Dec. 20, 1927. 1,653,172

J. H. HAMMOND, JR

RADIOCONTROL OF ENGINE SPEED

Original Filed June 11, 1920 2 Sheets-Sheet 1

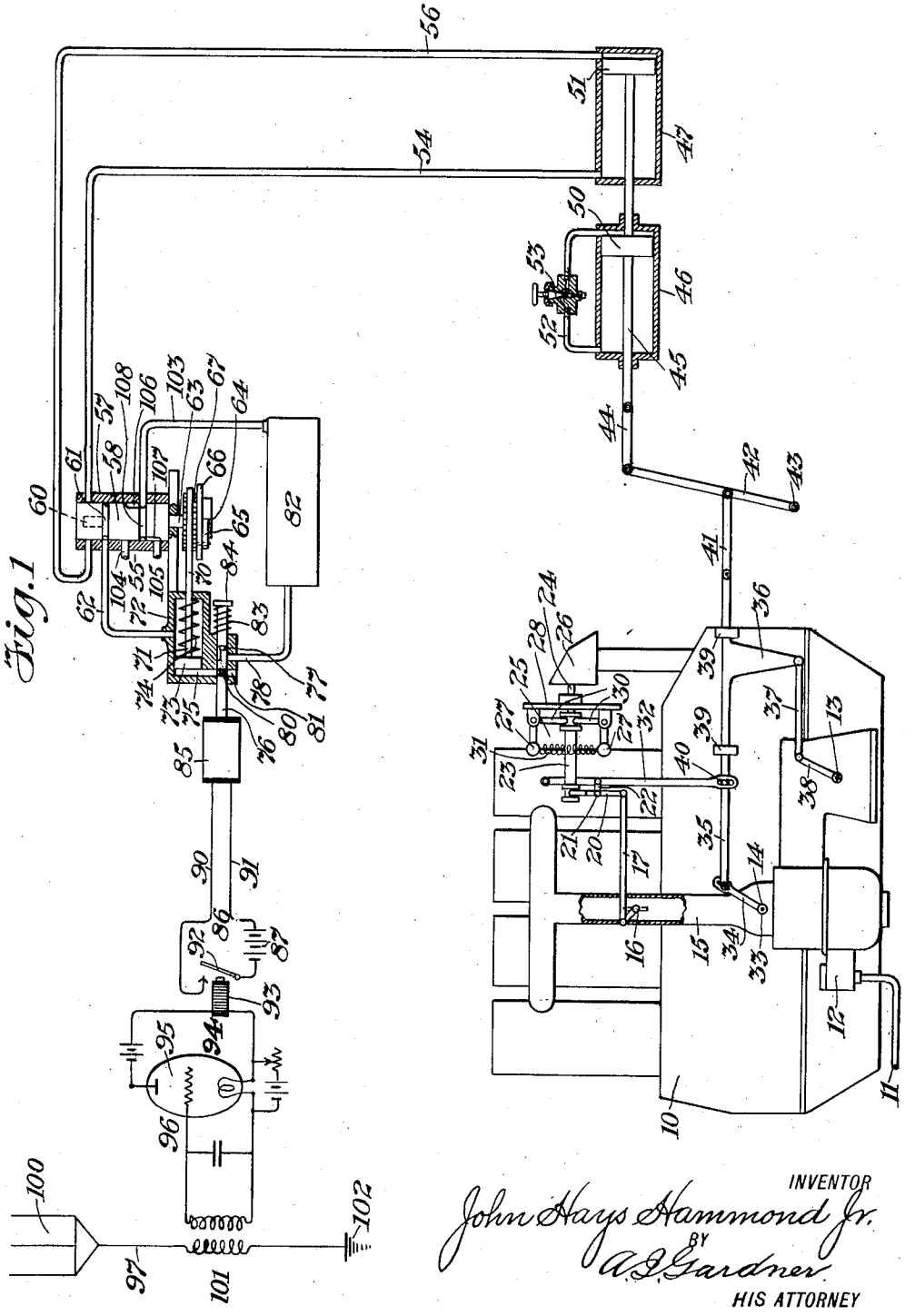


Fig. 1

INVENTOR

John Hays Hammond Jr.

