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FUEL CONTROL SYSTEM FOR FUEL BURNING ENGINES

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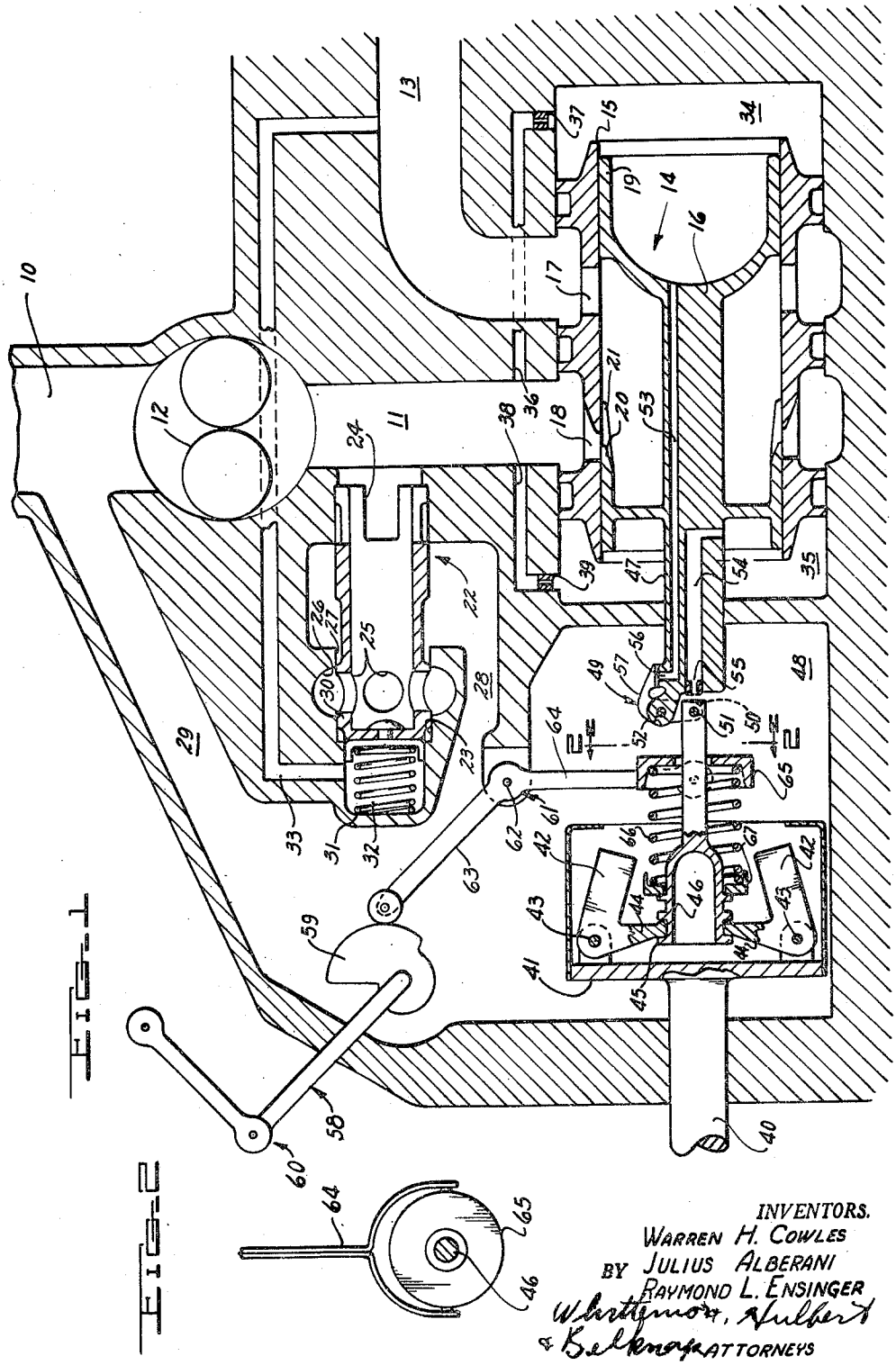


FIG. 1

FIG. 2

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FUEL CONTROL SYSTEM FOR FUEL BURNING ENGINES

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This invention relates to fuel control systems for engines of the fuel burning type.

