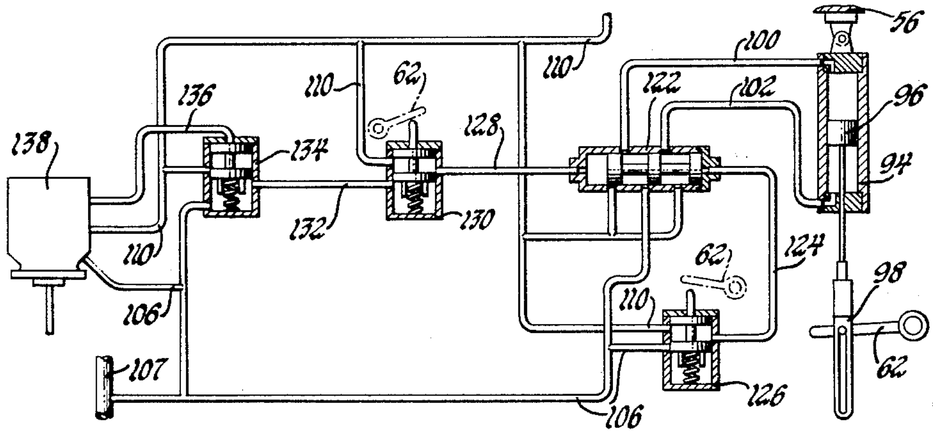

Fig. 9

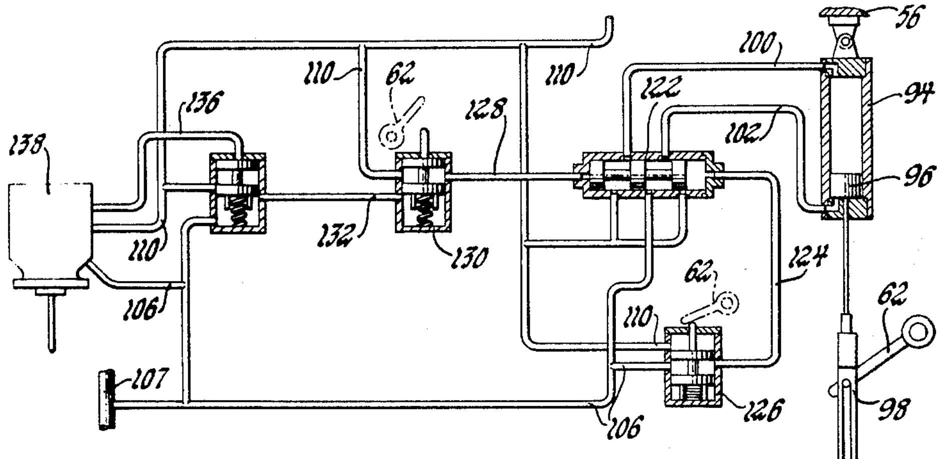

Fig. 10

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3,433,209
Patented Mar. 18, 1969

3,433,209

ENGINE OVERSPEED CONTROL

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Filed July 28, 1967, Ser. No. 656,831
U.S. Cl. 123—198 10 Claims
Int. Cl. F02d *31/00, 23/02, 1/00*

ABSTRACT OF THE DISCLOSURE

An engine overspeed control including a mechanically actuated overspeed shutdown mechanism which acts to shut off fuel injection above a preset engine speed, an automatic reset mechanism which resets the shutdown mechanism to restore normal operation when engine has dropped to a predetermined safe level and manually actuated shutdown and lockout means which manually trip the overspeed shutdown mechanism and prevent actuation of the reset mechanism to secure a complete shutdown of the engine when desired. Both electrical and hydraulic systems for controlling the reset mechanism are disclosed.

Background of the invention

This invention relates to engine protective mechanisms and more particularly to overspeed control means for an internal combustion engine arranged to provide protection against engine overspeed without complete engine shutdown but providing for manual selection of a shutdown function.

It is known in the art to provide an internal combustion engine with means to stop the engine, such as by cutting off the fuel, whenever a predetermined maximum engine speed condition has been reached. One example of such an arrangement applied to a diesel engine comprises a camshaft carried flyweight which, at a predetermined engine speed, moves outwardly under centrifugal force to actuate a trip lever so as to permit a spring actuated linkage to rotate cams against the fuel injector rocker arms, locking the arms in a depressed position and cutting off fuel to the engine cylinders. The linkage includes an external, manually operated, reset lever by which the linkage may be returned to the latched position, permitting the resumption of normal engine operation.