BY

A. G. Gardner

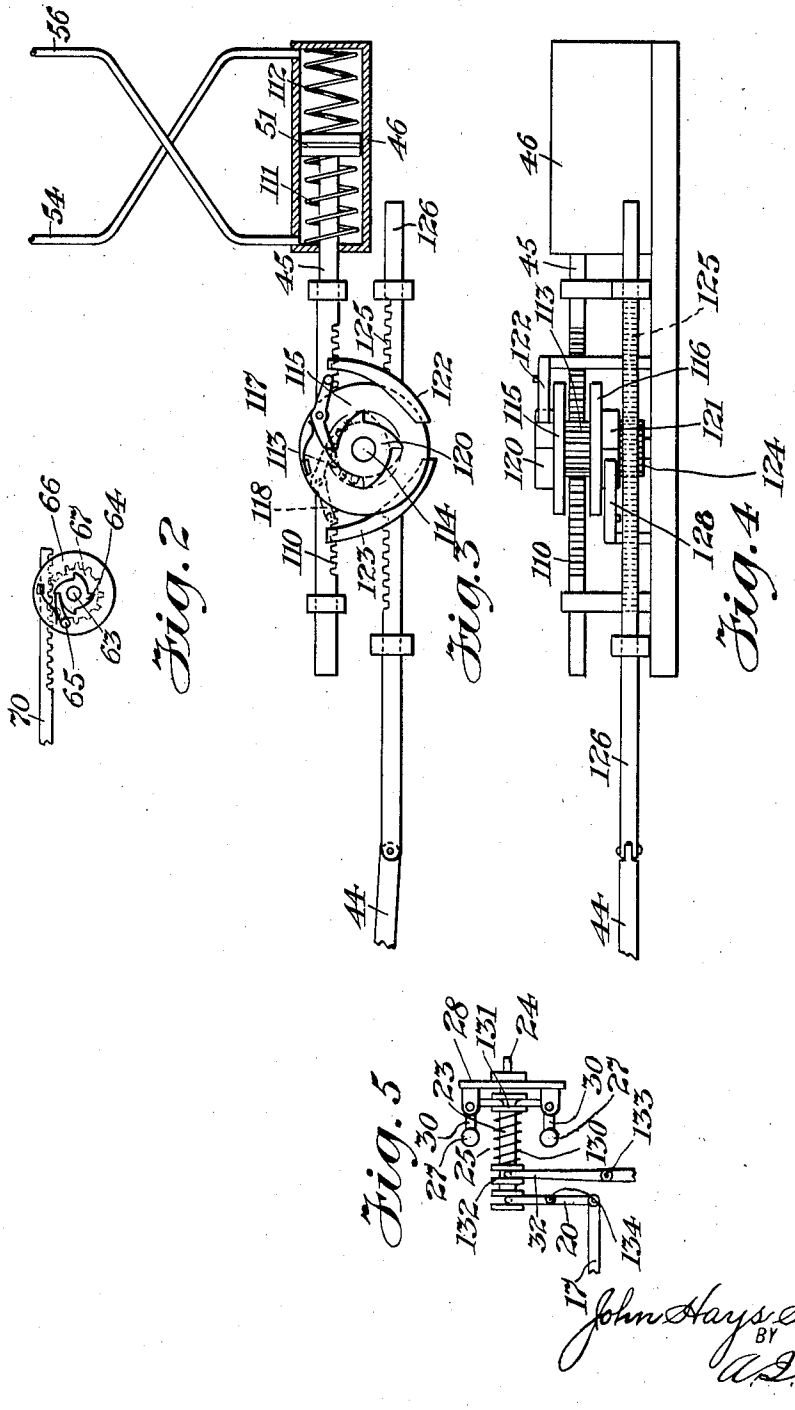
HIS ATTORNEY

Dec. 20, 1927. 1,653,172

J. H. HAMMOND, JR

RADIOCONTROL OF ENGINE SPEED

Original Filed June 11, 1920 2 Sheets-Sheet 2



INVENTOR

John Hays Hammond Jr.

BY

A. S. Gardner

HIS ATTORNEY

Patented Dec. 20, 1927. 1,653,172

UNITED STATES PATENT OFFICE.

JOHN HAYS HAMMOND, JR., OF GLOUCESTER, MASSACHUSETTS.

RADIOCONTROL OF ENGINE SPEED.