It is an object of this invention to provide improved means for automatically regulating the flow of fuel to the engine during any preselected speed control setting to maintain the engine speed substantially uniform regardless of changes in operating conditions which have a tendency to affect the speed of the engine.

It is another object of this invention to regulate the flow of fuel under pressure from a supply passage to a delivery passage through a valve controlled orifice and to also maintain the pressure differential between the two passages substantially constant. As a result, the flow of fuel under pressure from the supply passage to the delivery passage is proportional to the effective flow area of the orifice. In other words, the pressure drop variable is omitted from consideration and more accurate control of the fuel is assured.

It is still another object of this invention to provide a fuel regulating system with a control valve having pressure chambers communicating with the supply passage and having a movable member for controlling the effective area of the orifice in response to differences in pressure in the two chambers.

It is a further object of this invention to provide the fuel control system with an element movable in opposite directions in response to variations of the engine speed and with means operated by the element for establishing the pressure differential in said chambers required to operate the control valve member.

It is still a further object of this invention to provide a lost motion mechanical connection between the element and control valve member for actuating the latter in response to movement of the element in the event of failure of the pressure means.

The foregoing as well as other objects will be made more apparent as this description proceeds especially when considered in connection with the accompanying drawing, wherein:

FIGURE 1 is a diagrammatic sectional view illustrating a fuel control system embodying the features of this invention; and

FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 1.

In FIGURE 1 of the drawing the numeral 10 indicates a source of fuel and the numeral 11 designates a supply passage for the fuel. The fuel from the source 10 is conveyed to the supply passage 11 by a pump 12 of the positive displacement type having the intake side communicating with the source and having the discharge side communicating with the supply passage 11. Thus, fuel flows under pressure through the supply passage 11. The discharge end of the supply passage 11 communicates with the receiving end of a delivery passage 13 and the latter is connected to the fuel burner of an engine, not shown herein.

The flow of fuel under pressure from the supply passage 11 to the delivery passage 13 is regulated by a control valve 14 having a fixed cylindrical casing 15 and having a valve member 16 mounted in the casing 15 for sliding movement in opposite directions. The cylindrical casing

15 has ports 17 which communicate with the receiving end of the delivery passage 13 and also has orifices 18 positioned to communicate with the discharge end of the supply passage 11.

The valve member 16 has a cylindrical enlargement 19 at the rear end for sliding engagement with the inner surface of the casing 15 beyond the ports 17 and has a second cylindrical enlargement 20 slidably engageable with the inner surface of the casing 15 adjacent the orifices 18. The cylindrical enlargement 20 overlies the orifices 18 and is recessed as at 21 to provide openings which register with the orifices 18 in the left hand position of the valve member 16 as seen in FIGURE 1. The arrangement is such that rearward movement of the valve member 16 from its illustrated position progressively to the right decreases the effective areas of the orifices 18 and hence reduces the amount of fuel flowing from the supply passage 11 to the delivery passage 13. On the other hand, movement of the valve member 16 to the left from a position wherein the orifices 18 are closed by the cylindrical enlargement 20 progressively increases the effective flow areas of the orifices 18 to correspondingly increase the flow of fuel from the supply passage 11 to the delivery passage 13.

The flow of fuel under pressure from the supply passage 11 to the delivery passage 13 varies in proportion to the effective flow area of the orifices 18 and the pressure drop across the orifices 18. In order to omit the pressure drop variable, provision is made herein for maintaining a substantially uniform pressure differential between the supply passage 11 and the delivery passage 13. For accomplishing this result, a bypass valve 22 is provided having a cylinder 23 and a valve member 24 slidably supported in the cylinder 23. The valve member 24 is in the form of a tube having the one end closed and having its other end open for communication with the supply passage 11. In addition, the valve member 24 has ports 25 through opposite side walls thereof and these ports register with an annular groove 26 formed in the adjacent wall of the cylinder 23. The annular groove 26 has a port 27 in concentric relationship to the valve member 24 and communicates with a chamber 28 which in turn is connected to the source of fuel supply 10 by a passage 29.