While such an overspeed trip mechanism is intended primarily as a safety device to prevent the engine running away upon failure of the speed control system commonly provided, there are certain engine applications, for example in marine use as the main engine of a vessel, in which it is considered desirable that the engine should not completely stop due to an overspeed condition, but that continued operation of the engine is permitted for an indeterminate period thereafter. Additionally, the provision of an manually actuated emergency shutdown mechanism is desirable.

Summary

The present invention contemplates the application to an engine, having overspeed shutdown mechanism, of means to automatically reset the shutdown mechanism after it has been tripped by an engine overspeed condition, and the engine speed has been reduced to a predetermined safe speed, so that normal engine operation may be resumed. To permit complete shutdown of the engine by the overspeed shutdown mechanism when desired, the invention provides manually actuated lockout means to hold the reset mechanism in the tripped position so as to prevent operation of the reset means. In addition, manual emergency shutdown of the engine is provided by including manual means to actuate the overspeed shutdown mechanism at will in conjunction with the lockout means to prevent operation of the reset means.

In order to provide broad utility of the invention, various specific mechanisms are included for arrangement in either electrically or hydraulically controlled systems, specific details of which are subsequently disclosed.

These and other features of the invention will be more readily apparent from the following description taken in connection with the accompanying drawings which form a part of this application.

Brief description of the drawings

In the drawings,

FIGURE 1 is a fragmentary end view of an engine having an electrically actuated overspeed shutdown control system according to the present invention;

FIGURE 2 is a partially diagrammatic view of the engine of FIGURE 1 showing internal portions of the overspeed shutdown mechanism in the reset condition;

FIGURE 3 is a view similar to FIGURE 2, but showing the overspeed shutdown mechanism in the tripped position;

FIGURE 4 is an enlarged fragmentary view of the engine of FIGURE 1 showing details of the reset member, lockout means and manual shutdown means disposed in their normal operating positions;

FIGURE 5 is a fragmentary view similar to FIGURE 4 and showing the components in their tripped positions;

FIGURES 6–10 are schematic views showing a hydraulically actuated overspeed shutdown control mechanism according to the invention in various phases of operation.

Description of the preferred embodiments

Referring now more specifically to the drawings wherein are disclosed preferred embodiments of electrical and hydraulic overspeed shutdown control systems according to the invention, FIGURE 1 illustrates an internal combustion engine of the diesel type generally indicated by numeral **12**. As shown in FIGURES 2 and 3, engine **12** includes a pair of camshafts **14** which are connected to and rotatably driven by the usual crankshaft (not shown). The camshafts include cams **16** which actuate rocker arms **18** to reciprocate the plungers of fuel injectors **20** and thereby supply metered amounts of fuel to the engine cylinders. Balance weights **22** are mounted eccentrically at the ends of camshafts **14** and rotate therewith to comprise a part of the engine balancing system.

The engine includes overspeed shutdown mechanism arranged to shut off fuel to the engine cylinders when a predetermined maximum engine speed condition is reached or exceeded. This mechanism includes a series of rocker arm engaging pawls **24** pivotally mounted with spring biased cam followers **26** which are engaged by cams **28** mounted on trip shafts **30** extending parallel to camshafts **14**. Shafts **30** are connected through suitable linkage **32** to a lever **34** biased downwardly by actuating spring **36** but normally retained in latched position as shown in FIGURE 2 by engagement of a trip lever **38** with a notch **40** located on a hub portion of trip lever **34**. A flyweight **42** is pivotally mounted on one of the balance weights **22** and is biased inwardly by a spring **44** to normally rotate with the balance weight **22**, passing close to but spaced from the end of trip lever **38**. The tension of spring **44** is adjustable by means of nuts **46** to vary the biasing force on the flyweight.