Application filed June 11, 1920, Serial No. 388,088. Renewed June 18, 1925.

Some of the objects of the present invention are to provide means for controlling the speed of an engine from a distance; to provide means operated by radiant energy for controlling the speed of an engine; to provide means for separately controlling the speed of an engine by automatic means and by means controlled from a distance by radiant energy; to provide means for varying the action of the governor of an engine in accordance with predetermined changes in speed of the engine caused by impulses of radiant energy of a predetermined character; and to provide other improvements as will hereinafter appear.

In the accompanying drawings, Fig. 1 represents diagrammatically a system of engine control embodying one form of the present invention; Fig. 2 represents a detail in side elevation of the ratchet mechanism; Fig. 3 represents a side elevation, partly in section, of a modified form of operating mechanism comprising a part of the system; Fig. 4 represents a bottom plan of the mechanism of Fig. 3; and Fig. 5 represents a detail of another embodiment of the governor controlled mechanism.

Referring to the drawings, and particularly to Fig. 1, one form of the present invention is shown as applied to an engine 10, of the explosive type, wherein a liquid fuel is supplied by a pipe 11 to a carburetor 12 having an air valve 13 for controlling the admission of air, and a main throttle valve 14 for controlling the carburetted mixture to the motor intake pipe 15.

For automatically regulating the speed of the engine 10, an auxiliary throttle valve 16 is provided, the same being located between the motor intake and the main throttle valve 14. This valve 16 is of the pivoted type having an operating rod 17 connected thereto and arranged to be operated by a link 20 which is pivoted at 21 to an arm 22 and has its opposite end secured to move with a sleeve 23 which is mounted for free sliding movement on a rotary shaft 24 of a governor 25. The shaft 24 is arranged to be driven by any suitable transmission from the shaft of the engine 10, these parts being enclosed in a casing 26. The governor 25 may be of any suitable kind but is here shown as of the ball type, having balls 27 pivotally carried by a disk 28 keyed to the shaft 24 and arranged to shift the sleeve 23 through movable arms 30 in a well known manner. A spring 31 connects the balls 27 and serves to return them to normal position upon a reduction of speed. The arm 22, which carries the fulcrum of the link 20, is secured to a movable control lever 32, the function of which will be hereinafter explained.

For the purpose of controlling or regulating the speed of the engine 10 at will from a distance, the main throttle valve 14 is arranged to be operated by an arm 33 connected by a link 34 to a reciprocatory rod 35, which is also connected through an extension 36 and a link 37 to an arm 38 which is arranged to operate the air valve 13. Suitable bearings 39 are provided to support and properly guide the rod 35 in the desired manner.

In order to transmit movement to the lever 32 to shift the fulcrum of the arm 22, the rod 35 is connected by a pin and slot connection 40 to the lever 32.

For operating the rod 35 to simultaneously change the position of the air valve 13 and the main throttle valve 14, a link 41 connects the rod 35 to a lever 42 which has one end connected to a pivot 43 and its other end connected to a link 44, which joins the projecting end of a piston rod 45. In the present construction the piston rod 45 passes through two alined cylinders 46 and 47 and carries two pistons 50 and 51, the former 50 being arranged for reciprocating movement in the cylinder 46, and the latter 51 being similarly arranged in the cylinder 47. The cylinder 46 contains oil or glycerine or any other suitable liquid, and has a conduit 52 communicating with opposite ends of the cylinder 46, this conduit 52 having a needle valve 53 by which the rate of flow of the liquid under the action of the piston 50 may be adjusted according to requirements.

As a means for shifting the piston 51 in

the direction required to either increase or decrease the speed of the engine 10, one end of the cylinder 47 communicates with a pipe 54 leading to a control valve 55, while the opposite end of the cylinder 47 communicates with a pipe 56 also leading to the control valve 55. The valve 55 is preferably of the rotary type having a fixed casing 57 containing a rotatable valve element 58 which has a distributing port 60, for pressure fluid, longitudinally disposed in its surface and arranged to continuously communicate with a circumferential groove 61 at one end and at its other end to communicate with either the pipe 54 or the pipe 56, these two pipes 54 and 56 opening through the casing 57 against the valve element 58 at diametrically opposite points. Pressure fluid is admitted to the groove 61 by way of a pipe 62, being controlled as will presently be explained.