The valve member 24 also has annular enlargements 30 at opposite sides of the ports 25 and slidably engageable with the inner surface of the cylinder 23 at opposite sides of the groove 26 to normally prevent escape of fuel from the groove 26 through post 27. However, movement of the valve member 24 by the fuel under pressure in the supply passage 11 opens the port 27 and permits the fuel to return to the source of supply 10. Movement of the valve member 24 by the pressure of the fuel in the supply passage 11 is resisted by a coil spring 31 acting on the closed end of the valve member 24 and arranged in a space 32 which is connected to a delivery passage 13 by a passage 33. Thus, the pressure of the fuel in the delivery passage 13 supplements the force of the spring 31 to resist movement of the valve member 24 by the pressure in the supply passage 11. With this arrangement, it will be noted that should the pressure differential between the fuel supply passage 11 and the delivery passage 13 become excessive, the valve member 24 is moved by the increased pressure in the supply passage 11 so that some of the fuel is bypassed from the supply passage back to the source of supply 10. Thus, a predetermined constant pressure differential is maintained between the supply passage 11 and delivery passage 13 by the bypass valve 22.

The purpose of maintaining a predetermined uniform pressure differential between the supply passage 11 and

the delivery passage **13** is to simplify as well as assure accurate control of the flow of fuel from the supply passage **11** to the delivery passage **13**. As stated above, the valve **14** serves to regulate the amount of fuel admitted to the delivery passage **13** from the supply passage **11** and this valve is operated in response to variations in engine speed. As shown in FIGURE 1, a pair of chambers **34** and **35** are respectively provided at opposite ends of the cylindrical enlargements of the valve member **16**. The chamber **34** communicates with the supply passage **11** through a passage **36** having a restriction **37** therein. The chamber **35** is also connected to the supply passage **11** by a passage **38** having a restriction **39** identical to the restriction **37**. Thus, the pressure of fluid supplied to the two chambers **34** and **35** is equal. The pressure in the chamber **34** acts on the enlargement **19** tending to move the valve member **16** in a direction to increase the flow areas of the orifices **18** and the pressure in the chamber **35** acts on the enlargement **20** tending to move the valve member **14** in a direction to reduce the effective areas of the orifices **18**. With this arrangement, the valve member **16** may be moved in the casing **15** to regulate the flow of fuel through the orifices **18** by creating a pressure differential in the chambers **34** and **35**.

In accordance with this invention, the pressures in the respective chambers **34** and **35** are relatively varied in response to changes in the engine speed. In this connection it will be noted from FIGURE 1 that the numeral **40** indicates a shaft which is driven by the engine and is connected to a plate **41** for rotating the latter. Carried by the plate **41** are centrifugally operated weights in the form of arms **42** having ends pivoted to the plate **41** adjacent the periphery of the latter by pins **43** having their respective axis extending perpendicular to the axis of the shaft **40**. The pivoted ends of the arms **42** have extensions **44** which project inwardly and are operatively connected at their inner ends to a collar **45**. The collar **45** is journalled on a shaft **46** and is fixed against movement axially of the shaft **46**. The arrangement is such that when the arms **42** swing outwardly in response to an increase in speed of rotation of the shaft **40**, the collar **45** together with the shaft **46** is shifted to the right as seen in FIGURE 1 by the extensions **44**, and when the arms **42** swing inwardly in response to a decrease in speed of the engine shaft, the collar **45** along with the shaft **46** is shifted to the left by the extensions **44**.