The portion of the mechanism so far described is known in the art and operates as follows. When the engine reaches a predetermined maximum speed condition, centrifugal force acting on flyweight **42** overcomes the bias of spring **44** permitting the flyweight to pivot outwardly so that it strikes the end of trip lever **38**. This dislodges lever **38** from notch **40** permitting spring **36** to actuate linkage **32**, rotating shafts **30** to force cams **28** against followers **26** and biasing pawls **24** against rocker arms **18**. When the camshafts **16** actuate the rocker arms to depress the plungers of injectors **20**, pawls **24** engage notches **48** formed in the rocker arms holding the rocker arms in their depressed positions so that further reciprocation of the injector plungers and the resulting admission of fuel to the engine cylinders is prevented. This condition is shown in FIGURE 3.

Surrounding the balance weights and portions of the overspeed shutdown mechanism at the end of the engine is a housing **50** closed by a cover **52** having spaced cylindrical openings over the individual balance weights, the openings being closed by covers **54** and **56**. Extending through cover **52** are shafts **58** and **60** which are rotatably fixed to levers **34** and **38** respectively, located internally of housing **50**.

Externally of cover **52** a reset lever **62** is secured to shaft **58** by a hub portion **64** which, as best shown in FIGURES 4 and 5, includes a notch **66** and an extending abutment **68**. Lever **62** rotates with shaft **58** and is adapted to be rotated in a counterclockwise direction, as shown in the figures, to reset the overspeed shutdown mechanism in its latched position after it has been tripped. Inboard from the end of shaft **60** a manual shutdown lever **70** is fixed. Actuation of lever **70** in a clockwise direction rotates trip lever **38**, initiating actuation of the overspeed shutdown mechanism in the same manner as if an engine overspeed condition had occurred.

Pivotally mounted on the end of shaft **60** adjacent lever **70** is a lockout lever **72** having adjacent its center a notch **73** and at one end a latch portion **74** adapted to engage notch **66** of the reset lever hub to hold the reset lever in the tripped position as shown in FIGURE 5. At the other end of lever **72** is a tail **76** which receives one end of a coil spring **78**. Lever **70** includes an extending portion **80** to which is secured a pin **82** pivotally carrying a lockout trip lever **84**. Lever **84** has at one end a latch portion **86** adapted to engage notch **73** of the lockout lever **72** to prevent its engagement with notch **66** of the reset lever. At its other end, lever **84** has a platform-like tail **88** having secured thereto one end of a manual pull cable **90** and receiving the other end of coil spring **78**. Tail **88** also includes an extending tang or abutment **92** which upon clockwise rotation of lever **84** is adapted to engage portion **80** of lever **70**.

The above-described mechanism operates as follows. When the engine is running normally, as shown in FIGURE 4, actuation of pull cable **90** rotates lever **84** in a clockwise direction removing latch portion **86** from notch **73** and permitting spring **78** to force lever **72** clockwise into engagement with hub **64** of the reset lever **62**. Upon further movement of lever **84**, tang **92** engages portion **80** of lever **70** rotating it clockwise and moving lever **38** so as to trip the overspeed shutdown mechanism, thereby shutting off the fuel to the engine cylinders as previously described. Upon tripping of the overspeed shutdown mechanism, lever **62** is rotated clockwise to the tripped position wherein latch portion **74** of lever **72** engages notch **66** holding the reset lever **62** in the tripped position and causing the engine to stop. This condition is shown in FIGURE 5.

FIGURES 1–3 disclose an electrically actuated reset mechanism applied to the previously described engine. This system incorporates a hydraulic ram **94** pivotally mounted on cover **56** and including a reciprocating piston **96** connected through a lost motion connection **98** to reset lever **62**. Piston **96** is hydraulically actuated through fluid connections **100** and **102** extending from a four-way solenoid valve **104** to the front and rear ends of the ram **94** respectively. Pressure lubricating oil is supplied to the solenoid valve **104** through a connection **106** to the outlet **107** of an engine driven lubricating oil pump **108** and a drain connection **110** is provided to return excess lubricating oil from the solenoid valve **104** to the interior of the engine. The solenoid valve is electrically connected in series with a normally open limit switch **112**, a normally closed limit switch **114**, a speed sensing switch **116** and a source of alternating current **118**. Limit switch **112** is carried on cover **54** and is normally engaged by abutment **68** of the reset lever **62**, holding the switch in the open position. Limit switch **114** is carried on portion **80** of shutdown lever **70** and is normally engaged by tail **88** of lockout trip lever **84**, holding the switch in the closed position. Speed sensing switch **116** is connected to an engine driven tachometer generator **120** which generates a voltage proportional to engine speed. Switch **116** is arranged to be open above a predetermined normal engine speed and to be closed below a second predetermined normal speed less than the first.