For turning the rotary element 58 so that the desired one of the pipes 54 or 56 can be selected for the transmission of pressure fluid, the rotary element 58 is rigidly secured to a short shaft 63 which projects from one end and has a ratchet 64 keyed thereon which is arranged to be engaged and turned with a step by step movement by a spring pressed pawl 65. The pawl 65 is pivoted to the face of a plate 66 fixed to a gear 67 loosely mounted on the shaft 63 and in mesh with a rack 70 carried by a piston rod 71 which projects from one end of a cylinder 72 and terminates in a piston 73 arranged to reciprocate in said cylinder 72 under the influence of pressure fluid admitted at one end of the cylinder 72 and a spring 74 opposed to such pressure. The spring 74 normally holds the piston 73 at one end of its stroke. Pressure fluid is admitted to the cylinder 72 by way of a port 75 controlled by a slide valve 76 having an admission port 77 arranged to establish communication between the port 75 and a supply pipe 78 in one position of the slide valve 76 and also having a port 80 arranged to establish communication between the port 75 and an exhaust opening 81 when the slide valve 76 is in normal or inoperative position. The supply pipe 78 is connected to and communicates with a source of pressure fluid, such as a compressed air tank 82. The slide valve 76 is held in and returned to its normal position by a coil spring 83 held between a fixed part and a head 84 formed on the valve 76.

For shifting the slide valve 76 to operative position to admit pressure fluid to the cylinder 72 the slide valve 76 is extended to form the core of a solenoid 85 which is arranged to be energized by a circuit 86 including a battery 87, conductors 90 and 91 and a relay armature 92, the latter being operated by a relay 93 included in a circuit 94 controlled by a detector 95, an oscillatory circuit 96 and an open aerial circuit 97, this latter including an antenna 100, primary inductance 101 and a ground 102. These control circuits operate in a well known manner and are fully described in applicant's co-pending application.

In connection with the pressure fluid control, it is preferable to connect the pipe 62 to the cylinder 72 at a point requiring the piston 73 to travel an appreciable distance before opening the said pipe 62 to the pressure fluid. By this construction a short impulse or succession of short impulses serves to rotate the valve element 58 to the required position for distribution of the working fluid, but are not sufficiently long to allow the working fluid to enter the pipe 62. A long impulse, however, allows the working fluid to pass from the supply pipe 78 through the cylinder 72 and into the pipe 62 where it passes to the valve 55 and is there distributed to either pipe 54 or pipe 56 depending upon the position the valve 55 has been turned to by the long impulse.

For controlling any other suitable apparatus by pressure fluid from the rotary valve 55 a second supply pipe 103 leads from the tank 82 and is arranged to communicate with either of two pipes 104 and 105 by properly positioning the rotary element 58 to bring ports 106 and 107 respectively into operative relation with the said pipes 104 and 105 by way of a groove 108 which communicates with the pipe 103.

In the operation of the form of the invention shown in Fig. 1 the engine 10 will be assumed to be running at a slow speed with the main throttle 14 nearly closed and the air valve 13 nearly closed. When a long impulse of radiant energy is received by the antenna 100 by means of the controlled circuits energizes the solenoid 85, the slide valve 76 is pulled to the left, as seen in Fig. 1, thereby admitting air from the tank 82 to the port 75, by way of the supply pipe 78 and port 77, and causing the piston 73 to move to the right. The movement of the piston 73 causes the rack 70 to turn the gear 67 so that the pawl 65 actuates the ratchet 64 to turn the valve element 58 through one quarter of a revolution from the position shown, thus bringing the distributing port 60 into communication with the pipe 56 whereupon the pressure fluid enters the right hand end of the cylinder 47. It will be understood that the long impulse has moved the piston 73 far enough to uncover the inlet end of the pipe 62 so that the pressure fluid is admitted to the groove 61. The piston 51 is then shifted to the left, its rate of travel, however, is determined by the setting of the needle valve 53

as the cylinder 46 acts as a dash-pot. This movement shifts the lever 42 relatively slowly in a counter-clockwise direction at the predetermined rate and consequently moves the rod 35 slowly in a direction to open the main throttle 14 and the air valve 13 thereby increasing the speed of the engine.