The right hand end of the shaft **46** has a lost motion mechanical type connection with an extension **47** projecting from the valve member **16** of the fuel control valve **14** into a relatively low pressure chamber **48**. The lost motion mechanical connection comprises a bell crank lever **49** having an arm **50** pivoted by a pin **51** to the end of the shaft **46** and also pivoted by a pin **52** to the adjacent end of the extension **47** on the valve member **16**. The two pivots **51** and **52** are spaced from one another to enable limited relative axial movement of the shaft **46** and valve member **16**. The purpose of this lost motion mechanical connection will become apparent as this description proceeds.

Referring again to FIGURE 1 of the drawing, it will be noted that the valve member **16** is formed with two passages **53** and **54** therethrough. The passage **53** connects the chamber **34** to the relatively low pressure chamber **48** through a port **56**, and the passage **54** connects the chamber **35** to the low pressure chamber **48** through a port **55**. The port **55** is located in a position to be closed by the end of the shaft **46** when the latter is shifted in response to an increase in speed of rotation of the engine shaft **40**. The port **56** on the other hand is adapted to be closed by the other arm **57** of the bell crank lever **49** in response to a decrease in speed of rotation of the engine shaft **40**. In this connection, attention is called to the fact that the lost motion connection accomplished by the bell crank lever **49** permits the relative movement of the valve member **16** and shaft **46** required to control the port **55** and **56**.

With the construction described above, it will be noted that should the speed of rotation of the engine shaft **40** increase for some reason, the arms **42** swing outwardly and shift the shaft **46** in a direction to close the port **55** and open the port **56**. As a result, the pressure in the chamber **34** drops sufficiently below the chamber **35** to permit movement of the valve member **16** relative to the valve casing **15**. Such movement of the valve member **16** reduces the effective areas of the orifices **18** and, hence, reduces the amount of fuel introduced to the delivery passage **13**. Should the speed of rotation of the engine shaft **40** decrease, the arms **42** swing in an inward direction to impart a shifting movement to the left to the shaft **46**. Movement of the shaft **46** in such a direction opens the port **55** and also actuates the bell crank lever **49** to close the port **56**. Thus, the pressure of the fuel in the chamber **35** drops below the pressure of the fuel in the chamber **34** sufficiently to move the valve member **16** in a direction to thereby increase the effective areas of the orifices **18** and supply a greater amount of fuel to the delivery passage **13**. Thus, the amount of fuel admitted to the delivery passage **13** is varied automatically in response to variations in the speed of rotation of the engine shaft **40**. Due to the lost motion mechanical connection between the shaft **46** and the valve member **16**, a certain amount of control of the valve **14** is possible even though the pressure system should become inoperative.

In order to enable presetting the speed of the engine, manually operable control mechanism **58** is provided. This mechanism comprises a cam **59**, lever means **60** for operating the cam and a bell crank lever **61** operated by the cam **59**. The bell crank lever **61** is pivoted by a pin **62** intermediate the ends thereof for swinging movement and one arm **63** of the bell crank lever is engaged by the cam **59**. The other arm **64** of the bell crank lever is pivoted to a collar **65** mounted for sliding movement relative to the shaft **46**. The collar **65** forms an abutment for the end of a coil spring **66** having its other end engagement an abutment **67** on the shaft **46**. Thus, the collar **65** is operatively connected to the shaft **46** by the coil spring **66** enabling the valve member **16** of the control valve **14** to be adjusted by the cam **59** to obtain a preselected engine speed. The spring **66** is preloaded by the cam **59** and serves to not only permit shifting movement of the shaft **46** relative to the speed setting mechanism but, in addition, resists outward movement of the centrifugal arms **42** in response to an increase in speed of the engine shaft **40**. Thus, the movement of the shaft **46** to in turn operate the control valve **14** is controlled by the force balance between the centrifugal force output of the arms **42** and the force applied by the spring **66**.