The operation of the electrically actuated system is as follows. If the engine overspeeds, the overspeed shutdown mechanism is tripped, as previously described, rotating lever **62** clockwise as permitted by lost motion connection **98**. This closes limit switch **112**. Limit switch **114** is already closed but, since engine speed is above the setting of switch **116**, solenoid valve **104** remains de-energized. The cut off engine fuel by the overspeed shutdown mechanism causes the engine to drop and, when it reaches the setting of switch **116**, the switch closes completing the circuit to, and energizing, solenoid valve **104**. This operates the solenoid valve to direct pressure oil from connection **106** through connection **102** against piston **96** and to drain oil on the other side of the piston through connection **100** and drain line **110**. Piston **96**, thus, moves leftwardly rotating lever **62** to its reset position and returning the engine to normal operation. When lever **62** reaches the latched position, limit switch **112** opens, de-energizing solenoid valve **104** which then returns to its original position permitting pressure oil from line **106** to pass through line **100** to the left side of the piston and draining oil on the right side through line **102** and drain line **110**. This returns the ram to its ready position but has no effect on lever **62** due to the lost motion connection **98**.

Limit switch **114** does not operate except in the case of a manual shutdown of the engine by actuation of pull cable **90** as previously described. In such an instance, clockwise movement of lever **84** opens limit switch **114** preventing the energizing of solenoid valve **104** so that complete shutdown of the engine takes place without actuation of the hydraulic ram **94**.

FIGURES 6–10 disclose schematically the arrangement of an alternative hydraulically actuated overspeed shutdown control system which may be utilized instead of portions of the electrically actuated system previously described. Certain elements in these figures are identical to those previously described and are identified by identical reference numerals. These includes the overspeed reset lever **62**, the hydraulic ram **94** with its associated components including lost motion connection **98**, connecting lines **100** and **102**, supply and drain lines **106** and **110**, each of which have various branches, and lubricating oil pump outlet **107**.

The system also includes a number of components different from those of the electrically actuated system. For example, a hydraulically actuated free-spool four-way valve **122** replaces solenoid valve **104**. Valve **122** connects with lines **100**, **102**, **106** and **110** and controls flow through these lines to and from the hydraulic ram in the same manner as the solenoid valve **104**. It is, however, operated hydraulically and for this purpose is connected at one end through line **124** with a three-way return valve **126**. Valve **126** is also connected with pressure line **106** and drain line **110** and is spring biased to normally connect line **124** to drain. The valve is actuated by lever **62** only when the lever is in a position of slight overtravel from normal latching so that in the latched position, lever **62** does not quite actuate valve **126**, leaving it in its normal position.

At its other end, four-way valve **122** is connected through line **128** to a second three-valve **130** acting as a trip valve. Valve **130** is also connected to drain line **110** as well as to a supply line **132**. It is spring biased to normally connect line **128** to drain and is actuated to connect lines **128** and **132** by contact with the reset lever **62** only when the lever is in the tripped position. Trip valve **130** connects through line **132** with a third three-way valve **134** which may be called a speed valve. Valve **134** is spring biased to normally connect line **132** with pressure line **106** but it is actuated by a hydraulic signal in a pilot line **136** to connect line **132** to drain line **110**. Line **136** is fed by an overspeed governor **138** which is driven directly by the engine at speeds proportonal to engine speed. It is arranged to supply a pressure signal to pilot line **136** whenever engine speed rises above a predetermined setting and to discontinue the pilot signal when the speed falls below a second setting somewhat less than the first.

Operation of the hydraulic system is as follows. In the normal running condition, as shown in FIGURE 6, reset lever **62** is rotated counterclockwise in its latched condition close to but not actuating valve **126** and away from valve **130**. Four-way valve **122** is in its leftward position connecting pressure line **106** through line **102** with the lower part of ram **94** so as to hold the piston **96** upwardly in its retracted or ready position as shown in the figure. Line **100** is connected to drain **110**. Both ends of four-way valve **122** are also connected to drain, the right end through line **124** and valve **126** and the left end through line **128** and valve **130** so that valve **122** remains in the leftward position. As long as engine speed remains below the setting of overspeed governor **138**, no pilot pressure is supplied to line **136** and, accordingly, line **132** is connected to pressure supply line **106**. However, this connection has no effect in this condition since it is discontinuous at valve **130**.