As the engine 10 speeds up, however, the governor 25 tends to move the sleeve 23 to the left, which would rotate the link 20 about the pivot 21 on the arm 32, thus moving the rod 17 to the right and closing the auxiliary throttle which would prevent the engine from attaining a higher speed. In order to overcome this, the lever 32 is moved to the left under the action of the rod 35 and carries with it the arm 22, thus moving the fulcrum 21 of the link 20 to the left. This will carry the rod 17 to the left, thus compensating for the motion of the governor so that the auxiliary throttle valve 16 remains open. If this new speed is exceeded, however, the governor 25 will act as previously described to close the valve 16 and thus decrease the speed. The speed will, therefore, be determined by the position of the rod 35, as the links and levers have been so proportioned that when the throttle 14 is open for a certain speed the governor 25 will automatically maintain that speed due to the action of the auxiliary valve 16 which, as long as the speed is constant, will be held in a certain position but which will be closed if this speed is exceeded or opened if it is decreased as just described. The speed of the engine 10 is therefore determined by the position of the piston 51 in the cylinder 47. When the piston 51 is at an extreme right position, in the present example, the engine 10 is running at its lowest speed. When the piston 51 is at an extreme left position the engine 10 is running at its maximum speed. When the piston 51 is at any intermediate position, the engine 10 is running at a corresponding speed and is held at that speed by means of the action of the governor. When a long impulse is received the piston 51 starts to move to the left at a definite speed and continues to move until the impulse ceases, when it will stop at whatever position it is in and the engine 10 would therefore assume a speed corresponding to this position. The change in speed of the engine 10 will be determined, therefore, by the length of this long impulse and the dash-pot cylinder 46 will be so calibrated that an impulse of a certain number of seconds' duration will mean a certain motion of the piston 51 and therefore a certain change of speed of the engine 10.

If a short impulse is sent the rotary element 58 will be turned through an additional one quarter revolution, making a half a revolution from the position shown in Fig. 1, but this will not affect the engine control but will admit pressure fluid to the pipe 104 for operating any desired steering mechanism or any other control mechanism. If now another long impulse is sent, the rotary element 58 will be turned through another quarter revolution and the pressure fluid will pass from the cylinder 72 through the pipe 62 into the pipe 54 and to the left hand end of the cylinder 47, thus moving the piston 51 to the right, its speed being determined by the setting of the needle valve 53. This tends to decrease the speed of the engine in a manner similar to that described for increasing the speed, and the length of time that the impulse is sent will determine the amount of decrease of speed. It is therefore possible by sending long impulses at the proper times to increase or decrease the speed of the engine 10 to any desired amount by controlling the length of these impulses.

In the form of the invention shown in Figs. 3 and 4 the dash-pot cylinder 46 is replaced by an equivalent construction wherein the piston rod 45 is provided with a rack 110 while the piston 51 is normally held in a central position by means of springs 111 and 112, acting in opposite directions. The rack 110 meshes with a gear 113 which is loosely mounted on a shaft 114 and has fixed thereto, at opposite sides, two disks 115 and 116 which carry respectively spring pressed pawls 117 and 118 arranged to actuate respectively two ratchets 120 and 121 fast to the shaft 114. The pawl 117 and ratchet 120 are arranged to turn the shaft 114 in one direction while the pawl 118 and ratchet 121 are arranged to turn the shaft 114 in the opposite direction. The outer ends of the pawls 117 and 118 are arranged to cooperate respectively with cam members 122 and 123 so that when the shaft 114 is turned in one direction by one ratchet, the pawl of the other ratchet will be held out of its ratchet until the parts have returned to their normal position. The shaft 114 has a second gear 124 fixed thereto which is in mesh with a rack 125 formed on a rod 126 having connection with the link 44 of the operating rod 35.

In the operation of this form of the invention when pressure fluid is admitted to the pipe 56 as previously described, the piston 51 is moved to the right and by means of the rack 110 causes the gear 113 to be turned in a clockwise direction, thereby actuating the pawl 118 to turn the ratchet 121 and thus turn the shaft 114 through one quarter of a revolution in a clockwise direction. The other pawl 117 riding against the member 122 is lifted out of its ratchet 120. The rotation of the shaft 114 turns the gear 124 through a quarter of a revolution and thus moves the rack 125 to the left a distance proportional to one quarter revolution of the gear 124, and moving the link 44

to the left through a definite distance. This causes the engine 10 to increase its speed a definite amount.