What we claim as our invention is:

1. A motor comprising means defining a pair of pressure chambers, a movable member having piston portions movable in said chambers, motor control means having a movable part, said movable member having a pair of restricted passages terminating in a pair of outlet ports located adjacent each other and communicating respectively with said chambers, lost motion means connecting said movable part and said movable member including outlet valves controlling said outlet ports, means interconnecting said outlet valves so that as either moves toward closed position the other moves toward open position, said lost motion means and movable member including abutment portions restricting relative movement between said movable part and movable member in both directions, and means for admitting a continuous but restricted flow of fluid to both of said chambers.

2. A piston, a cylinder in which said piston is movable, said piston having an extension located outside said cylinder, means for actuating said piston including a member movable in a direction parallel to the axis of said cylinder, said piston having a pair of passages extending from opposite ends of said piston to a pair of

outlet ports located adjacent each other on said extension, means providing a continuous restricted flow of fluid under pressure into both ends of said cylinder, lost motion coupling means connecting said member and extension and including valve parts movable respectively toward and away from said ports to effect opposite variations of pressure at opposite ends of said cylinder to shift said piston, and abutments between said coupling means and extension engageable to effect mechanical movement of said piston in either direction by movement of said member.

3. A cylinder, means providing a continuous restricted flow of fluid under pressure into both ends of said cylinder, a piston in said cylinder, said piston having an extension outside said cylinder, said piston having a pair of passages extending from opposite ends of said piston to a pair of outlet ports located adjacent each other on said extension, one of said ports being at the end of said extension and the other at a side of said extension adjacent the end thereof, means comprising a member adjacent said extension and movable parallel to the axis of said cylinder, a coupling element pivoted to said member and to said extension and having valving portions normally in partly closing relation to said outlet ports and movable respectively toward and away upon movement of said member in either direction to oppositely control pressure within end portions of said cylinder to cause said piston to follow said member, said valving portions being engageable with said extension to limit pivoting of said coupling element to effect mechanical coupling of said extension and member.

4. A cylinder, means providing a continuous restricted flow of fluid under pressure into both ends of said cylinder, a piston in said cylinder, said piston having an extension outside said cylinder, said piston having a pair of passages extending from opposite ends of said piston to a pair of outlet ports located adjacent each other on said extension, means comprising a member adjacent said extension and movable parallel to the axis of said cylinder, a coupling element pivoted to said member and to said extension and having valving portions normally in partly closing relation to said outlet ports and movable respectively toward and away upon movement of said member in either direction to oppositely control pressure within end portions of said cylinder to cause said piston to follow said member, said element including abutment portions engageable with abutment portions on one of said member and element to provide for mechanical movement of said piston by said element in the absence of fluid pressure.

5. A cylinder, means providing a continuous restricted flow of fluid under pressure into both ends of said cylinder, a piston in said cylinder, said piston having an extension outside said cylinder, said piston having a pair of passages extending from opposite ends of said piston to a pair of outlet ports located adjacent each other on said extension, means comprising a member adjacent said extension and movable parallel to the axis of said cylinder, a coupling element pivoted to said member and to said extension and having valving portions normally in partly closing relation to said outlet ports and movable respectively toward and away upon movement of said member in either direction to oppositely control pressure within end portions of said cylinder to cause said piston to follow said member, said valving portions being movable into engagement with said extension to limit pivotal movement thereof coincidental with full closure of either of said outlet ports to provide for mechanical movement of said piston by said element in the absence of fluid pressure.

6. Valve mechanism for controlling the rotative speed of an engine comprising a valve body having a cylinder therein closed at both ends, a piston-like valve slidable in said cylinder and having heads at opposite ends defining pressure chambers with the closed end portions of said cylinder, a valve port in the side of said cylinder intermediate the ends thereof, said piston-like valve having a valving portion slidable across asid port to control flow of fluid therethrough, a passage for supplying fluid under pressure to said valve port, restricted passages connecting said first mentioned passage to opposite ends of said cylinder, said piston-like valve having an extension slidably received in an opening provided at one end of said cyilnder, bleed passages extending longitudinally of said extension and communicating respectively with the pressure chambers at opposite ends of said cylinder and terminating in a pair of outlet bleed ports located adjacent each other, speed responsive means adapted to be actuated by said engine and including a member movable adjacent said bleed ports, and lost motion bleed valve means connected to said member having rigidly connected bleed valve portions movable respectively toward and away from their associated bleed valve ports.