If engine speed rises to an overspeed condition, the overspeed shutdown mechanism trips, moving reset lever **62** clockwise as shown in FIGURE 7. This movement rotates lever **62** completely away from valve **126** and into actuating contact with valve **130** connecting line **128** with line **132**. However, the increase in engine speed prior to tripping the overspeed shutdown mechanism has caused overspeed governor **138** to apply a pilot signal through line **136** to valve **134**, actuating it downwardly and connecting line **132** to drain so that no further action occurs at this time and engine speed falls due to the shut off of fuel by the overspeed shutdown mechanism.

When engine speed has dropped to the predetermined speed setting of governor **138**, the governor cuts off the signal to line **136** permitting valve **134** to move upwardly, as shown in FIGURE 8, so as to connect pressure line **106** with line **132** and supply pressure oil through valve **130** and line **128** to valve **122**. This moves valve **122** to its rightward position connecting line **106** through line **100** with the upper part of ram **94** so as to apply a downward pressure on piston **96**. At the same time, line **102** is connected to drain relieving pressure on the underside of piston **94**.

Piston **96** of the reset ram then begins to move downwardly as shown in FIGURE 9 wherein it is seen that lost motion connection **98** has engaged reset lever **62** and moved it approximately halfway toward its latched position. As the reset lever is moved away from the tripped position, it moves out of contact with valve **130** connecting line **128** to drain and relieving pressure on the left side of valve **122**. Valve **122** still remains in the rightward position, however, since its right end is still connected to drain.

Piston **96** moves downwardly as shown in FIGURE 10 to its fully extended position at which point reset lever **62** has been moved slightly beyond the latched position to a position of slight overtravel. In this position lever **62** actuatingly contacts valve **126** moving it downwardly so as to connect pressure line **106** through line **124** with the right end of valve **122**. This moves valve **122** again to its leftward position connecting the upper end of ram **94** to drain and again supplying pressure oil to the lower end. This then causes piston **94** to move upwardly to its ready position and re-establishes the normal operating condition of FIGURE 6.

The above-described hydraulic system differs functionally from the electrical system previously described in the case of a manual shutdown, although the same result is reached. The difference is that in the hydraulic system prevention of the resetting function is obtained by relying completely on the engagement of lockout lever **72** with notch **66** of the reset lever **62** to prevent the ram from resetting the overspeed shutdown mechanism. While it would be possible to place in the hydraulic system a cut out device to forestall the attempted resetting action of the ram whenever a manual shutdown is initiated, as is done by limit switch **114** in the electrical system, such an added device has not been found to be necessary and, thus, is not included in the hydraulic system.

While applicant's invention has been presented by reference to specific embodiments incorporating certain specific aspects of the invention, it is obvious that numerous modifications or changes could be made within the scope of the inventive concept as herein disclosed and it is, accordingly, intended that the invention should not be limited except as defined by the following claims.

I claim:

1. In combination with an internal combustion engine, overspeed control means comprising
- overspeed shutdown mechanism actuable in response to engine operation above a predetermined maximum engine speed to shut off fuel to the engine,
- a movable reset member having a tripped position and a reset position, said member being connected with said shutdown mechanism such that actuation of said mechanism to shut off engine fuel moves said member to said tripped position and return of said member to said reset position resets said mechanism to again permit normal fuel flow to the engine and
- reset means responsive to engine operation below a second predetermined engine speed less than said maximum speed to actuate said reset member into said reset position whereby complete engine shutdown due to an engine overspeed is avoided.

2. The combination of claim **1** and further including manually actuable lockout means to hold said reset member in the tripped position so as to prevent actuation of said member by said reset means whereby complete engine shutdown may be accomplished by actuation of said overspeed shutdown mechanism.

3. The combination of claim **2** and further comprising manually actuable emergency shutdown means to actuate said overspeed shutdown mechanism and means adapted to actuate both said lockout means and said emergency shutdown means by a single action.