When the impulse stops the piston 51 is turned to a central position under the action of the springs 111 and 112 and the pawls 117 and 118 return to their original position without turning the shaft 114, because the pawl 117 is held out of engagement with the ratchet 120 by means of the member 122. If pressure fluid is again admitted to the pipe 56, as previously described, a similar operation will occur and the rack 125 will be moved an additional increment to the left, thus causing an additional increase of speed to the engine 10.

If pressure fluid is admitted to the pipe 54 the piston 51 is moved to the left and the pawl 117 turns the shaft 114 and the gear 124 a quarter revolution in a counter-clockwise direction, thus moving the rack 125 through an increment to the right and decreasing the speed of the engine a definite amount. In this manner, by sending a suitable number of long impulses so as to allow pressure fluid to enter pipe 54 or pipe 56, as may be desired, any given number of times, the speed of the engine may be increased or decreased by definite amounts until the speed desired is obtained, where it will be held constant under the action of the governor 25, as previously described.

In Fig. 5 a modified form of governor 25 is shown wherein the governor spring 130 is coiled about the sleeve 23 bearing at one end against a collar 131 fixed to the sleeve 23 and operated by the ball arms 30 and at the other end against a collar 132 free to slide on the sleeve 23 and arranged to be moved by the control lever 32, which is here pivoted at 133. The link 20 in this instance is secured to a fixed pivot 134 instead of a movable one as in the embodiment shown in Fig. 1.

In the operation of this form of governor 25 the speed of the engine 10 is increased by moving the rod 35 to the left as previously described and as the balls 27 move outward the sleeve 23 is moved to the left so that the link 20 is swung in a counter-clockwise direction thus shifting the rod 17 which tends to close the auxiliary throttle valve 16. The control lever 32, however, being connected to the operating rod 35 is moved in a clockwise direction about the pivot 133, which moves the collar 132 to the right compressing the spring 130 thus moving the sleeve 23 to the right, thereby turning the link 20 and moving the rod 17 to the left to open the valve 16. Thus, as the speed of the engine 10 is changed by the operation of the main throttle 14 the tension in the spring 130 will be changed a corresponding amount, so that the governor 25 will keep the engine 10 running at a speed proportional to the position of the throttle valve 14 which is dependent upon the position of the piston 51 in the cylinder 47.

Having now fully described my invention, what I claim is:—

1. In a control system, an engine, means including a governor for variably controlling the speed of said engine, and means actuated by radiant energy for varying the action of said governor.

2. In a control system, an engine, means for controlling the speed of said engine, means actuated by radiant energy for operating said controlling means, a governor, and means controlled by said radiant energy actuated means for varying the action of said governor.

3. In a control system, an engine, means for supplying actuating medium to the engine, means actuated by radiant energy for varying the quantity of actuating medium delivered, and means for maintaining substantially constant the speed of the engine.

4. In a control system, an engine, means for supplying actuating medium to the engine, means actuated by radiant energy for varying the quantity of actuating medium delivered and a governor controlled by radiant energy for maintaining a desired speed.

5. In a control system, an engine, a main throttle controlling the speed of the engine, an auxiliary throttle substantially independent thereof for maintaining the speed of the engine constant, means responsive to the speed of the engine for controlling the auxiliary throttle, and means responsive to radiant energy for controlling the main throttle and said auxiliary throttle controlling means.

6. In a control system, an engine, a main throttle controlling the speed of the engine, an auxiliary throttle substantially independent thereof for maintaining the speed of the engine constant, means responsive to the speed of the engine for controlling the auxiliary throttle, means responsive to radiant energy for controlling the main throttle, and means interconnecting said main throttle controlling means and said auxiliary throttle for readjusting said auxiliary throttle controlling means when changes are made in the speed.

7. In a control system, an engine, a main throttle controlling the speed of the engine, an auxiliary throttle substantially independent thereof for maintaining the speed of the engine constant, a governor responsive to the speed of the engine for controlling the auxiliary throttle, means responsive to radiant energy for controlling the main throttle, and means interconnecting said main throttle controlling means and said auxiliary throttle for readjusting said governor when changes are made in the speed.