7. Valve mechanism for controlling the rotative speed of an engine comprising a valve body having a cylinder therein closed at both ends, a piston-like valve slidable in said cylinder and having heads at opposite ends defining pressure chambers with the closed end portions of said cylinder, a valve port in the side of said cylinder intermediate the ends thereof, said piston-like valve having a valving portion slidable across said port to control flow of fluid therethrough, a passage for supplying fluid under pressure to said valve port, restricted passages connecting said first mentioned passage to opposite ends of said cylinder, said piston-like valve having an extension slidably received in an opening provided at one end of said cylinder, bleed passages extending longitudinally of said extension and communicating respectively with the pressure chambers at opposite ends of said cylinder and terminating in a pair of outlet bleed ports located adjacent each other, speed responsive means adapted to be actuated by said engine and including a member movable adjacent said bleed ports, and lost motion bleed valve means connected to said member having rigidly connected bleed valve portions movable respectively toward and away from their associated bleed valve ports and being engageable therewith to effect mechanical movement of said piston-like valve by said member.

8. An engine speed governor comprising an engine speed responsive device, operator controlled means for adjusting said device to select an operating speed for the engine, servo-valve means controlled by said device, governor valve means having two opposed piston and cylinder devices connected thereto, a regulated pressure fluid source, a passage having a restriction therein connecting each of said piston and cyilnder devices to said source, a bleed passage connected to each of said piston and cylinder devices, said servo-valve means comprising separate valves controlling flow in said bleed passages, and operable by said speed responsive device to simultaneously vary the flow in said bleed passages in opposite sense, said servo-valve means and said engine speed responsive device being so constructed and arranged with respect to said governor valve means that a predetermined decrease in the pressure of said source causes said governor valve to become mechanically connected to said engine speed responsive device for the purpose of controlling the speed of the engine in an increasing and decreasing direction.

9. An engine speed governor comprising an engine speed responsive device, operator controlled means for adjusting said device to select an operating speed for the engine, servo-valve means controlled by said device, governor valve means having two opposed piston and cylinder devices connected thereto, a fuel pump, passage means connecting said fuel pump to said governor valve means, means responsive to pressure drop across said governor valve means to regulate the pressure of fuel supplied to said governor valve means, passages each having a restriction therein connecting each of said piston and cylinder devices to said passage means, a bleed passage con-

nected to each of said piston and cylinder devices, said servo-valve means comprising separate valves controlling flow in said bleed passages, and operable by said speed responsive device to simultaneously vary the flow in said bleed passages in opposite sense, said servo-valve means and said engine speed responsive device being so constructed and arranged with respect to said governor valve means that a predetermined decrease in the pressure of fuel supplied to said governor valve means causes said governor valve means to become mechanically connected to said engine speed responsive device for the purpose of controlling the speed of the engine in an increasing and decreasing direction.

References Cited in the file of this patent

UNITED STATES PATENTS

1,004,541	Martin	Sept. 26, 1911
1,258,337	Imblum	Mar. 5, 1918
2,281,372	Muller	Apr. 28, 1942
2,343,223	Pfau	Feb. 29, 1944
2,371,793	Bourland	Mar. 20, 1945
2,573,724	Neal	Nov. 6, 1951
2,612,944	Orr	Oct. 7, 1952
2,633,830	McCourty et al.	Apr. 7, 1953
2,671,860	Bevins	Mar. 9, 1954
2,711,158	Leduc	June 21, 1955
2,847,020	Anderson	Aug. 12, 1958