4. In combination with an internal combustion engine having a source of pressure fluid, overspeed control means comprising
- overspeed shutdown mechanism actuable in response to engine operation above a predetermined maximum engine speed to shut off fuel to the engine,
- a movable reset member having a tripped position and a reset position, said member being connected with said shutdown mechanism such that actuation of said mechanism to shut off engine fuel moves said member to said tripped position and return of said member to said reset position resets said mechanism to again permit normal fuel flow to the engine,

a fluid actuated ram secured to said engine and connected with said reset member through a lost motion connection permitting said reset member to move to the tripped position, said ram being connected with said source of pressure fluid for actuation thereby to return said reset member to the reset position and

means to control the flow of pressure fluid to said ram, said fluid control means being responsive to engine operation below a second predetermined engine speed less than said maximum speed to permit fluid actuation of said ram to reset said shutdown mechanism whereby complete engine shutdown due to an engine overspeed is avoided.

5. The combination of claim **4** wherein said fluid control means comprises

an engine driven electric generator having an output varying with engine speed,

a speed switch connected with said generator output and responsive thereto to open above a predetermined engine speed intermediate said maximum and second predetermined speeds and to close below said second predetermined engine speed,

a trip switch arranged to be actuated by said reset member so as to be open when said member is in the reset position and closed at other times and

an electric solenoid valve connected with said pressure fluid source and said ram and arranged such that when said solenoid valve is energized it directs pressure fluid to actuate said ram in a resetting direction,

said solenoid valve, said trip switch and said speed switch being connected in series with an electric power source so as to energize said solenoid valve whenever said switches are closed.

6. The combination of claim **5** and further including manual shutdown means comprising

manually actuable lockout mechanism engageable with said reset member to hold said member in the tripped position so as to prevent resetting of said overspeed shutdown mechanism by said ram,

manually actuable emergency shutdown mechanism to actuate said overspeed shutdown mechanism and

mechanical actuating means to actuate both said lockout mechanism and said emergency shutdown mechanism by a single mechanical action.

7. The combination of claim **6** and further including

a manual shutdown indicating switch arranged to be actuated by said manual shutdown means such that said indicating switch is open whenever said manual shutdown means is actuated to shutdown said engine and said indicating switch is closed at other times,

said indicating switch being connected in series with said solenoid valve, said trip switch and said speed switch whereby, upon actuation of said manual shutdown means, said indicating switch opens preventing the energizing of said solenoid valve so as to forestall resetting of said overspeed shutdown mechanism by said ram.

8. The combination of claim **4** wherein said fluid control means comprises

an engine driven hydraulic overspeed governor having a fluid pressure output varying with engine speed,

a speed valve connected with said governor output and responsive thereto to move to a first operative position during engine operation below said second predetermined speed and to move to a second operative position during engine operation above a predetermined engine speed intermediate said maximum and second predetermined speeds,

a trip valve arranged to be actuated by said reset member so as to move to a first operative position when said reset member moves away from its reset position and to move to a second operative position when said reset member moves to its reset position and

a hydraulic selector valve connected with said pressure fluid source and said ram and having a first operative position in which it directs pressure fluid to actuate said ram in a resetting direction and a second operative position in which it directs pressure fluid to actuate said ram in a returning direction,

said speed valve and said trip valve being connected in series intermedite said pressure fluid source and said hydraulic selector valve such that when both said speed valve and said trip valve are in their first operative positions pressure fluid is directed to said hydraulic selector valve moving it to its first operative position and causing actuation of said ram to reset said overspeed shutdown mechanism.

9. The combination of claim **8** and further comprising

a return valve normally positioned in a first operative position and arranged to be actuated by said reset member so as to move to a second operative position during overtravel of said reset member beyond its reset position, said return valve being connected with said pressure fluid source and said selector valve and arranged in said first operative position to drain fluid from said selector valve to permit actuation of the selector valve to its first operative position and said return valve being arranged in its second operative position to direct pressure fluid to said selector valve to move said selector valve to its second operative position and thereby cause actuation of said ram in a returning direction.

10. The combination of claim **8** and further including manual shutdown means comprising

manually actuable lockout mechanism engageable with said reset member to hold said member in the tripped position so as to prevent resetting of said overspeed shutdown mechanism by said ram,

manually actuable emergency shutdown mechanism to actuate said overspeed shutdown mechanism and

mechanical actuating means to actuate both said lockout mechanism and said emergency shutdown mechanism by a single mechanical action.

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WENDELL E. BURNS, *Primary Examiner.*

U.S. Cl. X.R.

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