8. In a control system, an engine, a main throttle controlling the speed of the engine and predetermining a desired maximum speed, an auxiliary throttle for maintaining constant the speed less than the desired maximum speed, means responsive to the speed of the engine for actuating the auxiliary throttle, means responsive to radiant energy for adjusting the main throttle, and means interconnecting said last named responsive means and said auxiliary throttle for readjusting said auxiliary throttle actuated means to maintain a different desired speed.

9. In a control system, an engine, a main throttle controlling the speed of the engine and predetermining a desired maximum speed, an auxiliary throttle for maintaining constant the speed less than the desired maximum speed, means responsive to the speed of the engine for partially closing the auxiliary throttle, means responsive to radiant energy for adjusting the main throttle, and means interconnecting said last named responsive means and said auxiliary throttle for readjusting said auxiliary throttle actuated means to maintain a different desired speed.

10. In a control system, an engine, a main throttle controlling the speed of the engine and predetermining a desired maximum speed, an auxiliary throttle for maintaining constant the speed less than the desired maximum speed, means responsive to the speed of the engine for partially closing the auxiliary throttle, a governor responsive to radiant energy for adjusting the main throttle, and means interconnecting said last named responsive means and said auxiliary throttle for readjusting said governor to maintain a different desired speed.

11. In a control system, an engine, means for variably controlling the speed of said engine, means actuated by radiant energy for operating said controlling means to vary the speed of said engine, and means for damping the operation of said controlling means.

12. In a control system, an engine of the explosive type, an air valve for said engine, a throttle valve for said engine, means controlled by radiant energy for simultaneously operating said valves each to a predetermined extent, and means for damping the operation of said radiant controlled means.

13. In a control system, an engine, means for supplying actuating medium to the engine, means actuated by radiant energy for definitely controlling said supplying means, and means for rendering the operation of said controlling means sluggish.

14. In a control system, an engine, means for supplying actuating medium to the engine, means actuated by radiant energy for definitely controlling said supplying means, and adjustable means for rendering the operation of said controlling means sluggish and for varying the time lag thereof.

15. In a control system, an engine, means for supplying a mixture of air and fuel to the engine, means for variably controlling said supplying means to give a predetermined character of mixture at a predetermined speed, and means controlled by radiant energy for varying the character of the mixture.

16. In a control system, an engine, means for supplying a mixture of air and fuel to the engine, means for variably controlling said supplying means to give a predetermined character of mixture at a predetermined speed, and means controlled by radiant energy for increasing the supply of air at increased speeds.

17. In a control system, an engine, means for supplying a mixture of air and fuel to the engine, means for variably controlling said supplying means to give a predetermined character of mixture at a predetermined speed, means controlled by radiant energy for varying the speed of the engine and means operatively connected therewith for increasing the quantity of air at relatively greater speeds.

18. In a control system, a motor, means actuated by raidiant energy for varying the speed of the motor, and means operatively interposed between the varying means and the motor for rendering sluggish changes in speed.

19. In a control system, a motor, means actuated by radiant energy for varying the speed of the motor, and adjustable means operatively interposed between the varying means and the motor for varying the sluggishness of response of the motor to the varying means.

20. In a control system, an engine; a main throttle for controlling the speed of the engine, means for maintaining the speed of the engine substantially constant comprising a governor and an auxiliary throttle controlled by the governor; and means actuated by radiant energy to change the position of the main throttle and to readjust the governor to maintain the changed speed substantially constant.

21. In a control system, an engine, means including a governor for variably controlling the speed of said engine, said governor including a yielding element, a throttle, means operatively interconnecting said throttle and said governor for modifying the action of said yielding element, and means actuated by radiant energy varying the action of said governor.

22. In a control system, an engine, means including a centrifugal device for variably controlling the speed of said engine, a throttle for controlling the supply of fuel to the engine, a retractile spring acting on said

centrifugal device and operatively connected to said throttle whereby the tension of said spring is varied upon movement of said throttle, and means actuated by radiant energy for varying the action of said centrifugal device.

23. In a control system, an engine of the internal combustion type, a throttle valve for said engine, a centrifugal device for controlling the action of said throttle, yielding means acting upon said centrifugal device for varying the action thereof and means controlled by radiant energy for varying the tension of said yielding means.

Signed at Gloucester county of Essex State of Mass. this 7th day of June, 1920.

JOHN HAYS HAMMOND, JR.